Dynegy Midwest Generation, LLC
1500 Eastport Plaza Dr.
Collinsville, IL 62234

May 6, 2025

Illinois Environmental Protection Agency
DWPC – Permits MC #15
Attn: Part 845 Coal Combustion Residual Rule Submittal
2520 W Iles Ave
P.O. Box 19276
Springfield, IL 62794-9276

Re: Hennepin Power Plant West Ash Pond System; IEPA ID # W1550100002-01-03

Dear Mr. LeCrone:

In accordance with 35 I.A.C. § 845.220(c) Dynegy Midwest Generation, LLC is submitting a corrective action construction permit application for the Hennepin Power Plant West Ash Pond System (IEPA ID # W1550100002-01-03). One hard copy is provided with this submittal.

The permit application was prepared in accordance with 35 I.A.C. § 845.220 (a) and (c). This submittal includes the completed permit application forms as required by § 845.210.

Sincerely,

Cynthia Vodopivec
SVP, Environmental, Health & Safety

Enclosures

Form CCR 1	Illinois Environmental Protection Agency CCR Surface Impoundment Permit Application Form CCR 1 – General Provisions

Bureau of Water ID Number:
W1550100002-01, 03

CCR Permit Number:
No Permit Issued

Facility Name:
Hennepin Power Plant

For IEPA Use Only

SECTION 1: FACILITY, OPERATOR, AND OWNER INFORMATION (35 Ill. Adm. Code 845.210(b))

Facility, Operator, and Owner Information

1.1	Facility Name		
	Hennepin Power Plant		
1.2	Illinois EPA CCR Permit Number (if applicable)		
	No Permit Issued		
1.3	Facility Contact Information		
	Name (first and last) Phil Morris	Title Senior Director - Environmental	Phone Number 618-343-7794
	Email address phil.morris@vistracorp.com		
1.4	Facility Mailing Address		
	Street or P.O. box 1500 Eastport Plaza Dr		
	City or town Collinsville	State IL	Zip Code 62234
1.5	Facility Location		
	Street, route number, or other specific identifier 13498 East 800th Street		
	County name Putnam	County code (if known)	
	City or town Hennepin	State Illinois	Zip Code 61327
1.6	Name of Owner/Operator		
	Dynegy Midwest Generation, LLC		

Facility, Operator, and Owner Info

1.7 Owner/Operator Contact Information

Name (first and last)	Title	Phone Number
Phil Morris	Senior Director - Environmental	618-343-7794

Email address: phil.morris@vistracorp.com

1.8 Owner/Operator Mailing Address

Street or P.O. box: 1500 Eastport Plaza Dr

City or town	State	Zip Code
Collinsville	IL	62234

SECTION 2: LEGAL DESCRIPTION (35 Ill. Adm. Code 845.210(c))

Legal Description

2.1 Legal Description of the facility boundary

See Attachment A.

SECTION 3: PUBLICLY ACCESSIBLE INTERNET SITE REQUIREMENTS (35 Ill. Adm. Code 845.810)

Internet Site

3.1 Web Address(es) to publicly accessible internet site(s) (CCR website)

www.luminant.com/illinois-ccr/

3.2 Is/are the website(s) titled "Illinois CCR Rule Compliance Data and Information"

☑	Yes	☐	No

SECTION 4: IMPOUNDMENT IDENTIFICATION

Impoundment Identification

4.1 List all the impoundment identification numbers for your facility and check the corresponding box to indicate that you have attached a written description for each impoundment.

W1550100002-01 (see Attachment A)	☑	Attached written description
W1550100002-03 (see Attachment A)	☑	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description

			☐	Attached written description
			☐	Attached written description
			☐	Attached written description
			☐	Attached written description

SECTION 5: CHECKLIST AND CERTIFICATION STATEMENT

Checklist and Certification Statement

5.1 In Column 1 below, mark the sections of Form 1 that you have completed and are submitting with your application. For each section, specify in Column 2 any attachments that you are enclosing.

Column 1		Column 2	
Section 1: Facility, Operator, and Owner Information	☑	w/attachments	☐
Section 2: Legal Description	☑	w/attachments	☑
Section 3: Publicly Accessible Internet Site Requirement	☑	w/attachments	☐
Section 4: Impoundment Identification	☑	w/attachments	☑

5.2 **Certification Statement**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name (print or type first and last name) of Owner/Operator	Official Title
Cynthia Vodopivec	SVP - Environmental
Signature: Cynthia J. Vod	Date Signed: 5/6/25

Form CCR 2CA	Illinois Environmental Protection Agency CCR Surface Impoundment Permit Application Form CCR 2CA – Corrective Action Construction

Bureau of Water ID Number:
W1550100002

CCR Permit Number:
No Permit Issued

Facility Name:
Hennepin Power Plant

For IEPA Use Only

SECTION 1: DESIGN AND CONSTRUCTION PLANS (35 Ill. Adm. Code 845.220)

Design and Construction Plans

1.1	CCR surface impoundment name.
	Old West Ash Pond (Pond No. 1 and No. 3); Old West Ash Polishing Pond
1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).
	W1550100002-01,03
1.3	Describe the boundaries of the CCR surface impoundment (35 Ill. Adm. Code 845.210 (c)).
	See Attachment A
1.4	State the purpose for which the CCR surface impoundment is being used.
	See Attachment C
1.5	How long has the CCR surface impoundment been in operation?
	See Attachment C
1.6	List the types of CCR that have been placed in the CCR surface impoundment.
	See Attachment D
1.7	List the name of the watershed within which the CCR surface impoundment is located.
	See Attachment F

Design and Construction Plans (Continued)

1.8	What is the size in acres of the watershed within which the CCR surface impoundment is located?	
	See Attachment C	
1.9	Check the corresponding boxes to indicate that you have attached the following:	
	☑	Drawings satisfying the requirements of 35 Ill. Adm. Code 845.220(a)(1)(F).
	☑	A description of the type, purpose, and location of existing instrumentation.
	☑	Area capacity curves for the CCR Impoundment.
	☑	A description of each spillway and diversion design features and capacities and provide the calculations used in their determination.
	☑	The construction specifications and provisions for surveillance, maintenance, and repair of the CCR surface impoundment.
	☑	A description of the physical and engineering properties of the foundation and abutment materials on which the CCR surface impoundment is constructed.
	☑	A statement of the type, size, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR surface impoundment.
	☑	A statement of the method of site preparation and construction of each zone of the CCR impoundment.
	☑	A statement of the approximate dates of construction of each successive stage of construction of the CCR surface impoundment.
1.10.1	Is there any record or knowledge of structural instability of the CCR surface impoundment?	
	☐ Yes	☑ No
1.10.2	If you answered yes to Item 1.10.1, provide detailed explanation of the structural instability.	

SECTION 2: NARRATIVE DESCRIPTION OF THE FACILITY (35 Ill. Adm. Code 845.220)

Narrative Description

2.1	List the types of CCR expected in the CCR surface impoundments.
	See Attachment D

Narrative Description (Cont.)	2.2	Have you attached a chemical analysis of each type of expected CCR?			
		☑	Yes		
	2.3	Estimate of the maximum capacity of the surface impoundment in gallons or cubic yards.			
		See Attachment C			
	2.4	Enter the rate at which CCR and non-CCR waste streams currently enter the CCR impoundment in gallons per day and dry tons.			
		See Attachment C	GPD	See Attachment C	dTn
	2.5	Estimate length of time the CCR surface impoundment will receive CCR and non-CCR waste streams.			
		See Attachment C			
	2.6	Have you attached an on-site transportation plan that includes all existing and planned roads in the facility that will be used during the operation of the CCR surface impoundment?			
		☑	Yes		
SECTION 3: MAPS (35 Ill. Adm. Code 845.220)					
Maps	3.1	Check the corresponding boxes to indicate that you have attached the following maps:			
		☑	A site location map on the most recent United Sates Geological Survey (USGS) quadrangle of the area from the 7 ½ minute series (topographic) or on another map whose scale clearly shows the information required in 35 Ill. Adm. Code 845.220(a)(3).		
		☑	Site plans maps satisfying the requirements of 35 Ill. Adm. Code 845.220(a)(4).		
SECTION 4: ATTACHMENTS					
Attachments	4.1	Check the corresponding boxes to indicate that you have attached the following:			
		☑	A narrative description of the proposed construction of, or modification to, a CCR surface impoundment and any projected changes in the volume or nature of the CCR or non-CCR waste streams.		
		☑	Plans and specifications fully describing the design, nature, function, and interrelationship of each individual component of the facility.		
		☑	The signature and seal of a qualified professional engineer.		
		☑	Certification that the owner or operator of the CCR surface impoundment completed the public notification and public meetings required under 35 Ill. Adm. Code 845.240.		
		☑	A summary of the issues raised by the public during the public notification and public meetings.		
		☑	A summary of any revisions, determinations, or other considerations made in response to those issues raised by the public during the public notification and public meetings.		
		☑	Certification that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment are participants in a training program that is approved by and registered with the U.S. Department of Labor's Employment and Training Administration and that includes instruction in erosion control and environmental remediation.		

		☑	Certification that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment are participants in a training program that is approved by and registered with the U.S. Department of Labor's Employment and Training Administration and that includes instruction in the operation of heavy equipment and excavation.
SECTION 5: GROUNDWATER MONITORING PROGRAM			
Groundwater Monitoring	5.1	Indicate that you have attached the following components of a new groundwater monitoring program or any modifications to an existing groundwater monitoring program by checking the corresponding boxes:	
		☑	A hydrogeologic site investigation meeting the requirements of 35 Ill. Adm. Code 845.620, if applicable.
		☑	Design and construction plans of a groundwater monitoring system meeting the requirements of 35 Ill. Adm. Code 845.630.
		☑	A proposed groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data as required by 35 Ill. Adm. Code 845.640 and 845.650.
SECTION 6: CORRECTIVE ACTION (35 Ill. Adm. Code 845.220(c))			
Corrective Action	6.1	Indicate that you have attached a corrective action plan as specified in 35 Ill. Adm. Code 845.670 by checking the box below:	
		☑	Corrective action plan as specified in 35 Ill. Adm. Code 845.670.
		☑	Corrective action groundwater monitoring program, including identification of revisions to the groundwater system for corrective action.
		☑	Any interim measures necessary to reduce the contaminants leaching from the CCR surface impoundment, and/or potential exposures to human or ecological receptors, including an analysis of the factors specified in 35 Ill. Adm. Code 845.680(a)(3).
SECTION 7: GROUNDWATER MODELING (35 Ill. Adm. Code 845.220(c))			
Groundwater Modeling	7.1	Indicate that you have attached the following by checking the corresponding boxes:	
		☑	The results of groundwater contaminant transport modeling and calculations showing how the corrective action will achieve compliance with the applicable groundwater standards.
		☑	All modeling inputs and assumptions.
		☑	Description of the fate and transport of contaminants with the selected corrective action over time.
		☑	Capture zone modeling, if applicable.
		☑	Any necessary licenses and software needed to review and access both the model and the data contained within the models required by 35 Ill. Adm. Code 845.220(c)(2).

Road Map for Corrective Action
Construction Permit Application
Hennepin Power Plant, West Ash Pond System
Hennepin, IL

CONSTRUCTION PERMIT APPLICATION
Hennepin Power Plant – West Ash Pond System

Appendix A
LEGAL DESCRIPTION
§845.210(c)
Legal description of the facility

Appendix B.1
CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
§845.680(a)(1)
Plan that establishes how data will be collected, documented, and evaluated to assess remedy effectiveness

Appendix B.2
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
§845.620
Hydrogeology, groundwater quality data, conceptual site model

Appendix C
HISTORY OF CONSTRUCTION
§845.220(a)(1)
Construction and operational history of the CCR surface impoundment

Appendix D
TYPES OF CCR AND CHEMICAL CONSTITUENTS
§845.220(a)(2)(A)
Types of CCR expected in the CCR surface impoundment, including chemical analysis of each type

Appendix E & F
SITE PLAN MAP & TRANSPORTATION MAP
§845.220(a)(3) and (a)(4)
Maps showing the facility and existing CCR surface impoundments, site boundaries, groundwater monitoring wells, access roads and transportation corridors

Appendix G
CORRECTIVE ACTION PLAN
§845.670
Identifies the selected remedy based on the results of the Corrective Measures Assessment

Appendix H
GEOTECHNICAL INFORMATION
Geotechnical information and calculations to support permit-level design

Appendix I
PUBLIC NOTIFICATION
§845.220(a)(9)
Certification that public notification and public meeting have been completed required under *§845.240*

Appendix J
CONTRACTOR CERTIFICATION
415 ILCS 5/22.59(b)(4)
Certification that CCR owner/operator will utilize contractors who are participants in an approved training program

Appendix A
CORRECTIVE ACTION ALTERNATIVE ANALYSIS (CAAA)
§845.670(e)
Evaluation of potential viable corrective actions identified in the Corrective Measures Assessment

Appendix B
DRAWINGS AND MATERIAL SPECIFICATIONS
Permit-level design drawings and specifications

Appendix A
HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT
§845.670(f)(4)
Evaluation of potential risks to human and ecological receptors

Appendix B
CAAA SUPPORTING INFORMATION REPORT
§845.670(e)
Information to support preparation of CAAA

Appendix C
CORRECTIVE MEASURES ASSESSMENT
§845.660
Assessment of potential corrective measure technologies to address GWPS exceedances at the CCR surface impoundment

Appendix D
NATURE AND EXTENT REPORT AND ADDENDUM
§845.650(d)(1)
Documents the nature and extent of constituents detected above the GWPS that are attributable to the CCR surface impoundment

Appendix E
GROUNDWATER POLISHING REPORT
§845.220(c)(2)
Presents results of geochemical modeling used to evaluate chemical mechanisms on groundwater polishing under current conditions and after implementation of the corrective measure

Appendix A
FEASIBILITY LEVEL DRAWINGS
Conceptual design drawings showing approximate extents and details of alternatives presented in the CAAA

Appendix B.1
GROUNDWATER MODELING TECHNICAL MEMORANDUM
§845.220(c)(2)
Presents additional groundwater modeling simulations and incorporates data collected since 2022 modeling (Appendix B.2) to support alternatives presented in the CAAA

Appendix B.2
2022 GROUNDWATER MODELING REPORT
§845.220(c)(2)
Presents results of 2022 MODFLOW and MT3DMS groundwater flow and transport models to evaluate potential alternatives

Appendix C
LABOR/MILEAGE ESTIMATES
Detailed material quantity, labor and mileage estimates for alternatives presented in the CAAA

Legend

- New Submittal
- Updated Submittal from Previous Submittal
- Re-submitted from Previous Submittal (No Updates)

Ramboll

Road Map for Corrective Action
Construction Permit Application
Hennepin Power Plant, West Ash Pond System
Hennepin, IL

Section	Rule Text	Location of Information Demonstrating Compliance			Version History			Notes
		Document	Section or Appendix	PDF Page No. & Hyperlink	Submitted Previously	Updated Submittal	New Submittal	
Section 845.220 - Construction Permits								
845.220(a)	All construction permit applications must contain the following information and documents.							
845.220(a)(1)	Design and Construction Plans (Construction History)	CPA	Appendix C	1042	X			
845.220(a)(2)	Narrative Description of the Facility. The permit application must contain a written description of the facility with supporting documentation describing the procedures and plans that will be used at the facility to comply with the requirements of this Part. The descriptions must include, but are not limited to, the following information:	CPA	Section 2.2	18			X	
845.220(a)(2)(A)	The types of CCR expected in the CCR surface impoundment, including a chemical analysis of each type of expected CCR;	CPA	Section 2.2	18		X		
845.220(a)(2)(B)	An estimate of the maximum capacity of each surface impoundment in gallons or cubic yards;	CPA	Section 2.2	18		X		
845.220(a)(2)(C)	The rate at which CCR and non-CCR waste streams currently enter the CCR surface impoundment in gallons per day and dry tons;	CPA	Section 2.2	18		X		
845.220(a)(2)(D)	The estimated length of time the CCR surface impoundment will receive CCR and non-CCR waste streams; and	CPA	Section 2.2	18		X		
845.220(a)(2)(E)	An on-site transportation plan that includes all existing and planned roads in the facility that will be used during the operation of the CCR surface impoundment.	CPA	Section 2.2	18			X	
845.220(a)(3)	Site Location Map. All permit applications must contain a site location map on the most recent United States Geological Survey (USGS) quadrangle of the area from the 7½ minute series (topographic), or on such other map whose scale clearly shows the following information:	CPA	Appendix F	1197		X		
845.220(a)(3)(A)	The facility boundaries and all adjacent property, extending at least 1000 meters (3280 feet) beyond the boundary of the facility;	CPA	Appendix F	1197		X		
845.220(a)(3)(B)	All surface waters;	CPA	Appendix F	1197		X		
845.220(a)(3)(C)	The prevailing wind direction;	CPA	Appendix F	1197		X		
845.220(a)(3)(D)	The limits of all 100-year floodplains;	CPA	Appendix F	1197		X		
845.220(a)(3)(E)	All natural areas designated as a Dedicated Illinois Nature Preserve under the Illinois Natural Areas Preservation Act [525 ILCS 30];	CPA	Appendix F	1197		X		
845.220(a)(3)(F)	All historic and archaeological sites designated by the National Historic Preservation Act (16 USC 470 et seq.) and the Illinois Historic Sites Advisory Council Act [20 ILCS 3410]; and	CPA	Appendix F	1197		X		
845.220(a)(3)(G)	All areas identified as critical habitat under the Endangered Species Act of 1973 (16 USC 1531 et seq.) and the Illinois Endangered Species Protection Act [520 ILCS 10].	CPA	Appendix F	1197		X		
845.220(a)(4)	Site Plan Map. The application must contain maps, including cross-sectional maps of the site boundaries, showing the location of the facility. The following information must be shown:	CPA	Appendix E	1195		X		
845.220(a)(4)(A)	The entire facility, including any proposed and all existing CCR surface impoundment locations;	CPA	Appendix E	1195		X		
845.220(a)(4)(B)	The boundaries, both above and below ground level, of the facility and all CCR surface impoundments or landfills containing CCR included in the facility;	CPA	Appendix E	1195		X		
845.220(a)(4)(C)	All existing and proposed groundwater monitoring wells; and	CPA	Appendix E	1195		X		
845.220(a)(4)(D)	All main service corridors, transportation routes, and access roads to the facility.	CPA	Appendix E	1195		X		
845.220(a)(5)	A narrative description of the proposed construction of, or modification to, a CCR surface impoundment and any projected changes in the volume or nature of the CCR or non-CCR waste streams.	CPA	Section 2.4	20			X	
845.220(a)(6)	Plans and specifications fully describing the design, nature, function and interrelationship of each individual component of the facility.	CPA	Appendix G	1199			X	
845.220(a)(7)	A new groundwater monitoring program or any modification to an existing groundwater monitoring program that includes but is not limited to the following information:	CPA	Appendix B.1	34			X	
845.220(a)(7)(A)	A hydrogeologic site investigation meeting the requirements of Section 845.620, if applicable;	CPA	Appendix B.2	124	X			
845.220(a)(7)(B)	Design and construction plans of a groundwater monitoring system meeting the requirements of Section 845.630; and	CPA	Section 2.6	22			X	
845.220(a)(7)(C)	A proposed groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data, as required by Sections 845.640 and 845.650.	CPA	Appendix B.1	34			X	
845.220(a)(8)	The signature and seal of a qualified professional engineer	CPA	Section 2.7	24			X	
845.220(a)(9)	Certification that the owner or operator of the CCR surface impoundment completed the public notification and public meetings required under Section 845.240, a summary of the issues raised by the public, a summary of any revisions, determinations, or other considerations made in response to those issues, and a list of interested persons in attendance who would like to be added to the Agency's listserv for the facility.	CPA	Appendix I	2937			X	
845.220(c)	Corrective Action Construction. In addition to the requirements in subsection (a), all construction permit applications that include any corrective action performed under Subpart F must also contain the following information and documents:							
845.220(c)(1)	Corrective action plan (see Section 845.670);	CPA	Appendix G	1199			X	
845.220(c)(2)	Groundwater modeling, including:	CPA	Appendix G	1199			X	
845.220(c)(2)(A)	The results of groundwater contaminant transport modeling and calculations showing how the closure will achieve compliance with the applicable groundwater standards;	CPA	Appendix G	1199			X	

Road Map for Corrective Action
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Hennepin Power Plant, West Ash Pond System
Hennepin, IL

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845.220(c)(2)(B)	All modeling inputs and assumptions;	GWTM	Section 2	1372			X	
845.220(c)(2)(C)	Description of the fate and transport of contaminants, with the selected closure over time; and	CPA	Appendix G	1199			X	
845.220(c)(2)(D)	Capture zone modeling, if applicable.	CPA	Appendix G	1199			X	
845.220(c)(3)	Any necessary licenses and software needed to review and access both the models and the data contained within the models required by subsection (c)(2);	CPA	Section 2.9	25			X	
845.220(c)(4)	Corrective action groundwater monitoring program, including identification of revisions to the groundwater monitoring system for corrective action; and	CPA	Section 2.9	25			X	
845.220(c)(5)	Any interim measures necessary to reduce the contaminants leaching from the CCR surface impoundment, and/or potential exposures to human or ecological receptors, including an analysis of the factors specified in Section 845.680(a)(3).	CPA	Section 2.9	25			X	
Section 845.620 - Hydrogeologic Site Characterization								
845.620(a)	The owner or operator of the CCR surface impoundment must design and implement a hydrogeologic site characterization.	CPA	Appendix B.2	124	X			Additional hydrogeologic site characterization information is also provided in the Nature & Extent Report - location depicted on the visual roadmap above.
Section 845.670 - Corrective Action Plan								
845.670(b)	Within one year after completing the assessment of corrective measures as specified in 35 I.A.C. § 845.660, and after completion of the public meeting in 35 I.A.C. § 845.660(d), the owner or operator of the CCR surface impoundment must submit, in a CP application [or modification to the facility's operating permit] to IEPA, a CAP that identifies the selected remedy. This requirement applies in addition to, not in place of, any applicable standards under any other State or federal law.	CPA	Appendix G	1199			X	
845.670(c)	The CAP must meet the following requirements:							
845.670(c)(1)	Be based on the results of the CMA conducted under 35 I.A.C. § 845.660;	CAAA	Appendix C	1484				
845.670(c)(2)	Identify a selected remedy that at a minimum, meets the standards listed in subsection (d);	CAAA	Section 2	1250			X	
845.670(c)(3)	Contain the corrective action alternatives analysis specified in subsection (e); and	CAAA	Section 2	1250			X	
845.670(c)(4)	Contain proposed schedules for implementation, including an analysis of the factors in subsection (f).	CAP	Table 2	1221			X	
845.670(d)	The selected remedy in the CAP must:							
845.670(d)(1)	Be protective of human health and the environment;	CAAA	Section 2.2.1	1256			X	
845.670(d)(2)	Attain the GWPS specified in 35 I.A.C. § 845.600;	GWTM	Section 4	1385			X	
845.670(d)(3)	Control the sources of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents listed in 35 I.A.C. § 845.600 into the environment;	CAAA	Section 2.2.2	1257			X	
845.670(d)(4)	Remove from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and	CAAA	Section 2.5	1271			X	
845.670(d)(5)	Comply with standards for management of wastes as specified in 35 I.A.C. § 845.680(d).	CAAA	Section 2	1250				
845.670(e)	CAAA. In selecting a remedy that meets the standards of subsection (d), the owner or operator of the CCR surface impoundment must consider the following evaluation factors:							
845.670(e)(1)	The long- and short-term effectiveness and protectiveness of each potential remedy, along with the degree of certainty that the remedy will prove successful based on consideration of the following:	CAAA	Section 2.2	1256			X	
845.670(e)(1)(A)	Magnitude of reduction of existing risks;	CAAA	Section 2.2.1	1256			X	
845.670(e)(1)(B)	Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;	CAAA	Section 2.2.3	1258			X	
845.670(e)(1)(C)	The type and degree of long-term management required, including monitoring, operation, and maintenance;	CAAA	Section 2.2.4	1258			X	
845.670(e)(1)(D)	Short-term risks that might be posed to the community or the environment during implementation of a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants;	CAAA	Section 2.2.5	1259			X	
845.670(e)(1)(E)	Time until GWPS in 35 I.A.C. § 845.600 are achieved;	CAAA	Section 2.2.6	1264			X	
845.670(e)(1)(F)	The potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, containment, or changes in groundwater flow;	CAAA	Section 2.2.7	1265			X	
845.670(e)(1)(G)	The long-term reliability of the engineering and institutional controls, including an analysis of any off-site, nearby destabilizing activities; and	CAAA	Section 2.2.8	1266			X	
845.670(e)(1)(H)	Potential need for replacement of the remedy.	CAAA	Section 2.2.9	1267			X	
845.670(e)(2)	The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of each of the following potential factors:	CAAA	Section 2.2.2	1257			X	
845.670(e)(2)(A)	The extent to which containment practices will reduce further releases; and	CAAA	Section 2.2.2	1257			X	
845.670(e)(2)(B)	The extent to which treatment technologies may be used.	CAAA	Section 2.2.2	1257			X	
845.670(e)(3)	The ease or difficulty of implementing each potential remedy based on consideration of the following types of factors:	CAAA	Section 2.3	1267			X	
845.670(e)(3)(A)	Degree of difficulty associated with constructing the technology;	CAAA	Section 2.3.1	1267			X	
845.670(e)(3)(B)	Expected operational reliability of the technologies;	CAAA	Section 2.3.2	1268			X	

Road Map for Corrective Action
Construction Permit Application
Hennepin Power Plant, West Ash Pond System
Hennepin, IL

Section	Rule Text	Location of Information Demonstrating Compliance			Version History			Notes
		Document	Section or Appendix	PDF Page No. & Hyperlink	Submitted Previously	Updated Submittal	New Submittal	
845.670(e)(3)(C)	Need to coordinate with and obtain necessary approvals and permits from other agencies;	CAAA	Section 2.3.3	1269			X	
845.670(e)(3)(D)	Availability of necessary equipment and specialists; and	CAAA	Section 2.3.4	1269			X	
845.670(e)(3)(E)	Available capacity and location of needed treatment, storage, and disposal services.	CAAA	Section 2.3.5	1270			X	
845.670(e)(4)	The degree to which community concerns are addressed by each potential remedy.	CAAA	Section 2.4	1271			X	
845.670(f)	The owner or operator must specify, as part of the CAP, a schedule for implementing, of and completing, remedial activities. The schedule must require the completion of remedial activities within a reasonable time, taking into consideration the factors in this subsection (f). The owner or operator of the CCR surface impoundment must consider the following factors in determining the schedule of remedial activities:							
845.670(f)(1)	Extent and nature of contamination, as determined by the characterization required under 35 I.A.C. § 845.650(d);	CAP	Section 3.3	1213			X	
845.670(f)(2)	Reasonable probabilities of remedial technologies achieving compliance with the GWPS established by 35 I.A.C. § 845.600 and other objectives of the remedy;	CAP	Section 3.3	1213			X	
845.670(f)(3)	Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;	CAP	Section 3.3	1213			X	
845.670(f)(4)	Potential risks to human health and the environment from exposure to contamination before completion of the remedy;	CAP	Section 3.3	1213			X	
845.670(f)(5)	Resource value of the aquifer, including:							
845.670(f)(5)(A)	Current and future uses, including potential residential, agricultural, commercial industrial and ecological uses;	CAP	Section 3.3	1213			X	
845.670(f)(5)(B)	Proximity and withdrawal rate of users;	CAP	Section 3.3	1213			X	
845.670(f)(5)(C)	Groundwater quantity and quality;	CAP	Section 3.3	1213			X	
845.670(f)(5)(D)	The potential impact to the subsurface ecosystem, wildlife, other natural resources, crops, vegetation, and physical structures caused by exposure to CCR constituents;	CAP	Section 3.3	1213			X	
845.670(f)(5)(E)	The hydrogeologic characteristic of the facility and surrounding land; and	CAP	Section 3.3	1213			X	
845.670(f)(5)(F)	The availability of alternative water supplies; and	CAP	Section 3.3	1213			X	
845.670(f)(6)	Other relevant factors.	CAP	Section 3.3	1213			X	
Section 845.680 Implementation of the Corrective Action Plan								
845.680(a)	Within 90 days after the Agency's approval of the corrective action plan submitted under Section 845.670, the owner or operator must initiate corrective action. Based on the schedule approved by the Agency for implementation and completion of corrective action, the owner or operator must:							
845.680(a)(1)	Establish and implement a corrective action groundwater monitoring program that:							
845.680(a)(1)(A)	At a minimum, meets the requirements of the monitoring program under Section 845.650;	CA GMP	Section 2.1	44			X	
845.680(a)(1)(B)	Documents the effectiveness of the corrective action remedy; and	CA GMP	Section 3	48			X	
845.680(a)(1)(C)	Demonstrates compliance with the groundwater protection standard under subsection (c).	CA GMP	Section 3	48			X	
845.680(a)(2)	Implement the corrective action remedy approved by the Agency under Section 845.670; and	CAP	Section 1.4	1205			X	
845.680(a)(3)	Take any interim measures necessary to reduce the contaminants leaching from the CCR surface impoundment, and/or potential exposures to human or ecological receptors. Interim measures must, to the greatest extent feasible, be consistent with the objectives of, and contribute to the performance of, any remedy that may be required by Section 845.670. The following factors must be considered by an owner or operator in determining whether interim measures are necessary:							
845.680(a)(3)(A)	Time required to develop and implement a final remedy;	CAP	Section 3.4	1216			X	
845.680(a)(3)(B)	Actual or potential exposure of nearby populations or environmental receptors to any of the constituents listed in Section 845.600;	CAP	Section 3.4	1216			X	
845.680(a)(3)(C)	Actual or potential contamination of sensitive ecosystems or current or potential drinking water supplies;	CAP	Section 3.4	1216			X	
845.680(a)(3)(D)	Further degradation of the groundwater that may occur if remedial action is not initiated expeditiously;	CAP	Section 3.4	1216			X	
845.680(a)(3)(E)	Weather conditions that may cause any of the constituents listed in Section 845.600 to migrate or be released;	CAP	Section 3.4	1216			X	
845.680(a)(3)(F)	Potential for exposure to any of the constituents listed in Section 845.600 as a result of an accident or failure of a container or handling system; and	CAP	Section 3.4	1216			X	
845.680(a)(3)(G)	Other situations that may pose threats to human health and the environment.	CAP	Section 3.4	1216			X	

Notes:
CAA = Closure Alternatives Analysis
CAAA = Corrective Action Alternatives Analysis
CAP = corrective action plan
CCR = coal combustion residuals
CMA = Corrective Measures Assessment
CPA = Construction Permit Application
GMP = Groundwater Monitoring Plan
GWPS = groundwater protection standards
GWTM = Groundwater Modeling Technical Memorandum
HCR = Hydrogeologic Site Characterization Report
IEPA = Illinois Environmental Protection Agency

Intended for
Dynegy Midwest Generation, LLC
13498 E 800th St
Hennepin, Illinois 61327

Date
May 6, 2025

Project No.
1940110241-006

CONSTRUCTION PERMIT APPLICATION FOR GROUNDWATER CORRECTIVE ACTION

HENNEPIN POWER STATION, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

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CONSTRUCTION PERMIT APPLICATION FOR GROUNDWATER CORRECTIVE ACTION HENNEPIN POWER STATION, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

Project name	**Hennepin West Ash Pond System**
Project no.	**1940110241-006**
Recipient	**Dynegy Midwest Generation, LLC**
Document type	**Construction Permit Application for Groundwater Corrective Action**
Revision	**FINAL**
Date	**May 6, 2025**
Prepared by	**Elizabeth (Richter) Rotstein, PE**
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Approved by	**Brian G. Hennings, PG**
Description	**Construction Permit Application for 35 I.A.C. § 845**

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APPENDICES

Appendix A	Legal Description (845.210(c))
Appendix B	Groundwater Information (845.210(d)(1), 845.220(a)(7)(A-C), and 845.220(c)(2-5))
Appendix C	History of Construction (845.220(a)(1))
Appendix D	Types of CCR and Chemical Constituents (845.220(a)(2)(A))
Appendix E	Site Plan Map and On-Site Transportation Plan ((845.220(a)(4) and 845.220(a)(2)(E))
Appendix F	Site Location Maps (845.220(a)(3))
Appendix G	Corrective Action Plan (845.670) and Proposed Schedule, including the Corrective Action Alternatives Analysis (845.670(e))
Appendix H	Geotechnical Information
Appendix I	Public Notification and Public Meeting Certification (845.220(a)(9))
Appendix J	Contractor Training Certification (45 ILCS 5/22.59(b)(4))

1. INTRODUCTION

Dynegy Midwest Generation, LLC (DMG) is the owner of the inactive coal-fired Hennepin Power Plant (HPP), also referred to as the Hennepin Power Station (HEN), in Hennepin, Putnam County, Illinois. According to the Illinois Environmental Protection Agency (IEPA), this power plant had five coal combustion residuals (CCR) surface impoundments, as listed in **Table 1** below. This Construction Permit Application (application) is for groundwater corrective action activities at the West Ash Pond System (WAPS) only. The WAPS is a CCR multi-unit which contains the Old West Ash Pond (OWAP) and the Old West Polishing Pond (OWPP). Closure of WAPS was completed in 2020; this included leaving CCR in place within the OWAP, removing all CCR from the OWPP, placing it within the OWAP, and installing a geomembrane final cover system over the consolidated OWAP [1, 2].

Table 1 – CCR Surface Impoundments at Hennepin Power Plant

Impoundment Name	Status	Acronym	IEPA ID Number	Vistra CCR Unit ID	National Inventory of Dams Number
East Ash Pond	Inactive	EAP	W1550100005-05	803	IL50363
Old West Ash Pond (Pond No. 1 and Pond No. 3)	**Closed**	**WAPS (West Ash Pond System)**	**W1550100002-01**	**804**	**IL50698**
Old West Polishing Pond			**W1550100002-03**	**804**	
Ash Pond No. 2	Closed	AP2	W1550100002-04	802	IL50363
Ash Pond No. 4		AP4	W1550100002-07	805	None

Note – Bold indicates impoundments included in this Corrective Action Construction Permit Application

This Construction Permit Application for Groundwater Corrective Action activities was developed in accordance with Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments [3]

1.1 Legal Description

Section 845.210(c): All permit applications must contain a legal description of the facility boundary and a description of the boundaries of all units included in the facility.

A legal description of the facility is provided in **Appendix A**.

1.2 Previous Assessments

Section 845.210(d): Previous Assessments, Investigations Plans, and Programs

The WAPS is also regulated by Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257, herein referred to as the Federal CCR Rule [4] and subsequently became regulated by 35 I.A.C. § 845 [3]. Several assessments and plans were completed for the WAPS to satisfy the requirements of both the Federal CCR Rule and 35 I.A.C. § 845; some of which are referred to within and attached to this application.

Section 845.210(d)(1): The Agency may approve the use of any hydrogeologic site investigation or characterization, groundwater monitoring well or system, or groundwater monitoring plan, bearing the seal and signature of an Illinois Licensed Professional Geologist or Licensed Professional Engineer, completed before April 21, 2021 to satisfy the requirements of this Part.

A hydrogeologic site investigation and characterization report was prepared for the WAPS in 2017 [5] and is included as **Appendix B.2**. A Corrective Action Groundwater Monitoring Plan has been developed to support this Construction Permit Application and is provided in **Appendix B.1**.

Section 845.210(d)(2): For existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed location restriction demonstration required by Section 845.300 (Placement Above the Uppermost Aquifer), Section 845.310 (Wetlands), Section 845.320 (Fault Areas), Section 845.330 (Seismic Impact Zones), and Section 845.340 (Unstable Areas) provide4845.d that the previously completed assessments meet the applicable requirements of those Sections.

No such previous assessments for Placement Above the Uppermost Aquifer, Wetlands, Fault Areas, Seismic Impact Zones, and/or Unstable Areas are included within this Construction Permit Application.

Section 845.210(d)(3): For existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed assessment to serve as the initial assessment required by Section 845.440 (Hazard Potential Classification Assessment), Section 845.450 (Structural Stability Assessment) and Section 845.460 (Safety Factor Assessment) provided that the previously completed assessment: A) Was not completed more than five years ago; and B) Meets the applicable requirements of those Sections.

No such previous assessments for the Hazard Potential Classification, Structural Stability, and/or Safety Factors are included within this Construction Permit Application.

Section 845.210(d)(4): For inactive closed CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a post-closure care plan previously approved by the Agency.

A post-closure care plan for the WAPS was previously submitted to the IEPA on December 20, 2017 [6]. The post-closure care plan was subsequently approved by the IEPA in 2018 [7].

2. CONSTRUCTION PERMIT

2.1 History of Construction

Section 845.220(a)(1): Design and Construction Plans (Construction History)

The initial History of Construction report for the WAPS and subsequent update prepared in 2021 are provided in **Appendix C**.

2.2 Narrative Description of Facility

Section 845.220(a)(2): Narrative Description of the Facility. The permit application must contain a written description of the facility with supporting documentation describing the procedures and plans that will be used at the facility to comply with the requirements of this Part. The descriptions must include, but are not limited to, the following information:

The Facility Narrative Description details are described in the following sections.

Section 845.220(a)(2)(A): The types of CCR expected in the CCR surface impoundment, including a chemical analysis of each type of expected CCR;

The types of CCR expected in the WAPS and analysis of the chemical constituents found within the CCR in the WAPS is provided in **Appendix D**.

Section 845.220(a)(2)(B): An estimate of the maximum capacity of each surface impoundment in gallons or cubic yards;

Prior to closure, the OWAP was estimated to contain approximately 590,000 cubic yards (CY) of CCR [8]. During closure, approximately 158,000 CY of additional material was placed beneath the final cover system. This included approximately 69,000 CY of CCR and non-CCR materials removed from the OWPP, 28,000 CY of materials excavated from the adjacent Hennepin Power Plant coal yard, and 61,000 CY of clean fill materials that were obtained on-site. This results in a total maximum capacity of the WAPS of approximately 748,000 CY.

Section 845.220(a)(2)(C): The rate at which CCR and non-CCR waste streams currently enter the CCR surface impoundment in gallons per day and dry tons;

There are no waste streams currently entering or will enter the WAPS in the future as final closure of the WAPS has been completed.

Section 845.220(a)(2)(D): The estimated length of time the CCR surface impoundment will receive CCR and non-CCR waste streams; and

There are no CCR or other non-CCR waste streams that are currently entering the WAPS or will enter the WAPS in the future as closure of the WAPS has been completed.

Section 845.220(a)(2)(E): An on-site transportation plan that includes all existing and planned roads in the facility that will be used during the operation of the CCR surface impoundment.

An On-Site Transportation Plan was developed as required by 35 I.A.C. § 845.220(a)(2)(E) and is provided for the WAPS in **Appendix E** that includes all on-site access roads and the surrounding roadways.

2.3 Site Maps

Section 845.220(a)(3): Site Location Map. All permit applications must contain a site location map on the most recent United States Geological Survey (USGS) quadrangle of the area from the 7½ minute series (topographic), or on another map whose scale clearly shows the following information:

A. The facility boundaries and all adjacent property, extending at least 1000 meters (3280 feet) beyond the boundary of the facility;

B. All surface waters;

C. The prevailing wind direction;

D. The limits of all 100-year floodplains;

E. All-natural areas designated as a Dedicated Illinois Nature Preserve under the Illinois Natural Areas Preservation Act [525 ILCS 30];

F. All historic and archaeological sites designated by the National Historic Preservation Act (16 USC 470 et seq.) and the Illinois Historic Sites Advisory Council Act [20 ILCS 3410]; and

G. All areas identified as critical habitat under the Endangered Species Act of 1973 (16 USC 1531 et seq.) and the Illinois Endangered Species Protection Act [520 ILCS 10].

A Site Location Map for the WAPS showing the information required in 35 I.A.C. § 845.220(a)(3) is provided in **Appendix F**. The Site Location Map consists of the most recent USGS topographic map (2024) which contains the facility and at least 1,000 meters of the surrounding area. Information included on the Site Location Map meets the requirements for a Flood Hazard Map, Topographic Vicinity Map, Designated Nature Map, Designated Historic and Archeological Site Map, and Identified Critical Habitat Map.

The data in the Site Location Map was collected by performing a comprehensive search of the Illinois Department of Natural Resources (IDNR) natural heritage database [9] for natural and protected areas within 1,000 meters of the WAPS. Within Putnam and adjacent Bureau County, a total of 21 sites were identified from the Illinois Natural Areas Inventory and 8 were identified from the Illinois Nature Preserves list. None of the natural areas or preserves fall within 1,000 meters of the WAPS.

The IDNR natural heritage database also includes a list of Endangered Species by County [10] and notes that a total of 52 threatened and endangered species as located within Putnam County and adjacent Bureau County, including 33 endangered and 19 threatened species. A review of the U.S. Fish and Wildlife Service (USFWS) Threatened & Endangered Species Active Critical Habitat Report [11] identified critical habitat for the endangered Indiana Bat located in adjacent Bureau County, on the opposite bank of the Illinois River from the Site and located within 1,000 meters of the WAPS.

A search of the IDNR Historic and Architectural Resources Geographic Information System (HARGIS) database [12] for historical sites within 1,000 meters of the Site located no results.

The 100-year flood plain limits were obtained from the Federal Emergency Management Area (FEMA) Flood Map Service Center [13]. The 100-year flood plain of the Illinois River is directly adjacent to the WAPS but does not extend over the existing final cover system.

Section 845.220(a)(4): Site Plan Map. The application must contain maps, including cross-sectional maps of the site boundaries, showing the location of the facility. The following information must be shown:

A. The entire facility, including any proposed and all existing CCR surface impoundment locations;

B. The boundaries, both above and below ground level, of the facility and all CCR surface impoundments or landfills containing CCR included in the facility;

C. All existing and proposed groundwater monitoring wells; and

D. All main service corridors, transportation routes, and access roads to the facility.

The Site Plan Map for the WAPS showing the information required in 35 I.A.C. § 845.220(a)(4) is provided in **Appendix E**.

2.4 Narrative Description of Proposed Construction

Section 845.220(a)(5): A narrative description of the proposed construction of, or modification to, a CCR surface impoundment and any projected changes in the volume or nature of the CCR or non-CCR waste streams.

The proposed modification for the WAPS will consist of supplementing the completed source control [1, 2] with the installation of a vertically- and laterally-continuous permanent and low-permeability deep cutoff wall (DCW) that will extend from the perimeter dikes of the WAPS into competent, low-permeability shale bedrock beneath the WAPS to form a continuous containment system (CCS). The CCS, as outlined in the Corrective Action Plan for the WAPS (see **Appendix G**), will result in CCR within the WAPS being physically isolated from the environment on all sides by a permanent, passive system of continuous low-permeability barriers, including the final cover system on the top, the DCW on the sides, and competent shale bedrock on the bottom. The CCS will control the source of releases of constituents listed in 35 I.A.C. § 845.60 and serve as the groundwater corrective action for the WAPS.

2.4.1 Proposed Corrective Action Construction

Corrective action construction will involve the construction of multiple elements of the CCS. These will include construction of the DCW, extending the final cover system over the DCW, and site restoration. No operations and maintenance activities are planned, outside of ongoing post-closure care activities, as the CCS will be a passive and low-maintenance structure.

Information associated with each of these construction elements of the CCS is provided below.

2.4.1.1 Deep Cutoff Wall Installation

The DCW that will encircle the entire perimeter of the former OWAP, with a total length of approximately 5,200 feet, will complement the existing site features and form a continuous containment system. The DCW will extend at least 1 foot into competent, low-permeability shale bedrock beneath the WAPS, which has a typical depth of approximately 90 feet below ground surface (bgs). The DCW will be constructed using either cement-bentonite or soil bentonite methods and will have a target hydraulic conductivity of 1×10^{-7} centimeters per second (cm/sec).

Construction of the DCW is expected to include the following tasks:

- The cutoff wall alignment will conflict with some perimeter areas of the WAPS' completed geosynthetic and soil final cover system. To allow for cutoff wall construction, the final cover system will be temporarily removed within the proposed limits of construction disturbance (limits of disturbance).
  - This will include stripping topsoil and cover soil from the geomembrane and temporarily stockpiling the materials for future final cover restoration.
  - Existing geosynthetic materials will be removed and disposed of at an off-site landfill.
  - Additional conflicting site infrastructure within the limits of disturbance including, but not limited to access roads, piezometers, monitoring wells, stormwater channels, stormwater letdown structures, and pressure relief vents, will also be abandoned and/or otherwise removed as part of the activities.
- A level working platform and temporary construction access roads will be constructed within the limits of disturbance to allow DCW construction equipment (*i.e.*, cranes, haul trucks, and light vehicles) access and traffic.
  - The working platform will require the grading of existing subsurface materials, which may include CCR and/or soils, in order to provide a level subgrade. This will likely require the excavation of materials in some areas and placement of fill in others.
  - The working platform will be designed to support surcharges induced from expected construction equipment, which may include large cranes.
  - The existing steel sheet pile wall located between the OWAP and OWPP will be removed. The wall will be either stored on-site, outside of the WAPS, or sold for off-site recycling or re-use.
- The DCW will be installed along its alignment through a process where the wall is excavated in vertical panels and the excavation is continually backfilled with either stabilizing slurry of a mixture of bentonite and subgrade soils.
  - A quality assurance and quality control (QA/QC) program will be implemented during construction of the DCW. This will include performing site-specific bench scale testing and mix design to develop an engineered wall backfill that meets the target wall hydraulic conductivity of 1×10^{-7} cm/sec prior to wall construction, collecting multiple samples of wall backfill material during construction for hydraulic conductivity and strength testing, and recording continuous logs of materials encountered during wall construction, including conditions at the tip of the DCW where it is keyed (*i.e.,* embedded) into competent shale bedrock. The purpose of this process is to verify that the as-constructed wall meets the design intent included within this Construction Permit Application.
  - 40,0000 to 60,000 CY of excavation spoils are expected to be generated during DCW installation. The spoils are expected to be predominantly non-CCR material and will be placed into off-road dump trucks and disposed of appropriately onsite. Spoils containing CCR materials will be placed into off-road dump trucks and disposed of in the East Ash Pond (EAP) as contouring fill in accordance with the submitted closure plan [14].

2.4.1.2 Final Cover System Extension

After the DCW is installed, the final cover system will be extended across the top of the DCW and restored to the original final closure design grades that are currently present at the WAPS. This will include placing a new low-permeability barrier layer within disturbed areas, welding it to the existing undamaged geomembrane barrier layer, extending the barrier layer over the top of the DCW, and terminating the geomembrane in a new anchor trench.

After the geomembrane is extended, a geotextile cushion will be extended over the top of the geomembrane barrier layer. Protective cover soil and a vegetative support layer will then be placed over the geotextile cushion. All final cover system materials and installation practices will be performed in accordance with the design and specifications that were prepared for the completed WAPS closure and will be consistent with the existing IEPA-approved closure plan [6]. QA/QC procedures will also be performed during final cover system extension where samples of geomembrane and cover soils are tested for conformance with the project specifications. All geomembrane seams and/or welds will also be subjected to QA/QC testing in accordance with the specifications utilized for the completed WAPS closure.

2.4.2 Site Restoration

After the final cover system extension is complete, site restoration activities will be initiated. This will include replacing any existing site infrastructure that was abandoned or otherwise removed from the limits of disturbance during CCS construction and establishing vegetation on disturbed areas.

2.5 Plans and Specifications

Section 845.220(a)(6): Plans and specifications fully describing the design, nature, function and interrelationship of each individual component of the facility.

Permit-level design plans and specifications for key construction materials are included within the Corrective Action Plan for the WAPS, provided in **Appendix G**. These plans were prepared in accordance with 35 I.A.C. § 845.670(a)(6) and are consistent with the narrative description provided in **Appendix G**, per 35 I.A.C. § 845.220(a)(5).

A permit-level evaluation of the stability of the WAPS perimeter dikes during installation of the DCW was prepared to support this Construction Permit Application. The stability assessment indicated that DCW installation activities using large construction equipment such as cranes is not expected to result in significant distress to the WAPS perimeter dikes, and that a safety factor of at least 1.30, in accordance with 845.460(a)(1), is expected to be maintained during DCW construction. This assessment and supporting geotechnical information is provided in **Appendix H**.

2.6 Groundwater Monitoring Program

Section 845.220(a)(7): A new groundwater monitoring program or any modification to an existing groundwater monitoring program that includes but is not limited to the following information:

A Corrective Action Groundwater Monitoring Plan is included in **Appendix B.1** of this application.

Section 845.220(a)(7)(A): A hydrogeologic site investigation meeting the requirements of Section 845.620, if applicable;

Hydrogeologic site investigations for the WAPS are provided in **Appendix B.2**.

Section 845.220(a)(7)(B): Design and construction plans of a groundwater monitoring system meeting the requirements of Section 845.630; and

Design and construction plans of a groundwater monitoring system as required by 35 I.A.C. § 845.630 are provided in the Operating and Closure and Post Closure Care Plan [6, 15]. The Corrective Action Groundwater Monitoring Plan (**Appendix B.1)** includes content requirements specific to 35 I.A.C. § 845.630 (Groundwater Monitoring System), 35 I.A.C. § 845.640 (Groundwater Sampling and Analysis), 35 I.A.C. § 845.650 (Groundwater Monitoring Program), and 35 I.A.C. § 845.680 (Implementation of the Corrective Action Plan) for the WAPS.

Section 845.220(a)(7)(C): A proposed groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data (see Sections 845.640 and 845.650).

A groundwater sampling and analysis program that meets the requirements of 35 I.A.C. § 845.640 and 845.650 is provided in **Appendix B.1.**

2.7 Certification

Section 845.220(a)(8): The signature and seal of a qualified professional engineer

I, Lucas P. Carr, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this Construction Permit Application has been prepared in accordance with the accepted practice of engineering. The content of this Construction Permit Application is not to be used other than for its intended purpose and meaning, or for extrapolations beyond the interpretations contained herein.

Lucas P. Carr
Printed name

5/6/2025
Signature Date

062-066694 IL 11/30/2025
Registration No. State Exp. Date

Affix Seal

2.8 Public Meeting Information

Section 845.220(a)(9): Certification that the owner or operator of the CCR surface impoundment completed the public notification and public meetings required under Section 845.240, a summary of issued raised by the public, a summary of any revisions, determinations, or other considerations made in response to those issues, and a list of interested persons in attendance who would like to be added to the Agency's listserv for the facility.

Certification that public notification and public meetings have been completed as required by 35 I.A.C. § 845.240 are provided in **Appendix I**.

2.9 Corrective Action Construction

Section 845.220(c)(1): Corrective action plan (see Section 845.670);

The Corrective Action Plan as required by 35 I.A.C. § 845.220(d)(4) is provided in **Appendix G**.

Section 845.220(c)(2): Groundwater modeling, including:

A. *The results of groundwater contaminant transport modeling and calculations showing how the corrective action will achieve compliance with the applicable groundwater standards;*
B. *All modeling inputs and assumptions;*
C. *Description of the fate and transport of contaminants with the selected corrective action over time; and*
D. *Capture zone modeling, if applicable.*

Groundwater modeling as required by 35 I.A.C. § 845.220(c)(2) is provided within Appendix B.1 of Corrective Action Alternatives Analysis Supporting Information Report, which is included as Appendix B of the Corrective Action Alternatives Analsyis, which is Appendix A of the Corrective Action Plan provided as **Appendix G** of this application.

Section 845.220(c)(3): Any necessary licenses and software needed to review and access both the models and the data contained within the models required by subsection (c)(2).

Consistent with previously submitted construction permit applications, electronic copies of the model files are provided within Appendix B.1 of the Corrective Action Alternatives Analysis Supporting Information Report. The Corrective Action Alternatives Analysis Supporting Information Report is included as Appendix B of the Corrective Action Alternatives Analysis, which is Appendix A of the Corrective Action Plan that is provided as **Appendix G** of this application. Publicly available software can be used to review and access the models and the data; no additional licenses or software are required.

Section 845.220(c)(4): Corrective action groundwater monitoring program, including identification of revisions to the groundwater monitoring system for corrective action.

The corrective action groundwater monitoring program as required by 35 I.A.C. § 845.220(c)(4) is provided in **Appendix B.1** of this application. The corrective action groundwater monitoring plan establishes how data will be collected, documented, and evaluated to assess remedy effectiveness for all currently documented and potential future releases from the WAPS. The presence of exceedances at the waste boundary will continue to be evaluated under the Operating Permit Groundwater Monitoring Plan (GMP) previously submitted to IEPA [15].

Section 845.220(c)(5): Any interim measures necessary to reduce the contaminants leaching from the CCR surface impoundment, and/or potential exposures to human or ecological receptors, including an analysis of the factors specified in Section 845.680(a)(3).

No interim measures are necessary or planned ahead of permit approval and completion of final design. The Corrective Action Plan, provided in **Appendix G**, provides an analysis of the factors specified in 35 I.A.C. § 845.680(a)(3).

3. ADDITIONAL INFORMATION

Certification that DMG will utilize contractors, subcontractors, and installers who are participants in an approved training program, in accordance with 415 Illinois Compiled Statutes (ILCS) 5/22.59(b)(4), is provided in **Appendix J**.

4. REFERENCES

[1] Dynegy Midwest Generation, LLC, "Hennepin Power Station; Old West Ash Pond, Ash Pond No. 2, Notification of Completion of Closure," Luminant, December 17, 2020.

[2] Dynegy Midwest Generation, LLC, "Hennepin Power Station; Old West Polishing Pond, Notification of Completion of Closure," Luminant, December 17, 2020.

[3] Illinois Administrative Code, "Title 35, Subtitle G, Chapter I, Subchapter J, Part 845: Standards for The Disposal Of Coal Combustion Residuals In Surface Impoundments," April 21, 2021.

[4] Code of Federal Regulations, "Title 40, Chapter I, Subchapter I, Part 257, Subpart D, Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," April 17, 2015.

[5] Natural Resource Technology, Inc., "Hydrogeologic Site Characterization Report, Hennepin West Ash Pond System, Hennepin, Illinois," December 20, 2017.

[6] Geosyntec Consultants, "Closure and Post-Closure Care Plan Old West Ash Pond Old West Polishing Pond at Hennepin Power Station," 2017.

[7] Illinois Environmental Protection Agency, "Correspondence with Luminant (formerly Dynegy Midwest Generation, LLC) regarding the Closure and Post-Closure Care Plan for Hennepin Old West Ash Pond System," July 19, 2018.

[8] Dynegy Midwest Generation, LLC, "Closure Plan for Existing CCR Surface Impoundment. 40 CFR 257.102(b). Hennepin Power Station, Old West Ash Pond," 17 October 2016. [Online]. Available: https://www.luminant.com/documents/ccr/Illinois/Hennepin/2016/Old%20West%20Ash%20Pond%20Closure%20Plan.pdf.

[9] Illinois Department of Natural Resources, "IDNR Natural Heritage Database," [Online]. Available: https://www2.illinois.gov/sites/naturalheritage/DataResearch/Pages/Access-Our-Data.aspx. [Accessed 7 February 2025].

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[13] Federal Emergency Management Agency, "FEMA Flood Map Service Center: Welcome!," [Online]. Available: https://msc.fema.gov/portal/home. [Accessed 7 February 2025].

[14] Geosyntec Consultant, "CCR Surface Impoundment Final Closure Plan, Hennepin Power Plant, East Ash Pond," 2022.

[15] Burns & McDonnell, "Initial Operating Permit, Hennepin West Ash Pond System," October 25, 2021.

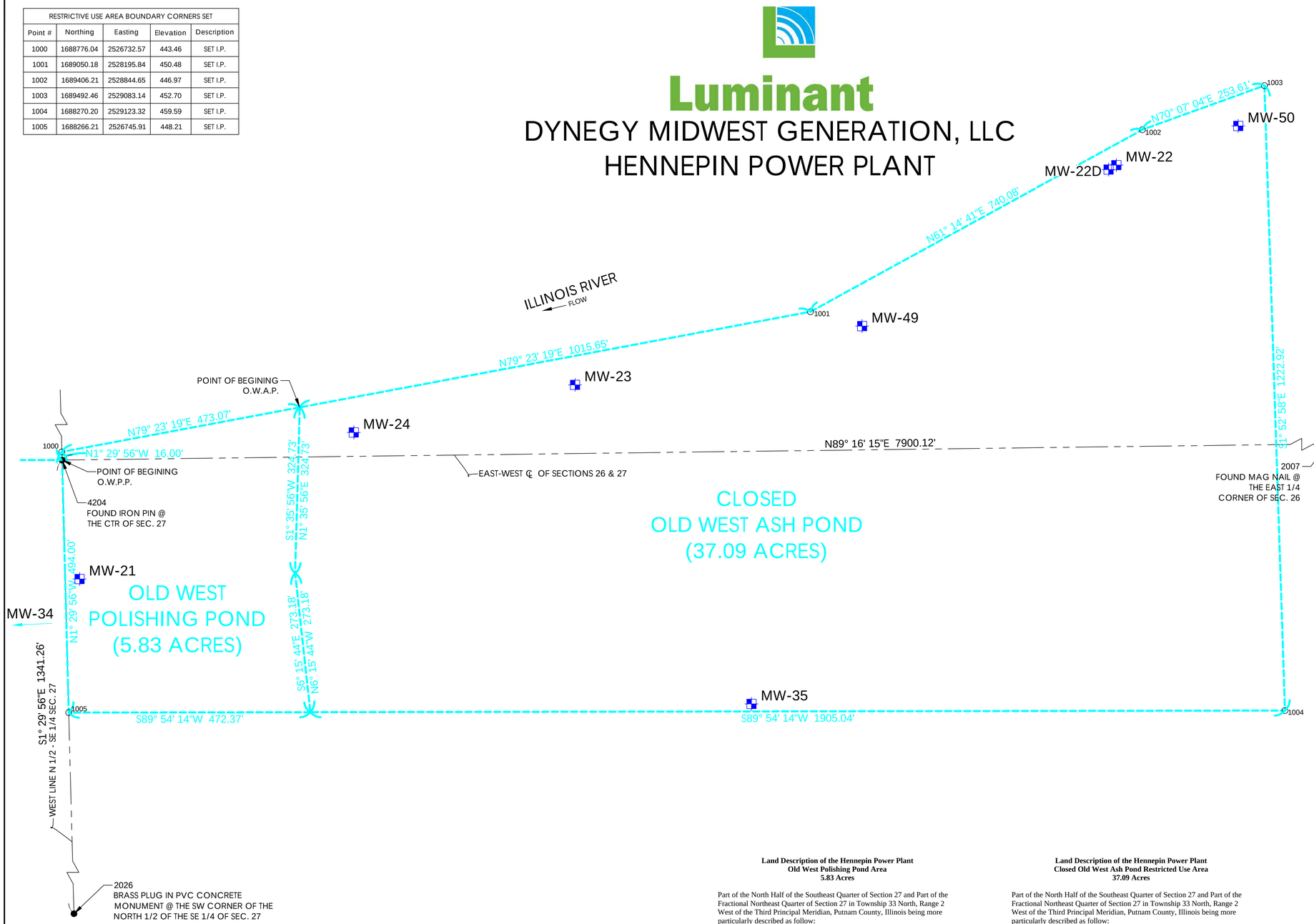
[16] Dynegy Midwest Generation, LLC, "Closure Plan for Existing CCR Surface Impoundment. 40 CFR 257.102(b). Hennepin Power Station, Old West Polishing Pond.," 17 October 2016. [Online]. Available: https://www.luminant.com/documents/ccr/Illinois/Hennepin/2016/Old%20West%20Polishing%20Pond%20Closure%20Plan.pdf.

APPENDIX A
LEGAL DESCRIPTION (845.210(c))

RESTRICTIVE USE AREA BOUNDARY CORNERS SET				
Point #	Northing	Easting	Elevation	Description
1000	1688776.04	2526732.57	443.46	SET I.P.
1001	1689050.18	2528195.84	450.48	SET I.P.
1002	1689406.21	2528844.65	446.97	SET I.P.
1003	1689492.46	2529083.14	452.70	SET I.P.
1004	1688270.20	2529123.32	459.59	SET I.P.
1005	1688266.21	2526745.91	448.21	SET I.P.

Luminant

DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER PLANT



N

0' 100' 200'

LEGEND

- ***SECTION LINE***
- ***RESTRICTED USE BOUNDARY***
- ***FOUND SURVEY MARKER AS NOTED***
- ***SET 5/8" IRON REBAR (UNLESS OTHERWISE NOTED)***
- ***DOWNGRADIENT WELL***
- ***UPGRADIENT WELL***

SURVEY NOTE:
THIS DRAWING AND THE INFORMATION SHOWN HERE ON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC BETWEEN FEBRUARY 12 THROUGH JULY 21, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS WEST 1202 STATE PLANE COORDINATE SYSTEM NAD 1983.

CONTROL CORNERS AND WELLS				
POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
2007	1688860.596	2534632.47	526.228	FOUND MAG NAIL
2026	1687410.247	2526768.079	448.67	BRASS PLUG IN PVC CONCRETE MONUMENT
4204	1688760.044	2526732.992	443.246	FOUND IRON PIN
2050	1689415.471	2529031.977	459.587	MW-50 GROUND
2049	1689328.200	2528778.555	462.007	MW-22D GROUND
2048	1689386.914	2528799.688	461.595	MW-22 GROUND
2062	1688022.106	2528296.703	465.673	MW-49 GROUND
2060	1688907.190	2527735.615	462.069	MW-23 GROUND
2064	1688814.130	2527303.166	461.889	MW-24 GROUND
2065	1688527.386	2526767.107	449.695	MW-21 GROUND
2066	1688398.258	2525785.698	453.588	MW-34 TOP METAL CASING
2067	1688269.08	2528080.549	451.639	MW-35 GROUND

Land Description of the Hennepin Power Plant
Old West Polishing Pond Area
5.83 Acres

Part of the North Half of the Southeast Quarter of Section 27 and Part of the Fractional Northeast Quarter of Section 27 in Township 33 North, Range 2 West of the Third Principal Meridian, Putnam County, Illinois being more particularly described as follow:

Beginning at the found Iron Pin at the Center of Section 27, from which bears a found Brass Plug in a PVC Concrete Monument at the Southwest Corner of the North Half of the Southeast Quarter of Section 27, South 1 degrees 29 minutes 56 seconds East a distance of 1341.26 feet and from which also bears a found Magnetic Nail at the East Quarter Corner of Section 26, North 89 degrees 16 minutes 15 seconds East a distance of 7900.12 feet; thence from said found Iron Pin at the Center of Section 27 being the Point of Beginning of the tract described herein North 1 degrees 29 minutes 56 seconds West a distance of 16.00 feet; thence North 79 degrees 23 minutes 19 seconds East a distance of 473.07 feet; thence South 1 degrees 35 minutes 56 seconds West a distance of 324.73 feet; thence South 6 degrees 15 minutes 44 seconds East a distance of 273.18 feet; thence South 89 degrees 54 minutes 14 seconds West a distance of 472.37 feet to the West line of the North Half of the Southeast Quarter of Section 27; thence North 1 degrees 29 minutes 56 seconds West, along said line, a distance of 494.00 feet to the Point of Beginning and containing 5.83 Acres.

Land Description of the Hennepin Power Plant
Closed Old West Ash Pond Restricted Use Area
37.09 Acres

Part of the North Half of the Southeast Quarter of Section 27 and Part of the Fractional Northeast Quarter of Section 27 in Township 33 North, Range 2 West of the Third Principal Meridian, Putnam County, Illinois being more particularly described as follow:

Beginning at the found Iron Pin at the Center of Section 27, from which bears a found Brass Plug in a PVC Concrete Monument at the Southwest Corner of the North Half of the Southeast Quarter of Section 27, South 1 degrees 29 minutes 56 seconds East a distance of 1341.26 feet and from which also bears a found Magnetic Nail at the East Quarter Corner of Section 26, North 89 degrees 16 minutes 15 seconds East a distance of 7900.12 feet; thence from said found Iron Pin at the Center of Section 27 North 1 degrees 29 minutes 56 seconds West a distance of 16.00 feet; thence North 79 degrees 23 minutes 19 seconds East a distance of 473.07 feet to the Point of Beginning of the tract described herein; thence continuing North 79 degrees 23 minutes 19 seconds East a distance of 1015.65 feet; thence North 61 degrees 14 minutes 41 seconds East a distance of 740.08 feet; thence North 70 degrees 07 minutes 04 seconds East a distance of 253.61 feet; thence South 1 degrees 52 minutes 58 seconds East a distance of 1222.92 feet; thence South 89 degrees 54 minutes 14 seconds West a distance of 1905.04 feet; thence North 6 degrees 15 minutes 44 seconds West a distance of 273.18 feet; thence North 1 degrees 35 minutes 56 seconds East a distance of 324.73 feet to the Point of Beginning and containing 37.09 Acres.

SURVEYOR CERTIFICATE:
THIS IS TO CERTIFY THAT WE, INGENAE, LLC, HAVE AT THE REQUEST OF AND FOR THE EXCLUSIVE USE OF THE OWNERS, PERFORMED A SURVEY OF THE TRACT AS SHOWN HEREON AND THAT THIS IS A TRUE REPRESENTATION OF THAT SURVEY. THIS PLAT AND THE SURVEY FROM WHICH IT IS BASED WERE DONE IN ACCORDANCE WITH THE "MINIMUM STANDARDS OF PRACTICE" FOR LAND SURVEYING IN THE STATE OF ILLINOIS.

INGENAE, LLC
PROFESSIONAL DESIGN FIRM
LICENSE NO. 184.007588-0010

MICHAEL J. GRAMINSKI, I.P.L.S. NO. 035.002901 ***DATE***
EXPIRES: 11/30/2022

IngenAE
502 Earth City Plaza, Suite 120
Earth City, MO 63045
www.ingenae.com

Submissions / Revisions:		Date:
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Luminant

Project Name & Location:

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POWER PLANT
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61327

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Drawing Name:

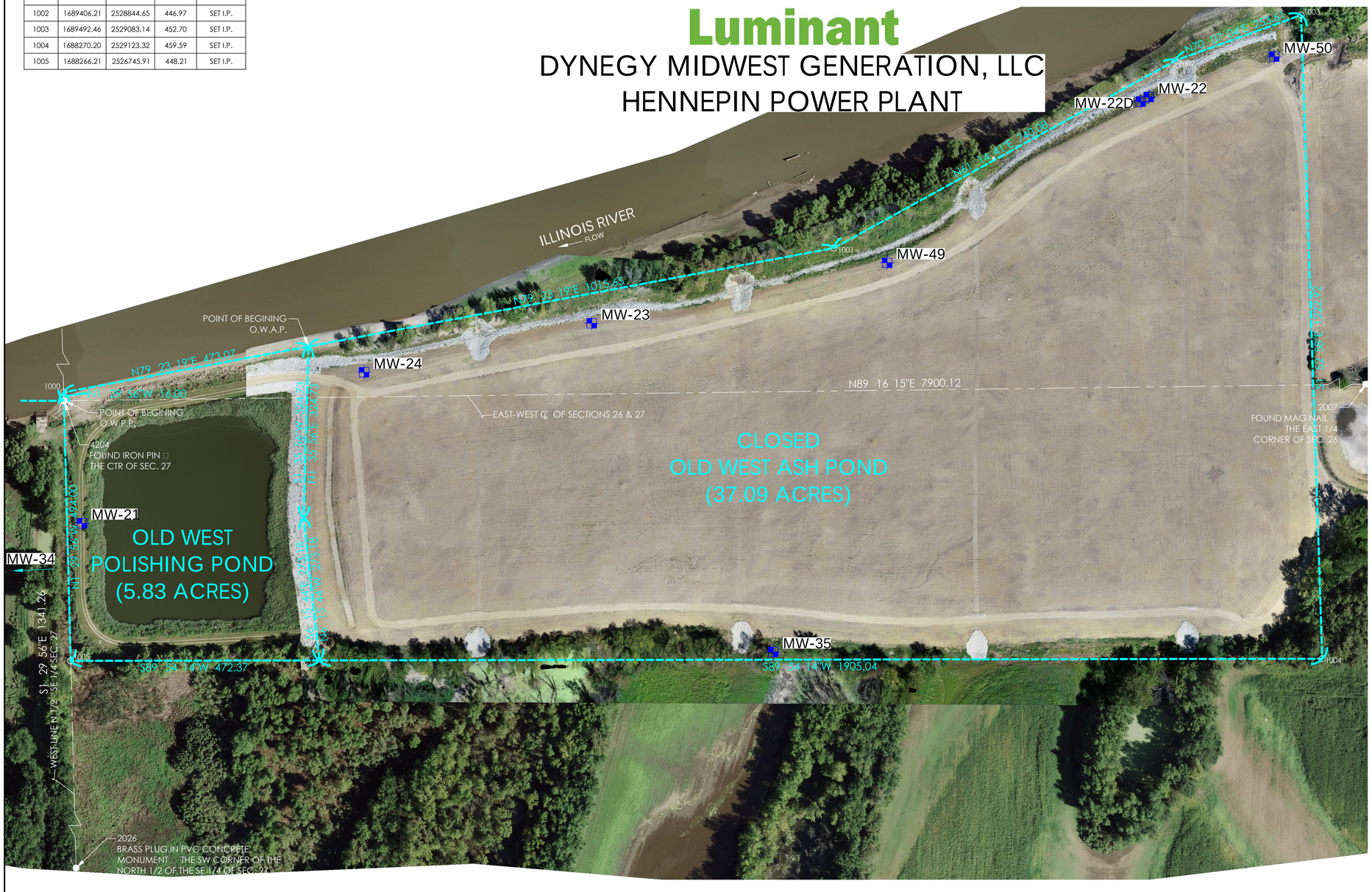
OLD WEST POLISHING POND & OLD WEST ASH POND RESTRICTED USE BOUNDARY EXHIBIT

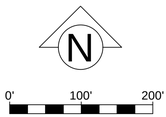
Date:	Project No.
9/22/2021	
Type: SITE	Drawing No. 1
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

RESTRICTIVE USE AREA BOUNDARY CORNERS SET				
Point □	Northing	Easting	Elevation	Description
1000	1688776.04	2526732.57	443.46	SET I.P.
1001	1689050.18	2528195.84	450.48	SET I.P.
1002	1689406.21	2528844.65	446.97	SET I.P.
1003	1689492.46	2529083.14	452.70	SET I.P.
1004	1688270.20	2529123.32	459.59	SET I.P.
1005	1688266.21	2526745.91	448.21	SET I.P.

Luminant

DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER PLANT





LEGEND

- ***SECTION LINE***
- ***RESTRICTED USE BOUNDARY***
- ***FOUND SURVEY MARKER AS NOTED***
- ***SET 5/8" IRON REBAR (UNLESS OTHERWISE NOTED)***
- ***DOWNGRADIENT WELL***
- ***UPGRADIENT WELL***

SURVEY NOTE:
THIS DRAWING AND THE INFORMATION SHOWN HERE ON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC BETWEEN FEBRUARY 12 THROUGH JULY 21, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS WEST 1202 STATE PLANE COORDINATE SYSTEM NAD 1983.

CONTROL CORNERS AND WELLS				
POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
2000	1688860.596	2534632.47	526.228	FOUND MAG NAIL
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2050	1689410.471	2529031.977	459.587	MW-50 GROUND
2060	1689928.200	2528778.555	462.007	MW-22D GROUND
2061	1689386.914	2528799.688	461.595	MW-22 GROUND
2062	1688022.106	2528296.703	465.673	MW-49 GROUND
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2066	1688898.258	2525785.698	453.988	MW-34 TOP METAL CASING
2067	1688269.08	2528080.549	451.639	MW-35 GROUND

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Luminant

Project Name & Location:

HENNEPIN
POWER PLANT
13498 EAST 800TH STREET
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Drawing Name:
OLD WEST POLISHING POND & OLD WEST ASH POND RESTRICTED USE BOUNDARY EXHIBIT

Date:	Project No.
9/22/2021	
Type: SITE	Drawing No. 2
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

APPENDIX B
GROUNDWATER INFORMATION (845.210(d)(1), 845.220(a)(7)(A-C), 845.220(c)(2-5))

APPENDIX B1
CORRECTIVE ACTION GROUNDWATER MONITORING PLAN

Intended for
Dynegy Midwest Generation, LLC
13498 E 800th St
Hennepin, IL 61327

Date
May 6, 2025

Project No.
1940110241-006

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN

HENNEPIN POWER PLANT, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

RAMBOLL Bright ideas. Sustainable change.

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
HENNEPIN POWER PLANT, WEST ASH POND SYSTEM,
IEPA ID NO. W1550100002-01 AND W1550100002-03

Project name	**Hennepin Power Plant West Ash Pond System**
Project no.	**1940110241-006**
Recipient	**Dynegy Midwest Generation, LLC**
Document type	**Corrective Action Groundwater Monitoring Plan**
Revision	**FINAL**
Date	**May 6, 2025**

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Brian G. Hennings, PG
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APPENDICES

Appendix A Boring Logs and Monitoring Well Construction Forms
Appendix B 35 I.A.C. § 845 Multi-Site Statistical Analysis Plan

ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
ASD	Alternative Source Demonstration
CCR	coal combustion residuals
COC	constituent of concern
cm/s	Centimeters per second
CSM	conceptual site model
DMG	Dynegy Midwest Generation, LLC
E001	Event 1
GMP	Groundwater Monitoring Plan
GWPS	groundwater protection standard
HCR	Hydrogeologic Site Characterization Report
HPP	Hennepin Power Plant
ID	identification
IEPA	Illinois Environmental Protection Agency
NID	National Inventory of Dams
No.	Number
OWAP	Old West Polishing Pond
OWPP	Old West Ash Pond
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RL	reporting limit
SI	surface impoundment
StAP	Statistical Analysis Plan
TDS	total dissolved solids
UA	uppermost aquifer
USEPA	United States Environmental Protection Agency
WAPS	West Ash Pond System

1. INTRODUCTION

1.1 Overview

In accordance with requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments, Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Corrective Action Groundwater Monitoring Plan (GMP) on behalf of Hennepin Power Plant (HPP), operated by Dynegy Midwest Generation, LLC (DMG). This GMP will apply specifically to the coal combustion residuals (CCR) Unit referred to as the West Ash Pond System (WAPS), CCR identification (ID) number (No.) 804, Illinois Environmental Protection Agency (IEPA) ID No. W1550100002-01 and W1550100002-03, and National Inventory of Dams (NID) No. IL50698. WAPS is comprised of two sub-units including the Old West Ash Pond (OWAP) and the Old West Polishing Pond (OWPP). Both sub-units were originally constructed as a single unit with a single perimeter dike and subsequently internally divided into sub-units as part of operational practices. This document and all past engineering and hydrogeological studies consider the WAPS as a single CCR unit. The WAPS is a closed, unlined CCR SI that was previously used to manage CCR and non-CCR waste streams at the HPP.

This Corrective Action GMP includes 35 I.A.C. § 845 content requirements specific to 35 I.A.C. § 845.630 (*Groundwater Monitoring System*), 35 I.A.C. § 845.640 (*Groundwater Sampling and Analysis*), 35 I.A.C. § 845.650 (Groundwater Monitoring Program), and 35 I.A.C. § 845.680 (*Implementation of the Corrective Action Plan*) for the WAPS at the HPP.

A checklist in **Table 1-1** provides references to sections, tables, and figures within this document that meet the specific requirements of 35 I.A.C. § 845.630, 35 I.A.C. § 845.640, 35 I.A.C. § 845.650, and 35 I.A.C. § 845.680.

This Corrective Action GMP is included as Appendix B.1 to the Construction Permit Application for the HPP WAPS. The Corrective Action Plan proposes a continuous containment system which includes a deep cutoff wall combined with previously implemented source control (*i.e.,* closure) as the selected remedy for the WAPS. As described in the Corrective Action Plan, the proposed remedy meets the performance standards of 35 I.A.C. § 845.670(d) and addresses all current and potential future releases from the WAPS. Likewise, this Corrective Action GMP establishes how data will be collected, documented, and evaluated to assess remedy effectiveness for all currently documented and potential future releases from the WAPS[1] per the process outlined in **Figure 1-1**.

Adaptive site management strategies are an integral part of corrective action groundwater monitoring. The adaptive site management approach consistent with National Research Council, Interstate Technology & Regulatory Council and United States Environmental Protection Agency (USEPA) methodologies will allow timely incorporation of new site information throughout corrective action to ensure the achievement of the groundwater protection standard (GWPS). The adaptive site management approach expedites progress toward meeting the GWPS while acknowledging uncertainties, such as the persistence of current groundwater flow directions and potential related changes in geochemical conditions. The structured decision-making process

[1] The presence of exceedances at the waste boundary will continue to be evaluated under the Operating permit GMP previously submitted to IEPA [4].

proposed in this Corrective Action GMP includes specific metrics used to evaluate remedy progress, criteria which would trigger adaptive management evaluation, and options for those management actions.

1.2 Site Location and Background

The HPP is an approximately 504-acre property consisting of 19 parcels positioned adjacent to the Illinois River, including a retired coal-fired power plant, CCR landfill and SIs, and farmland. The HPP is located in the northwest quarter of Section 26, Township 33 North, Range 2 West, Putnam County, Illinois and approximately 3 miles north-northeast of the Village of Hennepin (**Figure 1-2**).

The HPP construction history includes construction of Unit 1 in 1953 and Unit 2 in 1969, with capacities of 70 megawatts (MW) and 210 MW, respectively. The plant initially burned high-sulfur Illinois coal and switched to sub-bituminous Powder River Basin coal in 1999 [1]. The HPP ceased operations in 2019 when the power plant was retired.

The WAPS is one of three CCR units at the HPP regulated under 35 I.A.C. § 845. The other two CCR units regulated under 35 I.A.C. § 845 (Ash Pond Number [No.] 2 and No. 4 multi-unit [AP2/AP4] and the East Ash Pond) are located adjacent to each other and the Landfill, east of the HPP. The WAPS is located west of the HPP. Areas surrounding the WAPS include agricultural land, with scattered groupings or rows of trees to the southeast, and low-lying floodplains of the Donnelley Wildlife Management Area to the southwest and west. The WAPS and surrounding properties are shown on **Figure 1-3**.

1.3 Conceptual Site Model

Significant site investigation has been completed at the HPP to characterize the geology, hydrogeology, and groundwater quality. Based on extensive investigation and monitoring, the WAPS has been well characterized and detailed in the Hydrogeologic Site Characterization Report (HCR) [2] included in the Operating Permit Application[2] and the Nature and Extent Report [3][3]. A conceptual site model (CSM) has been developed and is discussed below.

The WAPS is characterized by two hydrostratigraphic units. The units, listed from surface downward, are summarized as follows:

- **Uppermost Aquifer (UA)**: Includes the Cahokia Alluvium which consists of fine-grained river deposits comprised of silts and clays (upper UA), fine-medium sands (middle UA), and highly permeable glacial outwash sands and gravels of the Henry Formation (lower UA). The UA contains variable amounts of cobbles and boulders within a sand and gravel matrix. Both the prevalence and size of the cobbles and boulders increase with depth.

- **Bedrock Confining Unit**: Comprised of interbedded layers of shales with thin limestone, sandstone, and coal beds. Representative hydraulic conductivity for shale ranges from 5×10^{-6} to 5×10^{-10} centimeters per second (cm/s) and this unit defines the lower boundary

[2] The HCR was previously included as Attachment H of the Hennepin Power Plant Old West Ash Pond No. 1 and No. 3 and Old West Polishing Pond Operating Permit Application, submitted to IEPA on October 25, 2021.
[3] The Nature and Extent Report was previously submitted to IEPA [3] and is provided with updates as Appendix D of the Corrective Action Alternatives Assessment (CAAA). The CAAA serves as Appendix A to the Corrective Action Plan to which this report is attached.

of the UA. Borings along the perimeter of the nearby East Ash Pond System confirm the presence of shale bedrock between elevations ranging from 399.2 to 410.2 feet [2].

The direction of groundwater flow and hydraulic gradient within the UA varies with the elevation of the Illinois River. During normal river stage the direction of groundwater flow is most often toward the river, but comparison of groundwater and river elevation data indicate reversals in this flow direction during times of high river elevations. The relative duration of these events is short, which leads to the determination of a predominant groundwater flow direction toward the river Flow directions are generally consistent between seasons. Groundwater elevations and contours for the May 30, 2023 groundwater monitoring event (Event 1 [E001]) are presented in **Figure 1-4**.

1.4 Groundwater Quality

Groundwater monitoring in accordance with the proposed Operating GMP and sampling methodologies provided in the operating permit application for groundwater compliance at the WAPS began in the second quarter of 2023 [4]. The proposed compliance monitoring wells yield groundwater samples that represent the quality of downgradient groundwater at the CCR boundary (as required in 35 I.A.C. § 845.630(a)(2)).

The E001 quarterly groundwater monitoring event was completed on June 1, 2023. In accordance with 35 I.A.C. § 845.610(b)(3)(C), and the statistical analysis plan submitted with the operating permit application (Appendix A of the Groundwater Monitoring Plan) constituent concentrations observed at compliance wells were evaluated for compliance the GWPSs summarized in 35 I.A.C. § 845.600 to determine exceedances[4] of the GWPS. The statistical determination identified the following GWPS exceedances at compliance groundwater monitoring wells [5]:

- Arsenic at wells 21R and 51
- Boron at wells 21R, 22, 23, and 35
- Cadmium at well 22
- Sulfate at wells 23 and 35

Pursuant to 35 I.A.C. § 845.650(e), an Alternative Source Demonstration (ASD) presented evidence demonstrating that sources other than the WAPS were the cause of the cadmium GWPS exceedance at well 22 [6], and the ASD was subsequently approved by the IEPA [7].

Subsequent compliance sampling events (following E001) were evaluated for exceedances of the GWPS as described in 35 I.A.C. § 845.600 [8, 9, 10, 11, 12, 13]. Exceedances identified during the subsequent events were consistent with those listed above. In addition to the exceedances listed above, the following exceedances were identified:

- Lithium at well 22
- Total dissolved solids (TDS) at well 35

[4] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or GWPSs as described in the proposed groundwater monitoring program, which was submitted to the IEPA on October 25, 2021 as part of DMG's operating permit application for the HPP WAPS. That operating permit application, including the proposed groundwater monitoring program, remains under review by the IEPA and, therefore, DMG has not identified any actual exceedances.

In accordance with 35 I.A.C. § 845.660, a Corrective Measures Assessment was developed to address current and potential future GWPS exceedances originating from the WAPS, exclusive of the cadmium exceedance addressed in the ASD, and was submitted to IEPA on May 8, 2024 [14]. The 35 I.A.C. § 845.650 groundwater monitoring requirements will continue to ensure that there will be timely detection of changes in groundwater quality during the stay. The selected remedy will meet the performance standards of 35 I.A.C. § 845.670(d) and once implemented and completed, the selected remedy presented in the Corrective Action Plan will attain the GWPSs.

1.5 Supplemental Site Investigation

A limited investigation was conducted in 2024 in accordance with 35 I.A.C. § 845.650 to assess the hydraulic conductivity of the bedrock in preparation for design of the proposed bedrock cutoff wall. Three borings were advanced along the perimeter of the HPP WAPS through unconsolidated materials and into competent bedrock. Soil lithology was logged continuously from borings completed at these locations, and packer testing was conducted on select intervals from each boring to evaluate ranges in bedrock hydraulic conductivities. During the bedrock investigation, one aquifer solids sample was collected to further assess nature, degree, and extent of arsenic groundwater impacts downgradient of the HEN WAPS [15].

2. CORRECTIVE ACTION GROUNDWATER MONITORING PLAN

This Corrective Action GMP is being provided to propose a groundwater monitoring program specific to the WAPS that will comply with 35 I.A.C. § 845.680. The Corrective Action GMP will monitor and evaluate groundwater quality specifically to document the effectiveness of the corrective action remedy. The groundwater monitoring program will include sampling and analysis procedures that are consistent and that provide an accurate representation of groundwater quality.

2.1 Corrective Action Groundwater Monitoring Program and Parameters

2.1.1 35 I.A.C. § 845 Corrective Action Groundwater Monitoring

The proposed 35 I.A.C. § 845 corrective action monitoring well network will consist of eight wells to document the effectiveness of the corrective action remedy and ultimately demonstrate compliance with GWPSs (**Figure 2-1**). The wells included in the corrective action monitoring well network include select compliance monitoring wells from the Operating GMP network (*e.g.*, those with previously reported exceedances of the GWPS) (**Section 1.4**).

As appropriate to meet the corrective action monitoring objectives and evaluate the effectiveness of the corrective action remedy (as described in **Section 3**), the corrective action monitoring program involves assigning each well to a monitoring category or purpose (**Table 2-1**). These monitoring categories include:

- **Inside Plume**: monitoring wells installed at the CCR boundary with GWPS exceedances.
- **Plume Definition**: wells located along the lateral or vertical boundary of the plume.

A summary of the well locations and associated purpose as it relates to the above categories is presented in **Table 2-1** and **Figure 2-1**. Monitoring well depths and construction details are listed in **Table 2-2**, and boring logs and monitoring well construction forms are provided in **Appendix A**. Groundwater samples will be collected and analyzed for the laboratory and field parameters in **Table 2-3**. Laboratory parameters include major ions for evaluating groundwater chemistry and constituents of concern (COCs) (*i.e.*, reported exceedances in accordance with the Operating GMP) the Corrective Action is intended to address. Sampling to evaluate corrective action effectiveness will begin the quarter after the corrective action remedy is implemented and commissioned.

2.2 Sampling Schedule

All wells in the corrective action GMP network, as presented in **Table 2-1**, will be sampled quarterly to provide a complete picture of corrective action effectiveness. Groundwater elevations will be determined at the time of sample collection from each well. Sampling will end in accordance with 35 I.A.C. § 845.680(c), when compliance with the GWPS has been demonstrated "at all points within the plume of contamination that lies beyond the waste boundary […] for a period of three consecutive years" (details in **Section 3.3**).

Consistent with 35 I.A.C. § 845.650(b)(4), quarterly sampling may be reduced to a semiannual frequency with IEPA approval after completion of five years of monitoring. A request for reduced sampling frequency will include a demonstration that corrective action monitoring effectiveness

will not be compromised; sufficient data has been collected to evaluate ongoing remedy effectiveness; and existing data show trends consistent with anticipated remedy performance (details in **Section 3.1**).

2.3 Groundwater Sample Collection

Groundwater sampling procedures have been developed and the collection of groundwater samples is being implemented to meet the requirements of 35 I.A.C. § 845.640. In addition to groundwater well samples, quality assurance samples will be collected as described in **Section 2.5** (**Table 2-3**). Groundwater samples will be collected and analyzed in accordance with the Multi-Site Sampling and Analysis Plan [16][5].

2.4 Laboratory Analysis

Laboratory analysis will be performed consistent with the requirements of 35 I.A.C. § 845.640(j) by a state-certified laboratory using methods approved by IEPA and USEPA. Laboratory methods may be modified based on laboratory equipment availability or procedures, but the Reporting Limit (RL) for all parameters analyzed, regardless of method, will be lower than the applicable groundwater quality standard [17]. Concentrations lower than the RL will be reported as less than the RL.

2.5 Quality Assurance Program

Consistent with the requirements of 35 I.A.C. § 845.640(a)(5), the sampling and analysis program includes procedures and techniques for quality assurance/quality control (QA/QC)[5]. Additional quality assurance samples to be collected will include the following:

- Field duplicates will be collected at a frequency of one per group of ten or fewer investigative water samples.
- One equipment blank sample will be collected and analyzed for each day of sampling. If dedicated sampling equipment is used, then equipment blank samples will not be collected.
- The duplicate and equipment blank quality assurance samples will be supplemented by the laboratory QA/QC program, which typically includes:
  - Regular generation of instrument calibration curves to assure instrument reliability
  - Laboratory control samples and/or quality control check standards that have been spiked, and analyses to monitor the performance of the analytical method
  - Matrix spike/matrix spike duplicate analyses to determine percent recoveries and relative percent differences for each of the parameters detected
  - Analysis of replicate samples to check the precision of the instrumentation and/or methodology employed for all analytical methods
  - Analysis of method blanks to assure that the system is free of contamination

Water quality meters used to measure pH and turbidity will be calibrated according to manufacturer's specifications. At a minimum, it is recommended that calibration of pH occur daily prior to sampling and checked for accuracy at the end of each day. Unusual or suspect pH

[5] The Multi-Site Sampling and Analysis Plan and Multi-Site Quality Assurance Project plan are living documents which are subject to routine evaluation and updates in accordance with USEPA recommended best practices [24, 25].

measurements during sampling events will be flagged, evaluated, and additional calibration may be performed throughout the sampling events. Turbidity meters will be checked daily, prior to and following sampling. Unusual measurements or erratic meter performance will be flagged and evaluated for overall effects on the data prior to reporting.

2.6 Groundwater Monitoring Well Maintenance Plan

Consistent with the requirements of 35 I.A.C. § 845.630(e)(2), maintenance will be performed according to the Multi-Site Sampling and Analysis Plan [16] as needed to assure that the monitoring wells provide representative groundwater samples. Monitoring wells will be inspected during each groundwater sampling event; inspections will consist of the following:

- Visual inspection, clearing of vegetation, replacement of markers, and painting of protective casings as needed to assure that monitoring wells are clearly marked and accessible
- Visual inspection and repair or replacement of well aprons as needed to assure that they are intact, drain water away from the well, and have not heaved
- Visual inspection and repair or replacement of protective casings as needed to assure that they are undamaged, and that locks are present and functional
- Checks to assure that well caps are intact and vented, unless in flood-prone areas in which case caps will not be vented
- Routine measurement of monitoring well depths to determine the degree of siltation within the wells. Wells will be redeveloped as needed to remove siltation from the screened interval if it impedes flow of water into the well
- Checks to assure that wells are clear of internal obstructions, and flow freely

If wells are damaged or become otherwise inoperable, they will be replaced by wells screened at the same elevation and as close to the original well as possible (ideally within 10 feet) and notification will be provided to IEPA. If a replacement well cannot be installed within approximately 10 feet of the original well location, notification will be sent to IEPA and a monitoring well will be installed as close as possible to the original monitoring well and given a new well identification number. Any well replacement activities will also be documented in the Annual Groundwater Monitoring and Corrective Action Report.

2.7 Statistical Analysis

A Multi-Site Statistical Analysis Plan (StAP) (**Appendix B**), has been developed to summarize the statistical procedures that will be used to evaluate the groundwater results.

2.8 Data Reporting

Groundwater monitoring and analysis completed in accordance with 35 I.A.C. § 845 under an approved monitoring program will be reported to IEPA annually by January 31 as required by I.A.C. § 845.550, for data collected the preceding year. The Annual Groundwater Monitoring and Correct Action Report will include the status of the groundwater monitoring and Corrective Action Plan for the WAPS in addition to other requirements detailed in 35 I.A.C. § 845.610(e).

2.9 Compliance with Applicable Groundwater Protection Standards

As provided in 35 I.A.C. § 845.680(c)(2), corrective action is considered complete when compliance with the GWPS has been achieved by demonstrating that concentration of

constituents listed in 35 I.A.C. § 845.600 have not exceeded the GWPSs for a period of three consecutive years, using the statistical procedures and performance standards in 35 I.A.C. § 845.640(f) and (g).

Attainment of GWPSs and conclusion of corrective action monitoring is discussed below in **Section 3.3**.

If a new exceedance is determined during monitoring under the Operating GMP, the Corrective Action groundwater monitoring program will be evaluated for monitoring of additional locations and/or constituents using the adaptive site management methods presented herein.

3. EFFECTIVENESS OF THE CORRECTIVE ACTION REMEDY

The methods for evaluating the effectiveness of the corrective action remedy described in this section are based on the following guidance documents:

- "Methods for Evaluating the Attainment of Cleanup Standards Volume 2: Groundwater," Office of Policy, Planning, and Evaluation, 1992 [18].
- "Groundwater Remedy Completion Strategy: Moving Forward with the End in Mind," Office of Solid Waste and Emergency Response, 2014 [19].
- "Adaptive Site Management – A Framework for Implementing Adaptive Management at Contaminated Sediment Superfund Sites," USEPA, Office of Superfund Remediation and Technology Innovation, 2022 [20].
- "Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model," USEPA Office of Solid Waste and Emergency Response, 2011 [21].

Evaluation of corrective action remedy effectiveness will occur in three phases (**Figure 3-1**): remedy progress evaluation, stability evaluation, and attainment evaluation [18].

1. Remedy progress evaluation occurs after implementation of corrective actions to assesses if the remedy is functioning as anticipated.
2. The stability evaluation, which assesses if a new post-treatment steady state in the groundwater has been reached.
3. Attainment evaluation occurs after a new steady state has been achieved and assesses if COC concentrations are below the GWPS.

COCs are parameters with exceedances of the GWPS to be addressed by the Corrective Action Plan. Corrective action monitoring at HEN WAPS includes the following COC parameters:

- Arsenic, boron, lithium, sulfate, and TDS

The effectiveness of the remedy at each phase is evaluated using performance metrics designed to assess the goals of that phase. Performance metrics answer questions designed to evaluate multiple aspects of remedy effectiveness with the ultimate goal of holistically guiding management decisions [19]. These metrics may be evaluated using qualitative (subject to expert judgement) or quantitative (numerical outcomes) methods.

This section details the goals and performance metrics of each phase of remedy evaluation. Within each phase, the well groups described in **Section 2.1** have distinct applicable metrics and/or potential management actions consistent with the role of that well group within the corrective action monitoring framework. The remedy evaluation metrics documented here are specific to wells within the Corrective Action monitoring program.

3.1 Remedy Progress Evaluation

The goal of remedy process evaluation is to determine if a groundwater remedy is on track to achieve cleanup standards within the proposed time frame and to inform adaptive management decisions if performance metrics are not achieved. Evaluation of remedy progress includes evaluating the response of COCs in individual monitoring wells and in the plume as a whole. Remedy progress is evaluated using performance metrics as described below. **Table 3-1** details

the questions used to assess remedy progress and metrics which would trigger additional evaluation of adaptive site management options. **Figure 3-2** presents an outline of the decision-making process regarding adaptive management actions (the first step of which is assessing remedy progress per **Table 3-1**).

Documentation of remedy progress metrics will be provided in the Annual Groundwater Monitoring and Corrective Action Report (**Section 2.8**) beginning after the second year of data collection: a minimum of eight data points is required to complete meaningful statistical analysis required for evaluation of the remedy progress metrics, which will be available after two years of quarterly sampling. Per USEPA guidance [19], a thorough review of corrective action progress and remedy effectiveness will be conducted every five years. A Five-Year Annual Groundwater Monitoring and Corrective Action Report will evaluate the comprehensive data set and, if triggered by the results of the remedy progress evaluation metrics (**Table 3-1**), evaluate whether adaptive management actions are needed (**Figure 3-2**). The five-year time frame allows adaptive management decisions to be based on a robust data sufficient to complete meaningful statistical analysis while remaining responsive to changing site conditions [19]. The remedy progress evaluation metrics and triggers for additional evaluation are described below.

3.1.1 Comparison to Groundwater Protection Standard

The plume wells in this monitoring plan were defined based on exceedances of the GWPS. The question posed to evaluate whether exceedances of the GWPS occur, and associated method of evaluation is (**Table 3-1**):

- Are COC concentrations greater than the GWPS? – Compare data points or summary statistics to site-specific GWPS values.

COC concentrations below the GWPS in plume wells may indicate that remedial actions are approaching completion and that moving to the next phase of remedy effectiveness evaluation may be warranted (see **Section 3.2**). Persistence of COC concentrations above the GWPS in Plume Definition wells may indicate that the plume is no longer properly delineated. Therefore, the trigger criterion for further evaluation is a central tendency measure of the last eight data points exceeding the GWPS.

3.1.2 Agreement with Groundwater Model

A groundwater flow and transport model[6] was used to compare the anticipated time to reach the GWPS for the different corrective actions considered at the WAPS.

The question posed to evaluate agreement of corrective action remedy progress with the groundwater model results is provided in **Table 3-1** and summarized below:

- Are concentrations of COCs at individual wells consistent with modeling expectations? – Evaluate if the observed results track with the predicted results in general direction and magnitude using expert professional judgement.

Only plume and Plume Definition wells included in the flow and transport model are evaluated according to this metric. Trigger criteria for additional adaptive site management evaluation include monitoring results failing to follow the general magnitude and direction of groundwater

[6] The Groundwater Modeling Technical Memorandum is included as an attachment to the Corrective Actions Alternative Analysis presented as part of the Corrective Action Plan.

model results at one or more locations. It is acceptable to conclude that if no further adaptive site management evaluation is triggered if future observations do not precisely match modeled results on an individual well basis if the direction of remedy progress is adequate.

3.1.3 Trend Analysis

Evaluation of COC trends in wells both within and outside of the plume is a major component of remedy progress evaluations [18, 19]. Decreasing COC concentrations within the groundwater plume provides critical support for remedy effectiveness evaluations. Changing concentrations in wells defining the plume may indicate unanticipated plume migration or a need for better Plume Definition. Both short-term and long-term trends are important to evaluate remedy performance [18]. All trend analyses are performed in accordance with the Multi-Site StAP (**Appendix B**) and the USEPA Unified Guidance for groundwater statistics [22].

The questions posed to evaluate if COC concentrations are decreasing in Inside Plume wells and the associated methods for evaluation are provided in **Table 3-1** and summarized as follows:

- Are average plume COC concentrations decreasing? – Evaluate trend based on quarterly average of COC concentrations of Inside Plume wells, both for the last eight sampling events and since corrective action was initiated.

The questions posed to evaluate if COC concentrations are changing in Inside Plume wells and Plume Definition wells and the associated methods for evaluation are provided in **Table 3-1** and summarized below:

- Are concentrations of COCs at individual wells changing? – Evaluate trend of COC concentrations, both for the last eight sampling events and since corrective action was initiated.

The goal of the corrective action is to reduce COC concentrations in the groundwater. Therefore, trigger criteria have been established for the two types of corrective action monitoring wells as follows:

- Inside Plume well triggers for adaptive site management evaluation are based on no decreasing trend in COC concentrations (short-term or long-term).
- Plume Definition well triggers are based on increasing COC concentrations, which may indicate improper delineation of the plume. Therefore, the trigger criterion for adaptive site management evaluation at Plume Definition wells is increasing short- or long-term trend.

3.1.4 Adaptive Management Actions

The goal of adaptive management actions is to understand why performance metrics are not met and, if the remedy is found to be unsuccessful in meeting remediation goals, drive supplemental corrective actions or, in extreme cases, re-evaluation of remedy selection. This section describes in greater detail the steps in the flow chart presented in **Figure 3-2** (adapted from Figure 2 in [19]).

As the remedy progress evaluation metrics are evaluated annually, failure to meet the metrics (as described in **Table 3-1**) leads to further action. If the data available at the time of the Five-Year Review are anticipated to be inadequate for determining the need for adaptive site

management actions, additional data may be collected before the Five-Year Review including collecting samples from additional wells or measuring additional parameters.

If the remedy progress is not found to be adequate during the Five-Year Review, the most critical question is whether or not the remedy is likely to achieve the GWPS in a reasonable time frame. This may be evaluated using methods such as regression analysis or analysis of groundwater flow. If the remedy progress is not judged to be adequate but the remedy is likely to achieve the GWPS in a reasonable time frame, the CSM or the groundwater model may require updating to reflect evolving field conditions[7]. Additional data collected may also suggest ways to optimize the monitoring network or performance metrics [19].

If the remedy does not appear likely to achieve the GWPS in a reasonable time frame, it may be due to changing hydrogeochemical dynamics within the plume or an additional source of COCs not accounted for in the CSM. If available data suggests either occurrence, the Five-Year Review will describe additional activities planned to investigate if the existing remedy is still a viable option for attaining the GWPS. If the remedy is still viable, an update to the CSM and groundwater model is likely required [19, 21] and will be conducted after additional investigation is completed.

If the remedy does not appear likely to achieve the GWPS in a reasonable time frame, the plume is appropriately delineated, there is no alternative source of COCs not accounted for in the CSM, and the plume is appropriately delineated; or if the investigation into the hydrogeochemical changes or alternative source of COCs determines that the remedial action is no longer solely viable as a corrective action, an evaluation of additional remedial actions will be initiated.

If the remedy progress evaluation metrics indicate that concentrations across the monitoring network are below the GWPS, the remedy progress phase may be considered complete, and the monitoring program may move to the Stability Evaluation phase (see **Section 3.2**).

3.2 Stability Evaluation

Evaluation of groundwater stability reflects the idea that implementation of a remedy will, by necessity, cause changes to the physical and chemical environment of the groundwater. Before assessing if compliance with the GWPS has been attained (Section 3.3), any transient effects of treatment on the groundwater (e.g., rebounding concentrations) should be allowed to dissipate [18]. Stability is evaluated to assess if a new stable equilibrium has been reached after final closure has been implemented. Stability is achieved when groundwater elevations are stable (accounting for seasonal variability); average COC concentrations are stable across all wells; and COC concentrations are stable at each well.

Trends in groundwater elevation and COC concentrations at each plume well will be evaluated using the most recent eight data points (*i.e.*, two years of data when sampling quarterly) according to methods presented in the Multi-Site StAP (**Appendix B**). This metric is met for a plume well when there is no statistically significant trend for three consecutive years.

Plume COC concentrations will be evaluated for trend using the most recent eight data points, with the average concentration across plume wells per sampling event considered as one data

[7] As stated in Section 1.4.1 of the Corrective Action Plan, "Estimated times to reach GWPS will be periodically reviewed and updated based on observed corrective action performance via an adaptive site management strategy."

point, according to methods presented in the Multi-Site StAP (**Appendix B**). This metric is met when there is no statistically significant trend in groundwater elevation or COC concentrations.

3.3 Attainment Evaluation and Conclusion of Corrective Action Monitoring

The ultimate goal of groundwater corrective action is to attain compliance with the GWPS for each COC in Inside Plume wells. After stability has been achieved per the metrics discussed in **Section 3.2**, attainment evaluation will begin. Per 35 I.A.C. § 845.680(c), corrective action is considered complete when compliance with the GWPS has been demonstrated "at all points within the plume of contamination that lies beyond the waste boundary […] for a period of three consecutive years". Attainment of the GWPS will be evaluated in accordance with the Multi-Site StAP (**Appendix B**). Corrective Action monitoring is considered complete for the site when COCs in the corrective action monitoring well network do not exceed the GWPS for three years.

4. REFERENCES

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TABLES

Table 1-1. 35 I.A.C. § 845 Requirements Checklist
Corrective Action Groundwater Monitoring Plan
Hennepin Power Plant
West Ash Pond System
Hennepin, IL

35 I.A.C. § 845 Reference	35 I.A.C. § 845 Components	Location of Information in Corrective Action GMP
845.630	**Groundwater Monitoring Systems**	
845.630(a)(2)	Potential contaminant pathways must be monitored.	NA
845.630(a) 845.630(b) 845.630(c)	At least two upgradient wells and four downgradient wells (min. 1 and 3, but requires additional documentation)	Section 2.1 Figure 2-1
845.630(a) 845.630(b) 845.630(c)	Downgradient Well Density	Figure 2-1
845.630(a)(2)	Downgradient wells at waste boundary	Figure 2-1
845.640	**Groundwater Sampling and Analysis Requirements**	
845.640(a)	Consistent sampling and analysis procedures	Section 2 Tables 2-1 and 2-3
845.640(b)	Methods are appropriate	Section 2 Tables 2-1 and 2-3
845.640(c)	Groundwater elevations must be measured in each well prior to purging, each time groundwater is sampled.	Section 2.2
845.640 (d)(e)(f)(g)(h)	Establishment of background and application of statistical methods	Section 2.7
845.640(i)	Analyze total recoverable metals	Sections 2.1 and Section 2.4
845.640(j)	Analyze groundwater samples using a certified laboratory	Section 2.4

Table 1-1. 35 I.A.C. § 845 Requirements Checklist
Corrective Action Groundwater Monitoring Plan
Hennepin Power Plant
West Ash Pond System
Hennepin, IL

35 I.A.C. § 845 Reference	35 I.A.C. § 845 Components	Location of Information in Corrective Action GMP
845.650	**Groundwater Monitoring Program**	
845.650(a)	Must include monitoring for all constituents with a groundwater protection standard in Section 845.600(a), calcium, and turbidity	Section 2.1
845.650(b)(c)	Groundwater Monitoring Frequency	Sections 2.1
845.650(d)(e)	Exceedances of the groundwater protection standard	Section 3.1.1
NA	Staff gauge/ piezometer to monitor head of neighboring surface water body	Section 1.3 Figure 1-4
845.680	**Implementation of the Corrective Action Plan**	
845.680(a)(1)(a)	Establish and implement a corrective action groundwater monitoring program that meets requirements of 845.650	Sections 2.3 and 3 Tables 2-1 and 3-1 Figure 2-1
845.680(a)(1)(b)	Document the effectiveness of the corrective action remedy	Section 3
845.680(a)(1)(c)	Demonstrate compliance with the groundwater protection standard under Subsection [845.680] (c)	Sections 3.11

Table 1-1. 35 I.A.C. § 845 Requirements Checklist
Corrective Action Groundwater Monitoring Plan
Hennepin Power Plant
West Ash Pond System
Hennepin, IL

35 I.A.C. § 845 Reference	35 I.A.C. § 845 Components	Location of Information in Corrective Action GMP
845.680(c)(1)	Demonstrate compliance with the groundwater protection standards established by 845.600 has been achieved at all points within the plume of contamination that lies beyond the waste boundary	Section 3
845.680(c)(2)	Demonstrate that concentrations of constituents listed in 845.600 have not exceeded the groundwater protection standards for a period of three consecutive years using statistical procedures and performance standards in 845.640(f) and (g)	Section 3

[O: CJC 08/17/21; C: LDC 08/30/21; U: MKC 07/16/24]

Notes:
GMP = Groundwater Monitoring Plan
NA = Not Applicable

Table 2-1. Summary of Monitoring Well Locations and Purpose
Corrective Action Groundwater Monitoring Plan
Hennepin Power Plant
West Ash Pond System
Hennepin, IL

Well ID	Monitored Unit	Corrective Action Monitoring Well System	
		Inside Plume	Plume Definition
21R	UA	X	
22	UA	X	
22D	UA		X
23	UA	X	
27	UA		X
35	UA	X	
50	UA		X
51	UA	X	

[O: JRK 11/26/2024; C: CJC 12/10/2024]

Notes:
UA = uppermost aquifer

Table 2-2. Monitoring Well Locations and Construction Details
Corrective Action Groundwater Monitoring Plan
Hennepin Power Plant
West Ash Pond System
Hennepin, IL

Location	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft bgs)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
21R	UA	02/06/2020	452.05	452.05	Top of PVC	449.37	37.6	47.6	411.77	401.77	50.0	399.4	10	2	41.299866	-89.328914
22	UA	12/09/1982	464.45	464.45	Top of PVC	461.46	24.4	34.4	437.06	427.06	34.6	426.9	10	2	41.302032	-89.321512
22D	UA	08/07/2019	465.43	465.43	Top of PVC	461.83	49.7	59.7	412.16	402.16	59.7	401.8	10	2	41.302017	-89.321572
23	UA	12/10/1982	463.39	463.39	Top of PVC	460.88	34.0	44.0	426.88	416.88	45.2	415.7	10	2	41.300881	-89.325376
27	UA	09/11/1995	450.58	450.58	Top of PVC	448.21	30.0	35.0	418.21	413.21	36.3	412.0	5	2	41.296911	-89.328898
35	UA	09/08/1999	454.83	454.83	Top of PVC	451.51	8.0	18.0	443.51	433.51	17.6	433.9	10	2	41.29916	-89.324145
50	UA	08/07/2019	463.94	463.94	Top of PVC	460.59	19.6	29.6	440.99	430.99	29.6	430.6	10	2	41.302243	-89.320647
51	UA	02/04/2020	464.80	464.80	Top of PVC	461.50	56.0	66.0	405.50	395.50	66.3	394.5	10	2	41.300639	-89.326953

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
bgs = below ground surface
ft = foot or feet
HSU = Hydrostratigraphic Unit
PVC = polyvinyl chloride
UA = uppermost aquifer

Table 2-3. Sampling and Analysis Summary
Corrective Action Groundwater Monitoring Plan
Hennepin Power Plant
West Ash Pond System
Hennepin, IL

Parameter	Analytical Method [1]	Number of Samples	Field Duplicates [2]	Field Blanks [3]	Equipment Blanks [3]	MS/MSD [4]	Total	Container Type	Minimum Volume [5]	Preservation (Cool to 6 °C for all samples)	Sample Hold Time from Collection Date
Corrective Action Parameter(s)[6]											
Arsenic	6020 [7]	8	1	0	0	1	10	plastic	600 mL	HNO_3 to pH<2	6 months
Boron	6020 [7]	8	1	0	0	1	10	plastic	600 mL	HNO_3 to pH<2	6 months
Lithium	EPA 200.7	8	1	0	0	1	10	plastic	600 mL	HNO_3 to pH<2	6 months
Sulfate	9056A, 9251 or EPA 300	8	1	0	0	1	10	plastic	50 mL	Cool to 6 °C	28 days
Total Dissolved Solids	SM 2540 C	8	1	0	0	1	10	plastic	200 mL	Cool to 6 °C	7 days
Inorganic Parameters											
Alkalinity, bicarbonate	SM 2320 B	8	1	0	0	1	10	plastic	500 mL	Cool to 6 °C	14 days
Alkalinity, carbonate	SM 2320 B	8	1	0	0	1	10	plastic	500 mL	Cool to 6 °C	14 days
Chloride	9056A, 9251 or EPA 300	8	1	0	0	1	10	plastic	100 mL	Cool to 6 °C	28 days
Fluoride	9056A, 9251 or EPA 300	8	1	0	0	1	10	plastic	300 mL	Cool to 6 °C	28 days
Magnesium	6020 [7]	8	1	0	0	1	10	plastic	600 mL	HNO_3 to pH<2	6 months
Sodium	6020 [7]	8	1	0	0	1	10	plastic	600 mL	HNO_3 to pH<2	6 months
Potassium	6020 [7]	8	1	0	0	1	10	plastic	600 mL	HNO_3 to pH<2	6 months
Field Parameters											
pH	SM 4500-H+ B	8	NA	NA	NA	NA	8	flow-through cell	NA	none	immediately
Dissolved Oxygen [8]	SM 4500-O/405.1	8	NA	NA	NA	NA	8	flow-through cell	NA	none	immediately
Temperature [8]	SM 2550	8	NA	NA	NA	NA	8	flow-through cell	NA	none	immediately
Oxidation/Reduction Potential [8]	SM 2580 B	8	NA	NA	NA	NA	8	flow-through cell	NA	none	immediately
Specific Conductance [8]	SM 2510 B	8	NA	NA	NA	NA	8	flow-through cell	NA	none	immediately
Turbidity [9]	SM 2130 B	8	NA	NA	NA	NA	8	flow-through cell or hand-held turbidity meter	NA	none	immediately

[O: JRK 11/26/2024; C: CJC 12/10/2024]

Notes:
[1] Analytical method numbers are from SW-846 unless otherwise indicated. Analytical methods may be updated with more recent versions as appropriate.
[2] Field duplicates will be collected at a frequency of one per group of 10 or fewer investigative water samples. Field duplicates will not be collected for radium analysis.
[3] Field blanks will be collected at the discretion of the project manager; Equipment blanks will be collected at a rate of 1 per sampling event if non-dedicated equipment is used.
[4] Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will be collected at a frequency of one per group of 20 or fewer investigative water samples per CCR unit/multi-unit. Additional volume to be determined by laboratory.
[5] Sample volume is estimated and will be determined by the laboratory.
[6] Determined by reported exceedances under the Operating Groundwater Monitoring Plan
[7] Metals may be analyzed via USEPA methods 6010 or 6020 depending on laboratory instrument availability.
[8] Parameter collected for quality assurance and quality control for field sampling purposes only; not required to be collected or reported under 35 IAC § 845; collection of parameter may be discontinued without notification.
[9] If turbidity exceeds 10 NTU, a duplicate sample filtered through a 0.45 micron filter may be collected for metals analysis in addition to the unfiltered sample. Both samples would be submitted for analysis.
< = less than
°C = degrees Celsius
HNO_3 = nitric acid
mL = milliliter
NA = not applicable
NTU = nephelometric turbidity unit

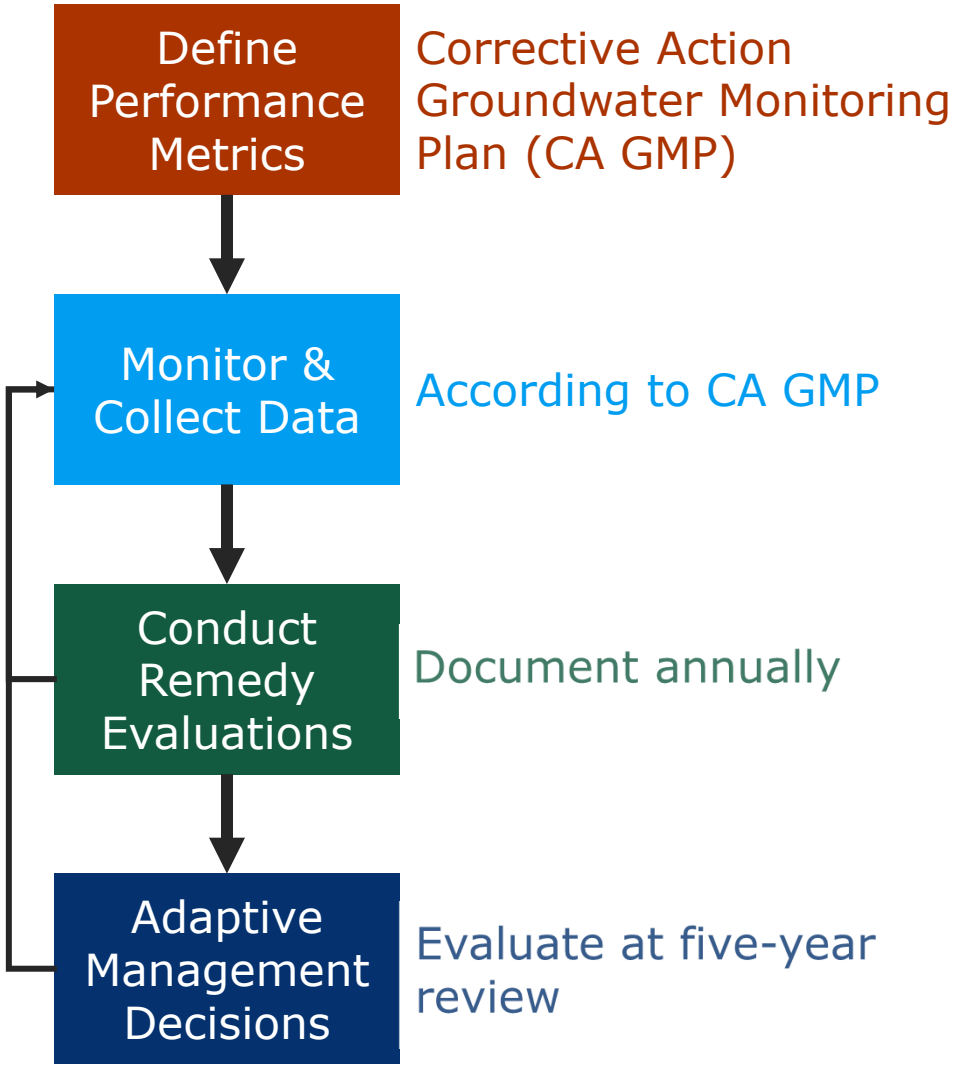
Table 3-1. Adaptive Site Management Metrics and Trigger Criteria
Corrective Action Groundwater Monitoring Plan
Hennepin Power Plant
West Ash Pond System
Hennepin, IL

QUESTION	Are COC concentrations greater than the GWPS?		Are concentrations of COCs at individual wells consistent with modeling expectations?[a]		Are the average COC concentrations decreasing?	Are concentrations of COCs at individual wells changing?	Adaptive Site Management Outcome
EVALUATION[b]	Compare data points or summary statistics to site-specific GWPS		Do the observed results track with the predicted results in general direction and magnitude? (Professional judgement)		Evaluate trend on quarterly average of well concentrations, both for last 8 data points and since corrective action initiated or closure completed	Evaluate trend of COCs at each well, both for last 8 data points and since corrective action initiated	
Inside Plume	Central tendency concentration of last eight data points above the GWPS	**AND**	Results inconsistent with model	**AND MORE THAN ONE OF**	Neither trend decreasing	Neither trend decreasing	**Additional Evaluation Triggered (See Figure 3-2)**
Lateral/Vertical Plume Definition	Central tendency concentration of last eight data points above the GWPS		Results inconsistent with model		--	Either trend increasing	

[O: CJC 10/23/2024; C: AOC 10/30/2024]

Notes:
a. Only applies to wells included in the flow and transport model
b. To be documented in Annual Monitoring and Corrective Action Reports
-- = No relevant trigger criteria
COC = constituent of concern
GWPS = groundwater protection standard

FIGURES



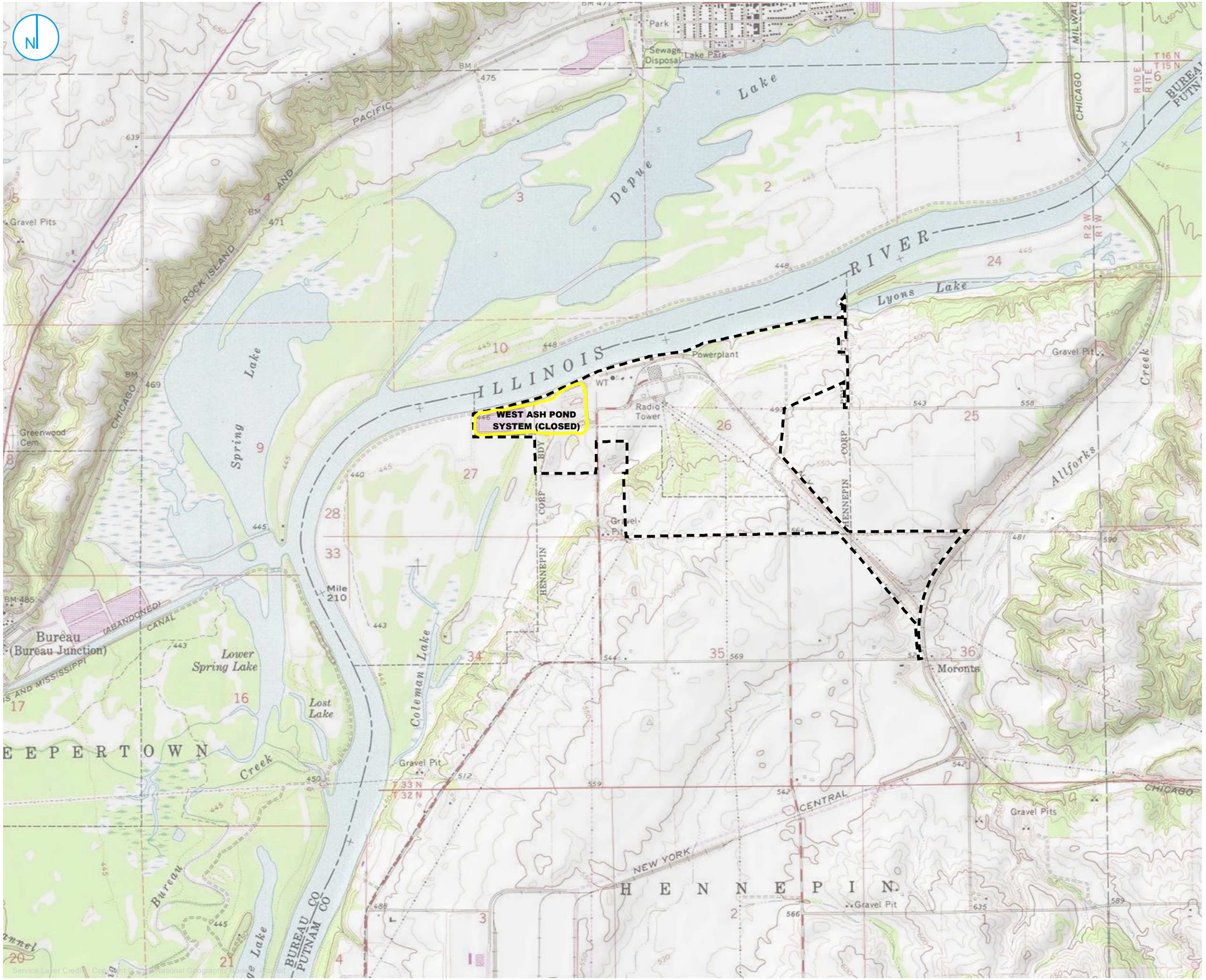
RAMBOLL

DRAFTED BY: AO | 11/27/2024

CORRECTIVE ACTION MONITORING OUTLINE

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
HENNEPIN POWER PLANT
WEST ASH POND SYSTEM
HENNEPIN, ILLINOIS

Figure 1-1



REGULATED UNIT (SUBJECT UNIT)

PROPERTY BOUNDARY

0 1,000 2,000 Feet

SITE LOCATION MAP

CORRECTIVE ACTION
GROUNDWATER MONITORING REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 1-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Service Layer Credits: Copyright © National Geographic Society, i-cubed

PROJECT: 169000XXXX | DATED: 4/23/2024 | DESIGNER: galammc

Y:\Mapping\Projects\22\2285\MXD\Nature_and_Extent\HEN\Nature_and_Extent_Report_Hen\West\Figure 1-1_Site Location Map.mxd

MONITORING WELL
REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 200 400
Feet

SITE MAP

CORRECTIVE ACTION
GROUNDWATER MONITORING REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 1-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\12285\MXD\GMP\Hennepin\OWAP_804\845_CorrectiveAction\HEN_804_845CA.aprx\Figure 1-3. Site Map

PROJECT: 169000XXXX | DATED: 12/10/2024 | DESIGNER: GALARNMC

COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
MONITORING WELL
GROUNDWATER ELEVATION CONTOUR (1 FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

NOTES:

1.ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.

2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

*ILLINOIS RIVER ELEVATION OBTAINED FROM STAFF GAGE SG02, LOCATED AT THE HENNEPIN POWER PLANT

0 200 400 Feet

UPPERMOST AQUIFER POTENTIOMETRIC SURFACE MAP MAY 30, 2023 (E001)

CORRECTIVE ACTION
GROUNDWATER MONITORING REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 1-4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 7/6/2023 | DESIGNER: GALARNMC

Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_2023\Hennepin\OWAP_804\HEN 804 OWAP Pot Surface 20230530.mxd

MONITORING WELL
REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY
XXX CORRECTIVE ACTION - INSIDE PLUME: DOWNGRADIENT OF CUTOFF WALL
XXX CORRECTIVE ACTION - LATERAL/VERTICAL PLUME DEFINITION

0 200 400 Feet

PROPOSED 35 I.A.C. § 845 CORRECTIVE ACTION MONITORING WELL LOCATION MAP

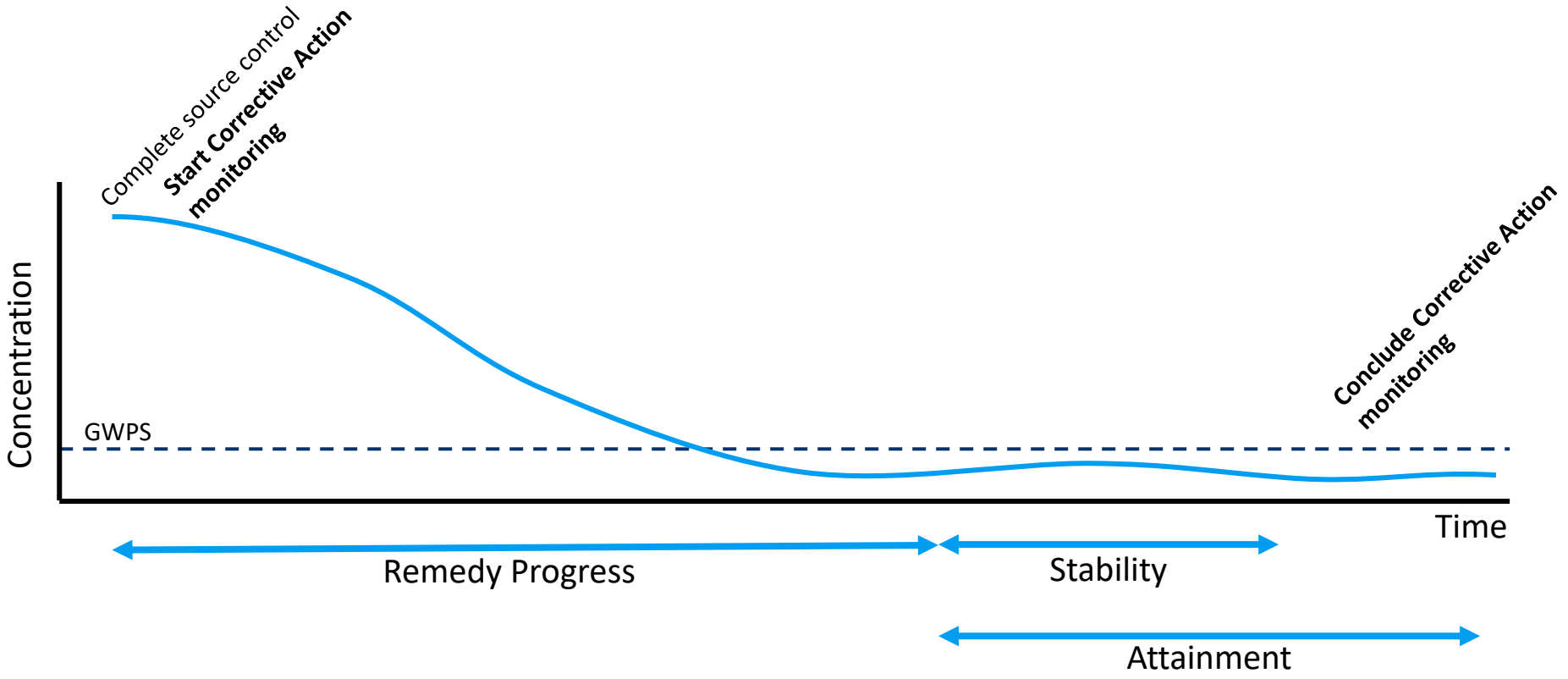
CORRECTIVE ACTION
GROUNDWATER MONITORING REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 12/11/2024 | DESIGNER: GALARNMC
Y:\Mapping\Projects\222285\MXD\GMP\Hennepin\OWAP_8041845_CorrectiveAction\HEN_804_845CA.aprx\Figure 2-1. Proposed 845 CA Monitoring Well Location Map



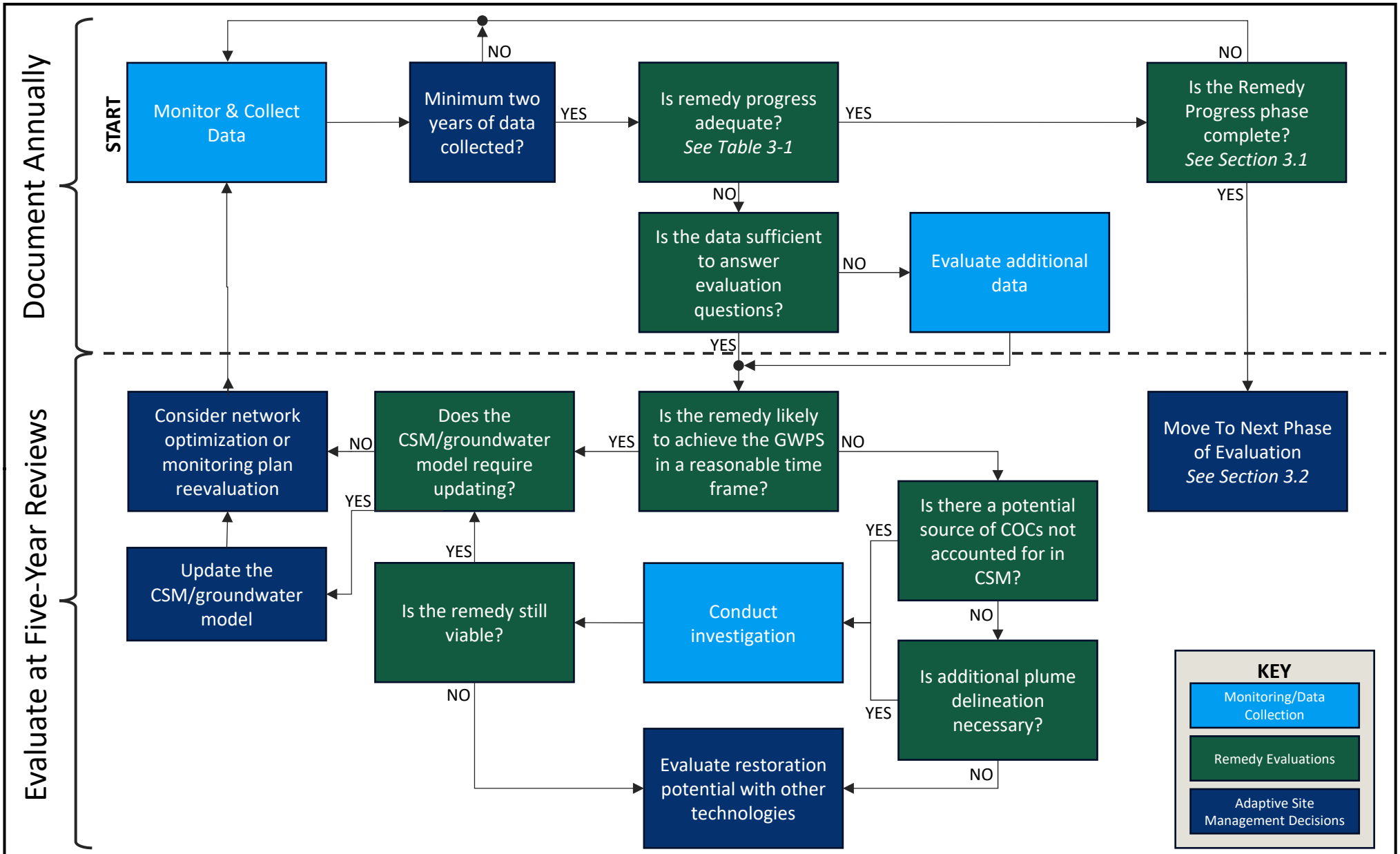
RAMBOLL

DRAFTED BY: AO | 11/27/2024

CORRECTIVE ACTION MONITORING TIMELINE

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
HENNEPIN POWER PLANT
WEST ASH POND SYSTEM
HENNEPIN, ILLINOIS

Figure 3-1



Adapted from Figure 2 in USEPA (2014) *"Groundwater Remedy Completion Strategy: Moving Forward with the End in Mind,"* Office of Solid Waste and Emergency Response. 9200.2-144. May. https://semspub.epa.gov/work/HQ/100000021.pdf

RAMBOLL

DRAFTED BY: AO | 11/27/2024

ADAPTIVE SITE MANAGEMENT FLOW CHART

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
HENNEPIN POWER PLANT
WEST ASH POND SYSTEM
HENNEPIN, ILLINOIS

Figure 3-2

APPENDICES

APPENDIX A
Boring Logs and Monitoring Well Construction Forms

Geosyntec consultants

1 McBride and Sons Center Dr
Suite 202
Chesterfield, MO 63005

GS FORM: WELL BORE 01/04

BOREHOLE LOG

BORING MW-21R **SHEET** 1 OF 2
START DRILL DATE February 5, 2020 **ELEVATION DATA:**
FINISH DRILL DATE February 5, 2020 **GROUND SURF. (Ft)** 449.37
LOCATION PUTNAM COUNTY, HENNEPIN IL **TOP OF CASING (Ft)** 452.05
PROJECT HENNEPIN POWER STATION **DATUM** NAVD 1988
NUMBER CHE8400

DEPTH (ft-bgs)	DESCRIPTION (1) Unit/Formation, Mem. 2) USCS Name 3) Color 4) Moisture 5) Percent Grain Size 6) Plasticity 7) Density/Consistency 8) Structure 9) Other (Mineralization, Discoloration, Odor, etc.)	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE NO.	TYPE	BLOW COUNT	N-Value	RECOVERY (%)	COMMENTS (1) Rig Behavior 2) Air Monitoring
0	Red brown, sandy gravel, GP, fill material					01		3 4 3 3	7	9/24	
						02		10 4 4 3	8	12/24	
	@ 4 ft wet				445	03		8 4 4 3	8	8/24	
5						04		1 0 0 1	0	12/24	
	@ 7.2 ft Dark gray, fly ash, ML, non-plastic, non-cohesive					05		1 1 2 2	3	18/24	
	@ 8 ft damp, medium soft				440						
10						06		1 1 1 1	2	14/24	
	No recovery					07		0 1 1 2	2	0/24	
	No recovery				435	08		0 1 1 2	2	24/24	
15											
	Gray/brown, silty clay, CL, medium plasticity, medium soft					09		0 1 2 2	3	24/24	
	Dark gray/black, diatomaceous, silty clay, CL, medium plasticity				430	10		0 0 1 2	1	24/24	
20	Dark gray, clay, CH, high plasticity, cohesive, medium soft, damp					11		0 0 2 2	2	24/24	
	Dark gray, silty clay, CL, medium low plasticity, medium soft, damp					12		0 1 1 2	2	20/24	
	@ 24 ft medium plasticity				425	13		0 1 1 2	2	24/24	
25						14		1 1 1 2	2	24/24	
	@ 28 ft diatomaceous				420	15		2 2 2 2	4	24/24	
30											

CONTRACTOR TSC
EQUIPMENT CME 75
DRILL MTHD HOLLOWSTEM AUGER
DIAMETER 6-inch
LOGGER C. CHRISTENSON **REVIEWER** L. CARR

NORTHING 1688527.77
EASTING 2526767.44
COORDINATE SYSTEM: STATE PLANE ILLINOIS WEST

NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

07-WELL BORE CHICAGO PROJECT.GPJ GEOSNTEC.GDT 2/24/20

Geosyntec consultants

1 McBride and Sons Center Dr
Suite 202
Chesterfield, MO 63005

GS FORM: WELL BORE 01/04

BOREHOLE LOG

BORING	**MW-21R**	**SHEET**	**2 OF 2**
START DRILL DATE	February 5, 2020	**ELEVATION DATA:**	
FINISH DRILL DATE	February 5, 2020	**GROUND SURF. (Ft)**	449.37
LOCATION	PUTNAM COUNTY, HENNEPIN IL	**TOP OF CASING (Ft)**	452.05
PROJECT	HENNEPIN POWER STATION	**DATUM**	NAVD 1988
NUMBER	CHE8400		

DEPTH (ft-bgs)	DESCRIPTION (1) Unit/Formation, Mem. 2) USCS Name 3) Color 4) Moisture 5) Percent Grain Size 6) Plasticity 7) Density/Consistency 8) Structure 9) Other (Mineralization, Discoloration, Odor, etc.)	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE NO.	TYPE	BLOW COUNT	N-Value	RECOVERY (%)	COMMENTS (1) Rig Behavior 2) Air Monitoring
	@ 31 ft fine sand lenses					16		0 1 1 2	2	24/24	
	Dark gray, diatomaceous silt with few clay, MH, soft, damp, low plasticity					17		1 1 1 2	2	24/24	
35	Dark gray, diatomaceous, silty clay, CL, medium plasticity, medium soft, damp				415	18		1 1 2 2	3	24/24	
	Dark gray, diatomaceous, silt with few clay and trace sand, MH, soft, damp, low plasticity					19		0 0 1 1	1	24/24	
	Dark gray, diatomaceous, silt with some clay, MH, medium-low plasticity, soft, damp				410	20		2 2 2 2	4	24/24	
40	Dark gray, silty sand, SM, wet					21		0 0 1 2	1	8/24	
	@ 41.5 ft, Dark Gray silty clay, CL, medium plasticity										
	Gray medium to fine sand, SP, with silty clay layer (CL), wet					22		2 3 4 4	7	24/24	
	@ 44 ft with trace clay and coarse sand				405						
45						23		3 5 3 5	8	24/24	
	Gray, fine sand, SP, with few coarse sand and some silt, medium soft, wet					24		6 9 10 12	19	24/24	
	Dark gray, silty clay, CL, medium plasticity, medium soft, damp					25		0 1 1 2	2	18/24	
50	End of boring at 50 ft.				400						
					395						
55											
					390						
60											

CONTRACTOR TSC
EQUIPMENT CME 75
DRILL MTHD HOLLOWSTEM AUGER
DIAMETER 6-inch
LOGGER C. CHRISTENSON
REVIEWER L. CARR

NORTHING 1688527.77
EASTING 2526767.44
COORDINATE SYSTEM: STATE PLANE ILLINOIS WEST

NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

07-WELL BORE CHICAGO PROJECT.GPJ GEOSNTEC.GDT 2/24/20

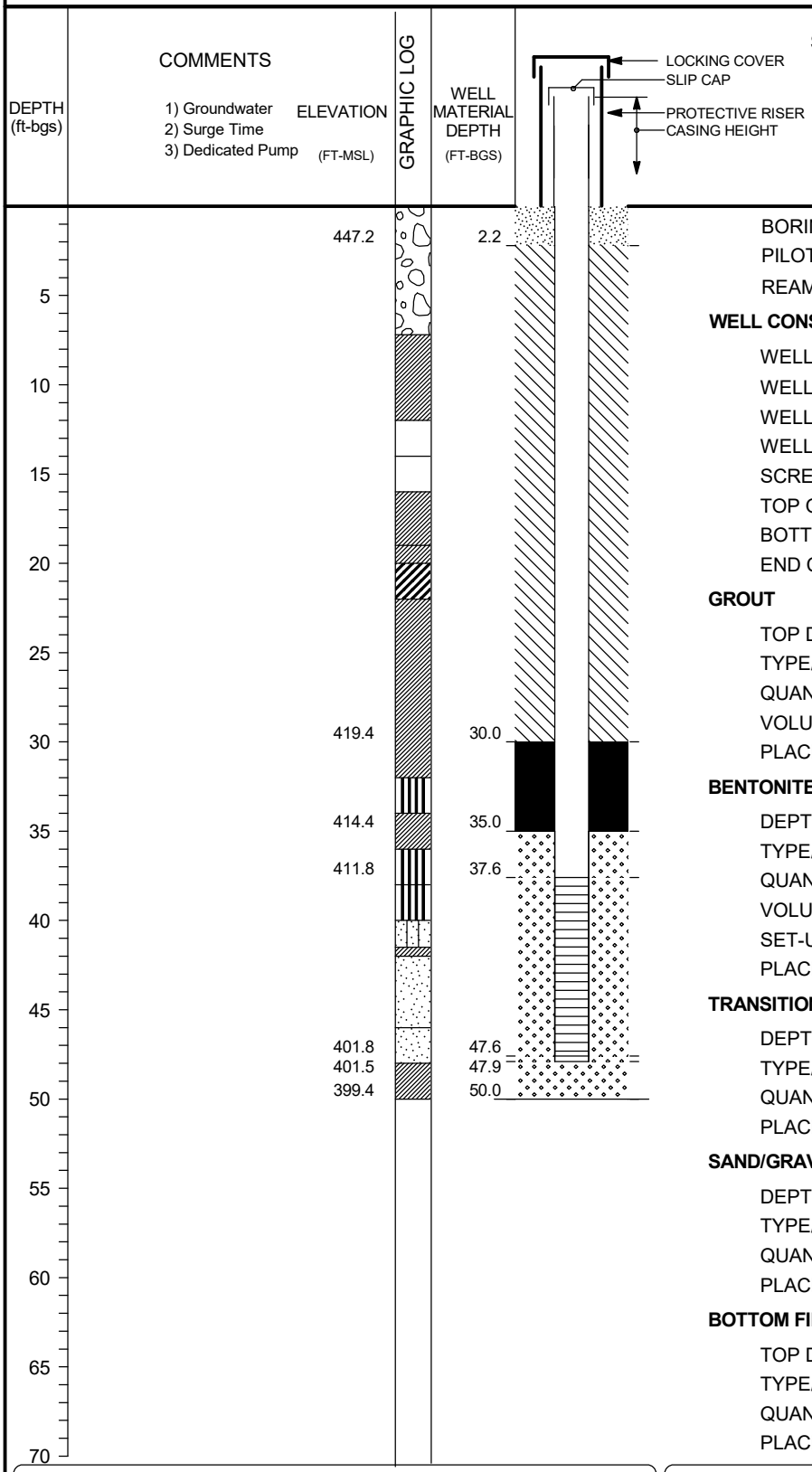
Geosyntec consultants

1 McBride and Sons Center Dr
Suite 202
Chesterfield, MO 63005

BORING	**MW-21R**	**SHEET**	**1 OF 1**
START DRILL DATE	February 5, 2020	**ELEVATION DATA:**	
FINISH DRILL DATE	February 5, 2020	**GROUND SURF. (Ft)**	449.37
LOCATION	PUTNAM COUNTY, HENNEPIN IL	**TOP OF CASING (Ft)**	452.05
PROJECT	HENNEPIN POWER STATION	**DATUM**	NAVD 1988
NUMBER	CHE8400		

GS FORM: WELL COMP AG 01/04

WELL CONSTRUCTION LOG



SURFACE COMPLETION:

TYPE	3-inch diameter steel
RISER HEIGHT	2.8-ft ags
RISER DIAM.	3-inch
WELL CASING HEIGHT	2.6-ft ags
CONCRETE PAD SIZE	

BORING DEPTH 50-ft bgs
PILOT BORING DIAMETER 6-inch
REAM BORING DIAMETER

WELL CONSTRUCTION

WELL CONSTRUCTION DATE 2/6/2020
WELL DEPTH 47.9 ft bgs
WELL CASING DIAMETER 2-inch
WELL CASING MATERIAL Sch. 40 PVC
SCREEN SLOT SIZE/DIRECTION 0.01-inch
TOP OF SCREEN 37.6 ft bgs
BOTTOM OF SCREEN 47.6 ft bgs
END CAP/SUMP LENGTH 0.33 ft

GROUT

TOP DEPTH 2.2 ft bgs
TYPE/BRAND Portland Cement/Quickgel
QUANTITY USED 150lbs cement/40 lbs gel
VOLUME FLUID USED 45 Gal
PLACEMENT METHOD Pump

BENTONITE SEAL

DEPTH 30 ft bgs
TYPE/BRAND 3/8-inch bentonite pellets
QUANTITY USED
VOLUME FLUID USED None
SET-UP TIME
PLACEMENT METHOD Hand

TRANSITION SAND

DEPTH
TYPE/BRAND
QUANTITY USED
PLACEMENT METHOD

SAND/GRAVEL PACK

DEPTH 35 ft bgs
TYPE/BRAND R.W. Sidley, Inc # 5 Sand
QUANTITY USED ~150 lbs
PLACEMENT METHOD Hand

BOTTOM FILL

TOP DEPTH
TYPE/BRAND
QUANTITY USED
PLACEMENT METHOD

CONTRACTOR TSC
EQUIPMENT CME 75
DRILL MTHD HOLLOWSTEM AUGER
DIAMETER 6-inch
LOGGER C. CHRISTENSON
REVIEWER L. CARR

NORTHING 1688527.77
EASTING 2526767.44
COORDINATE SYSTEM: STATE PLANE ILLINOIS WEST

Notes

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

08-WELL_COMP_AG CHICAGO PROJECT.GPJ GEOSNTEC.GDT 2/24/20

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-2
SHEET 1 OF 1

22

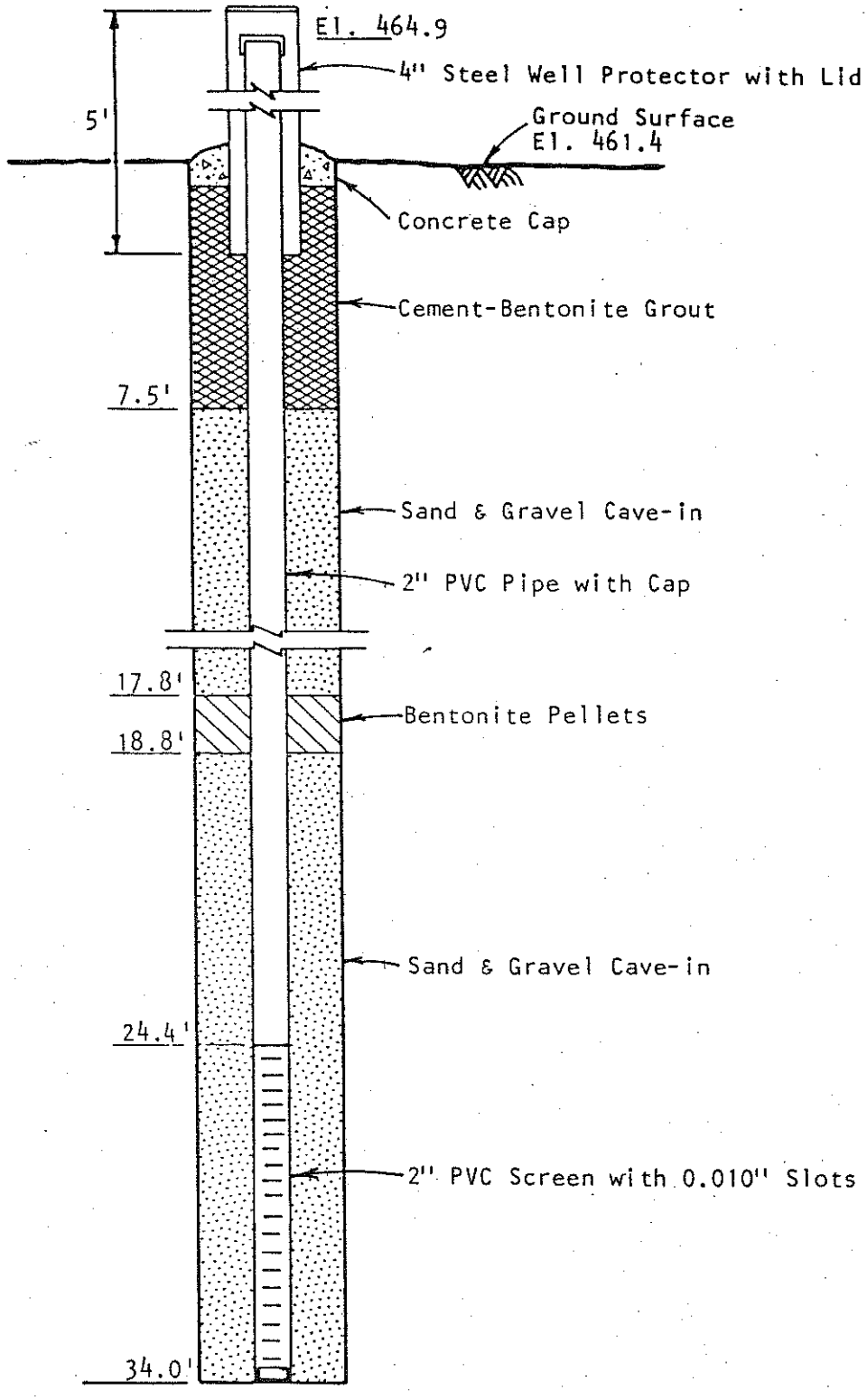
DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Soil Classification System Unified Surface Elevation 461.4'		
	1	AS			Brown Sandy CLAY, CL		
-5-	2	SS	18/9		Gray - Brown Silty CLAY Trace Sand, CL	3-5-5	
					Brown Fine SAND w/Silt Trace Gravel, SM		
-10-	3	SS	18/16			5-7-5	
-15-	4	SS	18/16			19-20-28	
					Gray-Brown GRAVEL w/Sand Trace Clay, GP		
-20-	5	SS	18/18			17-27-38	
-25-	6	SS	18/13		-Coal @ 25.4'	23-18-12	
					Brown Fine SAND, SP		
-30-	7	SS	18/15			6-11-11	
					Brown GRAVEL w/Sand Trace Clay, GP-GC		
-35-	8	SS	18/6		TOB	0-4-6	

Shear Strength, tsf
SV△ QP/2□ QU/2○
0 ½ 1 1½ 2 2½
PL + NMC • LL x
0 50 100
Rock Quality Designation
0 50 100

DRILLING METHOD Hollow Auger
DATE DRILLED 12/9/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at 8.0 Feet
___ Hours after completion ___ Feet
6 Days after completion 8.0 Feet
___ after completion ___ Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.



6" Borehole to Termination Depth

Not to Scale

22

PIEZOMETER W-2

John Mathes & Associates, Inc.

PLATE 16

SOIL BORING LOG INFORMATION

RAMBOLL

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Hennepin Power Station - Hennepin West Delineation		22D

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jeff Croel Mateco Drilling	8/6/2019	8/7/2019	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
22D	Feet (NAVD88)	461.83 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒

State Planel ,689,328.25 N, 2,528,778.84 E E/W

1/4 of 1/4 of Section , T N, R

Lat 41° 18' 7.2341"

Long -89° 19' 17.6376"

Local Grid Location

Feet ☐N ☐S Feet ☐E ☐W

Facility ID	County	State	Civil Town/City/ or Village
	Putnam	Illinois	Hennepin

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 54		0 1 2 3 4	0 - 1.8' **TOPSOIL:** (ML)s, brown, little fine sand. 1' - 1.8' gray.	(ML)s									
			2 3 4	1.8 - 4.75' **SANDY SILT WITH GRAVEL:** to **SILTY SAND WITH GRAVEL:** s(ML)g, yellowish brown, fine sand, coarse gravel, dry.	s(ML)g									
2 CS	120 84		5 6 7	4.75 - 7.6' **LEAN CLAY:** CL, brownish gray, trace subangular gravel, hard, low plasticity, dry.	CL									
			8 9 10 11 12	7.6 - 17' **POORLY-GRADED GRAVEL WITH SAND:** (GP)s, yellowish brown, coarse gravel to cobbles, dense, dry.	(GP)s									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature SH WK

Firm Ramboll
234 W. Florida St., Fifth Floor, Milwaukee, WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

RAMBOLL

Boring Number 22D

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			13	7.6 - 17' **POORLY-GRADED GRAVEL WITH SAND:** (GP)s, yellowish brown, coarse gravel to cobbles, dense, dry. *(continued)*										
			14											
3 CS	120 78		15	15' '- 17' brown, cobbles to gravel.	(GP)s									
			16											
			17											
				17 - 18' **POORLY-GRADED SAND:** SP, brown, fine to medium sand.	SP									
			18	18 - 25' **POORLY-GRADED GRAVEL WITH SAND:** (GP)s, brown, coarse gravel to cobbles, dense, dry.										
			19											
			20											
			21		(GP)s									
			22											
			23											
			24											
			25											
4 CS	120 48			25 - 27' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g, brown, fine to medium sand, wet.										
			26		(SP)g									
			27	27 - 39' **POORLY-GRADED GRAVEL WITH SAND:** (GP)s, brown, cobbles to gravel.										
			28											
			29											
			30		(GP)s									
			31											
			32											

RAMBOLL

Boring Number 22D

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			33	27 - 39' **POORLY-GRADED GRAVEL WITH SAND:** (GP)s, brown, cobbles to gravel. *(continued)*										
			34											
5 CS	120 72		35		(GP)s									
			36											
			37											
			38											
			39	39 - 60' **POORLY-GRADED SAND:** SP, brown, fine sand, wet.										
			40											
			41											
			42											
			43											
			44											
6 CS	120 120		45		SP									
			46											
			47											
			48											
			49											
			50											
			51											
			52											

RAMBOLL

Boring Number 22D

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			53	39 - 60' **POORLY-GRADED SAND:** SP, brown, fine sand, wet. *(continued)*										
			54											
7 CS	60 60		55											
			56		SP									
			57											
			58											
			59											
			60	60' End of Boring.										

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Hennepin Power Station - Hennepin West Delineation

Facility License, Permit or Monitoring No.:

Facility ID:

Type of Well: mw

Distance from Waste/Source: ft. | State: Illinois

Local Grid Location of Well: ☐ N. ft. ☐ S. ☐ E. ft. ☐ W.

Local Grid Origin ☐ (estimated: ☐) or Well Location ☒

Lat. 41° 18' 7.234" Long. -89° 19' 17.638" or

St. Plane 1,689,328.25 ft. N, 2,528,778.84 ft. E. E/Ⓦ

Section Location of Waste/Source: ☐ E ☐ W

1/4 of 1/4 of Sec. , T. N, R.

Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known

Gov. Lot Number:

Well Name: 22D

Date Well Installed: 08/07/2019

Well Installed By: (Person's Name and Firm): Jeff Croel; Mateco Drilling

A. Protective pipe, top elevation: 465.56 ft. MSL

B. Well casing, top elevation: 465.43 ft. MSL

C. Land surface elevation: 461.83 ft. MSL

D. Surface seal, bottom: 461.1 ft. MSL or 0.8 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☒
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ Hollow Stem Auger ☐ Sonic Other ☒

15. Drilling fluid used: Water ☒ 0 2 Air ☐ Drilling Mud ☐ 0 3 None ☐

16. Drilling additives used? ☐ Yes ☒ No

Describe

17. Source of water (attach analysis, if required): Distilled

E. Bentonite seal, top: 416.8 ft. MSL or 45.0 ft.

F. Fine sand, top: ft. MSL or ft.

G. Filter pack, top: 414.3 ft. MSL or 47.5 ft.

H. Screen joint, top: 412.2 ft. MSL or 49.7 ft.

I. Well bottom: 402.2 ft. MSL or 59.7 ft.

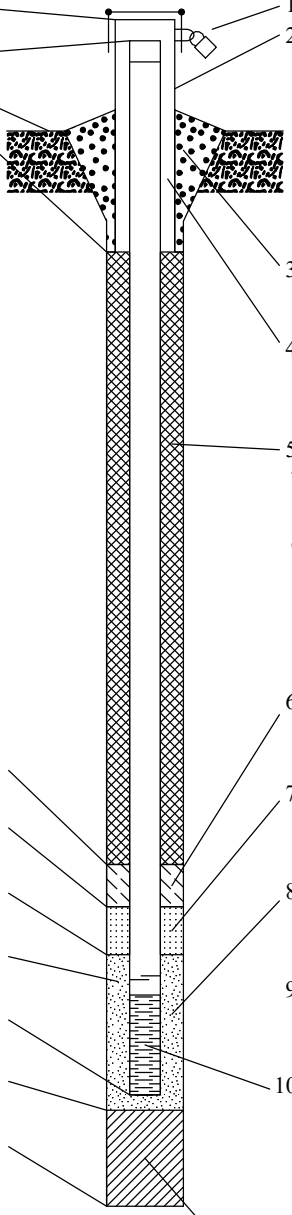
J. Filter pack, bottom: 402.2 ft. MSL or 59.7 ft.

K. Borehole, bottom: 401.8 ft. MSL or 60.0 ft.

L. Borehole, diameter: 6.0 in.

M. O.D. well casing: 2.38 in.

N. I.D. well casing: 2.07 in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 4.0 in.
b. Length: 5.0 ft.
c. Material: Steel ☒ Other ☐
d. Additional protection? ☒ Yes ☐ No
If yes, describe: 3 Steel Bollards

3. Surface seal: Bentonite ☐ Concrete ☒ Other ☐

4. Material between well casing and protective pipe: Bentonite ☐ Sand Other ☒

5. Annular space seal: a. Granular/Chipped Bentonite ☒
b. Lbs/gal mud weight . . . Bentonite-sand slurry ☐
c. 9.5 Lbs/gal mud weight . . . Bentonite slurry ☒
d. % Bentonite . . . Bentonite-cement grout ☐
e. 7.8 Ft^3 volume added for any of the above
f. How installed: Tremie ☐ Tremie pumped ☒ Gravity ☐

6. Bentonite seal: a. Bentonite granules ☐
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒
c. Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a.
b. Volume added ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. K & E Well Gravel
b. Volume added 2.1 ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ Flush threaded PVC schedule 80 ☐ Other ☐

10. Screen material: Schedule 40 PVC
a. Screen Type: Factory cut ☒ Continuous slot ☐ Other ☐
b. Manufacturer Johnson
c. Slot size: 0.010 in.
d. Slotted length: 10.0 ft.

11. Backfill material (below filter pack): None ☒ collapsed formation materials Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge. Date Modified: 11/19/2019

Signature: SH WK

Firm: Ramboll
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-3 (23)
SHEET 1 OF 2

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
	1	AS			Brown Sandy CLAY w/Gravel, Fill, CL		
					Dark Gray FLYASH w/Bottom Ash, FILL, ML		
-5-	2	SS	18/18			7-9-8	
					Dark Gray BOTTOM ASH, FILL, ML		
-10-	3	SS	18/14			7-17-16	
-15-	4	SS	18/12			7-7-5	
					Dark Gray Silty CLAY, CL		
-20-	5	SS	18/15			1-1-1	
-25-	6	SS	18/16			WH-2-1	
					Dark Gray CLAY w/Silt Trace Sand, Shells, OH		
-30-	7	SS	18/18			WH-2-2	
-35-	8	SS	18/10		Brown GRAVEL w/Sand Trace Clay, GP-GC	8-19-16	

Surface Elevation 460.2'
Soil Classification System Unified

Shear Strength, tsf
SV△ QP/2□ QU/2○
0 ½ 1 1½ 2 2½
PL + NMC • LL x
0 50 100
Rock Quality Designation
0 50 100

DRILLING METHOD Hollow Auger
DATE DRILLED 12/10/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at	18.4	Feet
0 Hours after completion	4.2	Feet
5 Days after completion	6.8	Feet
___ after completion	___	Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

mathes

John Mathes & Associates, Inc.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-3 (23)
SHEET 2 OF 2

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Soil Classification System Unified Surface Elevation 460.2'		
					Brown GRAVEL w/Sand Trace Clay, GP-GC		
40	9	SS	18/18		Brown Sandy CLAY w/Gravel, CL	4-2-37	
					Brown GRAVEL w/Sand Trace Clay, GP-GC		
45	10	SS	18/10		TOB	10-33-38	
50							

Shear Strength, tsf
SV△ QP/2□ QU/2○
0 ½ 1 1½ 2 2½
PL + NMC • LL x
0 50 100
Rock Quality Designation
0 50 100

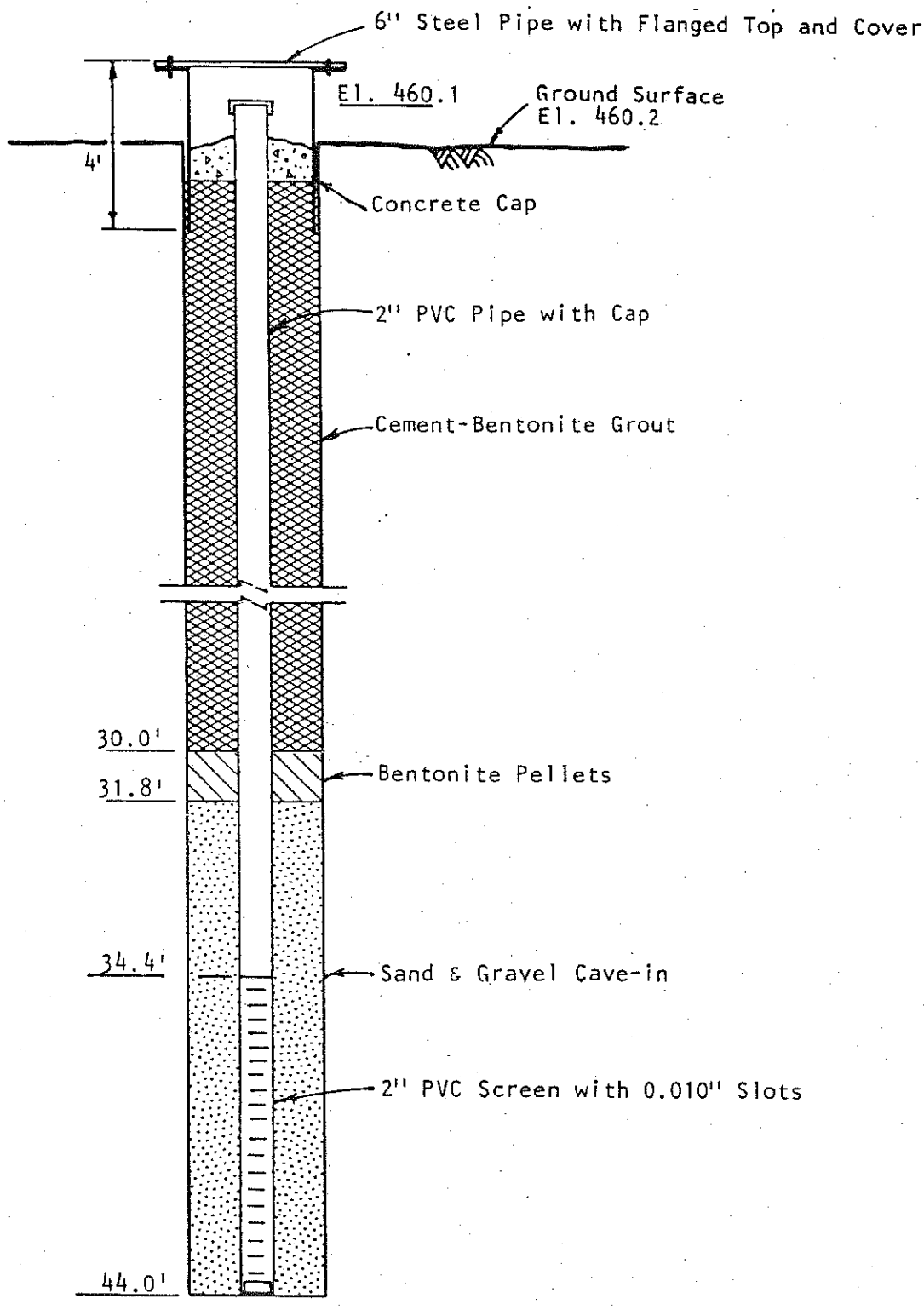
DRILLING METHOD Hollow Auger
DATE DRILLED 12/10/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS

	Encountered at 18.9		Feet
0	Hours after completion	4.2	Feet
5 Days	after completion	6.8	Feet
___	after completion	___	Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

John Mathes & Associates, Inc.



6" Borehole to Termination Depth

Not to Scale

23

PIEZOMETER W-3

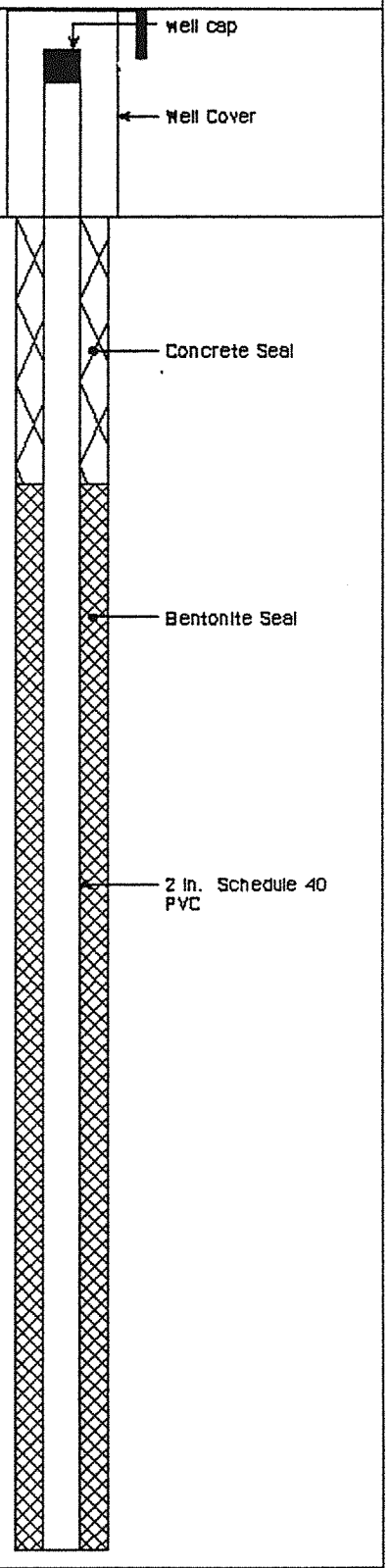
Monitoring Well No. 27

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 09-11-95
HOLE DIA.: 7 in.
FINAL GW: 3.88 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 447.94 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Dark gray, clayey silt, uniform, organic matter, soft, stickey			0–5	
Dark gray, clayey silt w/ some sand, roots, soft, uniform, wet			5–10	SS-1
Same as above, except color changes to lighter gray at 16 ft.			10–15	SS-2
Mottled gray, orange, uniform, clayey silt, soft, moist			15–20	SS-3



STMI
2511 N. 124th St. Suite 205
Brookfield, Wisconsin 53005-8208

Notes:

Project No. 135-1.31

Monitoring Well No. 27

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 09-11-95
HOLE DIA.: 7 in.
FINAL GW: 3.88 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 447.94 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Same as above			20–24	SS-3	2 in. Schedule 40 PVC
Uniform, brown grading to gray silty fine sand, wet, soft			24–26	SS-4	Bentonite Seal
uniform gray silty fine sand, wet, soft			26–30	SS-5	#7 Fine Sand
uniform brown fine-medium sand, wet, soft			30–33	SS-5	Formation Collapse and #5 Sand
Uniform brown fine-medium sand with pebbles (may be blown in)			33–34	SS-6	.01 Slotted Well Screen
Poorly sorted brown coarse sand and gravel, wet (glacial)			34–36	SS-6	
			36–40		

STMI
2511 N. 124th St. Suite 205
Brookfield, Wisconsin 53005-8208

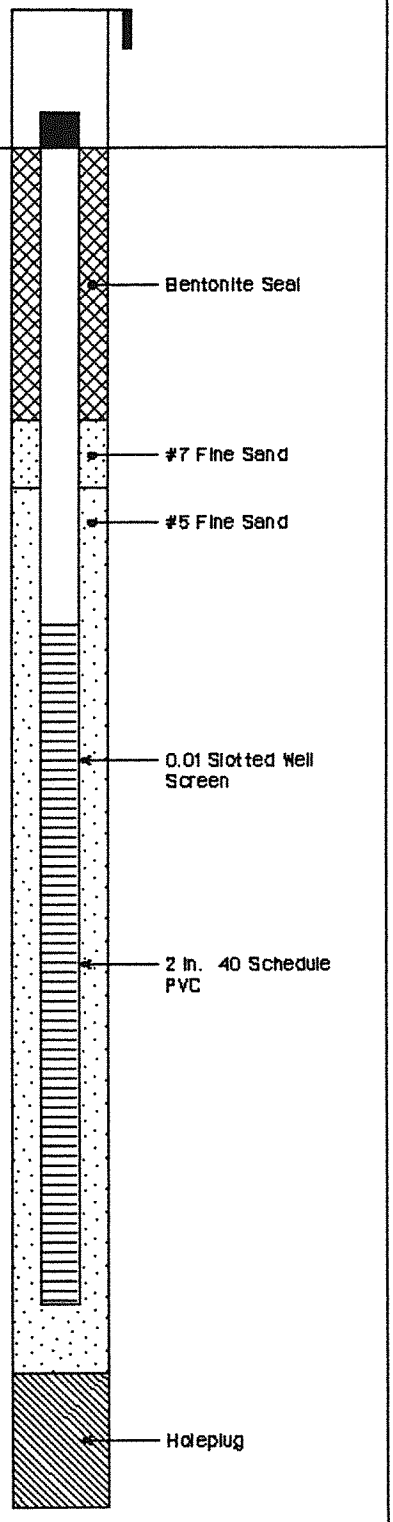
Notes:

Project No. 135-1.31

Monitoring Well No. 32

PROJECT Title: Hennepin West Ash Impoundment
DATE: 8-21-96
LOGGED BY: Mueller/Tu
DRILL RIG: Hollow Stem Auger
HOLE DIA.: 7 in.
SAMPLER: Split Spoon
DRILLER: Boart Longyear
FINAL GW: 5.06 ft.
HOLE ELEV.: 451.35 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Clay, little organic debris (twigs, wood chips, fine roots), dark brown, low to medium plasticity, moist (alluvium)			0–4	A-1A
Sand, well sorted, subangular to rounded, little silt, some clay, loose red to brown in color. Saturated at approximately 4 to 4.5ft.			4–9	A-1B
Sand and gravel, medium-grained, well-rounded, well sorted quartz and sand, fine to coarse-grained, subangular to subrounded quartz and calcareous gravel. Redish-brown in color (alluvium). Wet.			9–11	A-1C
			11–20	A-1D



STMI
2511 N. 124th St. Suite 205
Brookfield, Wisconsin 53005-8208

Notes:
Dicontinuously sampled every 5 feet. Sample numbers refer to saved samples

Project No.
135-1.31

Monitoring Well No. 32

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-21-96
HOLE DIA.: 7 in.
FINAL GW: 5.06 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 461.35 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Sandy clay, no plasticity, reddish brown in color, with rusty red laminations. Wet.			20–40	A-1E, A-1F, A-1G	Holeplug
Silty clay, trace coarse subangular sand, mixed lithologies, olive gray, no to low plasticity, hard, moist (till).					

STMI
2511 N. 124th St. Suite 205
Brookfield, Wisconsin 53005-8208

Notes:
Discontinuously sampled every 5 feet. Sample numbers refer to saved samples

Project No. 135-1.31

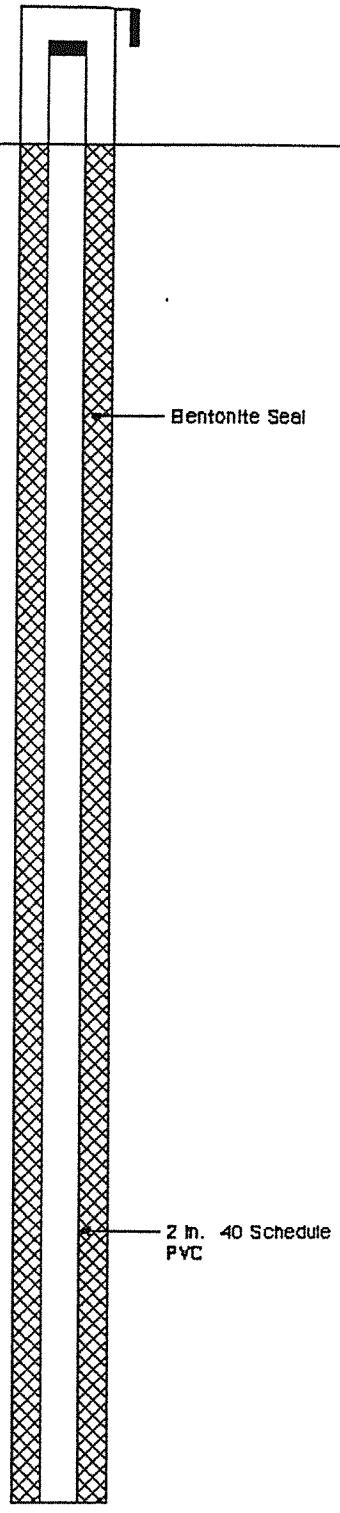
Monitoring Well No. 34

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-22-96
HOLE DIA.: 7 in.
FINAL GW: 7.54 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 448.19 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Silty clay, trace of plant debris, little fine-grained sand, very dark brown in color, medium to high plasticity (alluvium).			0	C-1A
			5	C-1B
			10	C-1C
			15	C-1D
			20	



STMI
2511 N. 124th St. Suite 205
Brookfield, Wisconsin 53005-8208

Notes:

Project No. 135-1.31

Monitoring Well No. 34

PROJECT TITLE: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-22-96
HOLE DIA.: 7 in.
FINAL GW: 7.54 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 448.19 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Clayey silt, trace to little fine-grained sand and shell fragments, soft, olive-gray. Wet.			20–26	C-1E, C-1F	Bentonite Seal; 2 in. 40 Schedule PVC
Sand, fine-grained to medium-grained, well-sorted, quartz, trace of silt, loose. Yellowish brown color grades to olive gray below 31 ft.			27–38	C-1G	#7 Fine Sand; #5 Fine Sand; 0.01 Slotted Well Screen; Holeplug

STMI
2511 N. 124th St. Suite 205
Brookfield, Wisconsin 53005-8208

Notes:

Project No. 135-1.31

Natural Resource Technology, Inc.
Standard Soil Boring Log

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION
Form Rev. 5-92

Facility/Project Name	**License/Permit/Monitoring Number**	**Boring Number**
DYNEGY – Hennepin Ash Impoundment		*WELL-35*

Boring Drilled By (Firm name and name of crew chief)	**Date Drilling Started**	**Date Drilling Completed**	**Drilling Method**
Boart Longyear *Bob Erickson*	*9/28/99*	*9/28/99*	*HSA 4 1/4"*

Facility Well No.	**Unique Well No.**	**Common Well Name**	**Final Static Water Level**	**Surface Elevation**	**Borehole Diameter**
			-- Feet MSL	*Feet MSL*	*8.25 inches*

Boring Location **State Plane**	**Feet N** **Feet E**	**Lat** **Long**	**Local Grid Location (If applicable)** ☐ N ☐ E ☐ S ☐ W

County		**Civil Town/City/ or Village**
Putnam		*Hennepin, IL*

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			1–11	0–5' Fill, white–grey,angular sandy gravel, dry.	FILL									
				5–7' Black silty sand, roots, small grey pebbles, dry.	SM									
				7–18' Brown medium sand, uniform texture.	SP									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm **Natural Resource Technology, Inc.**

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			13		SP									
			14											
			15											
			16											
			17											
			18											
			19	EOB @ 19'										
			20											
			21											
			22											
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30											
			31											

SOIL BORING LOG INFORMATION

RAMBOLL

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Hennepin Power Station - Hennepin West Delineation		50

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jeff Croel Mateco Drilling	8/6/2019	8/7/2019	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
50	Feet (NAVD88)	460.59 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒

State Planel ,689,413.16 N, 2,529,032.25 E E/W

1/4 of 1/4 of Section , T N, R

Lat 41° 18' 8.0486"

Long -89° 19' 14.3067"

Local Grid Location

Feet ☐N ☐S Feet ☐E ☐W

Facility ID	County	State	Civil Town/City/ or Village
	Putnam	Illinois	Hennepin

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 24		0 1 2 3	0 - 3.5' **TOPSOIL:** s(ML)g, brown, little gravel.	s(ML)g									
			4	3.5 - 12.5' **SANDY LEAN CLAY WITH GRAVEL:** s(CL)g, brown, little fine gravel, firm, low plasticity.										
2 CS	90 90		5 6 7 8 9 10 11 12		s(CL)g				1					

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature SH WL

Firm Ramboll
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Boring Number 50

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
				12' gravel content increases,.										
3 CS	90 72		13	12.5 - 22.5' **POORLY-GRADED GRAVEL WITH SAND:** (GP)s, coarse gravel, wet.	(GP)s									
			14											
			15											
			16											
			17											
			18											
			19											
4 CS	120 90		20	20' - 22.5' cobbles.										
			21											
			22											
			23	22.5 - 30' **WELL-GRADED SAND:** SW, trace coarse rounded gravel, wet.	SW									
			24											
			25											
			26											
			27											
			28											
			29											
			30	30' End of Boring..										

Geosyntec consultants

1 McBride and Sons Center Dr
Suite 202
Chesterfield, MO 63005

GS FORM: WELL BORE 01/04

BOREHOLE LOG

BORING	**MW-51**	**SHEET**	**1 OF 3**
START DRILL DATE	February 4, 2020	**ELEVATION DATA:**	
FINISH DRILL DATE	February 4, 2020	**GROUND SURF. (Ft)**	461.50
LOCATION	PUTNAM COUNTY, HENNEPIN IL	**TOP OF CASING (Ft)**	464.80
PROJECT	HENNEPIN POWER STATION	**DATUM**	NAVD 1988
NUMBER	CHE8400		

DEPTH (ft-bgs)	DESCRIPTION 1) Unit/Formation, Mem. 6) Plasticity 2) USCS Name 7) Density/Consistency 3) Color 8) Structure 4) Moisture 9) Other (Mineralization, Discoloration, Odor, etc.) 5) Percent Grain Size	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE NO.	TYPE	BLOW COUNT	N-Value	RECOVERY (%)	COMMENTS 1) Rig Behavior 2) Air Monitoring
0	Brown/red, clayey gravel, GC, fill material				460	01		2 4 4 3	8	17/24	
						02		5 3 11 12	14	18/24	
5	Brown/red, clayey sand with trace coarse sand, SC, low plasticity				455	03		5 6 9 5	15	16/24	
						04		6 3 4 5	7	2/24	
	Dark gray, fly ash, ML, non-plastic, non-cohesive					05		3 4 5 9	9	21/24	
10					450	06		3 3 3 4	6	24/24	
						07		2 1 1 2	2	24/24	
	@14 ft changes to dark gray/black					08		4 4 32 40	36	24/24	
15					445	09		3 3 3 4	6	24/24	
	Dark gray/black silty clay, CL, medium plasticity, damp					10		2 3 3 3	6	24/24	
20						11		2 1 3 2	4	18/24	
					440	12		0 1 2 2	3	24/24	
	@ 24 ft red brown coarse gravel lens					13		0 2 3 4	5	24/24	
25	@ 26 ft changes to dark gray				435	14		0 1 1 1	2	24/24	
	@ 28 ft changes to medium stiff					15		1 2 2 3	4	18/24	
30											

CONTRACTOR TSC
EQUIPMENT CME 75
DRILL MTHD HOLLOWSTEM AUGER
DIAMETER 6-inch
LOGGER C. CHRISTENSON
REVIEWER L. CARR

NORTHING 1688814.68
EASTING 2527303.58
COORDINATE SYSTEM: STATE PLANE ILLINOIS WEST

NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

07-WELL BORE CHICAGO PROJECT.GPJ GEOSNTEC.GDT 2/24/20

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Suite 202
Chesterfield, MO 63005

GS FORM: WELL BORE 01/04

BOREHOLE LOG

BORING MW-51 **SHEET** 2 OF 3
START DRILL DATE February 4, 2020 **ELEVATION DATA:**
FINISH DRILL DATE February 4, 2020 **GROUND SURF. (Ft)** 461.50
LOCATION PUTNAM COUNTY, HENNEPIN IL **TOP OF CASING (Ft)** 464.80
PROJECT HENNEPIN POWER STATION **DATUM** NAVD 1988
NUMBER CHE8400

DEPTH (ft-bgs)	DESCRIPTION 1) Unit/Formation, Mem. 6) Plasticity 2) USCS Name 7) Density/Consistency 3) Color 8) Structure 4) Moisture 9) Other (Mineralization, Discoloration, Odor, etc.) 5) Percent Grain Size	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE NO.	TYPE	BLOW COUNT	N-Value	RECOVERY (%)	COMMENTS 1) Rig Behavior 2) Air Monitoring
35	@ 31 ft medium gravel lens				430	16		3 4 5 5	8	6/24	
						17		0 1 2 2 2	3	19/24	
						18		2 3 4 5	7	24/24	
	Dark gray clay and gravel mixture, wet, GC				425	19		2 2 3 5	5	6/24	
	Dark gray, silt with trace clay, ML, low plasticity, damp					20		0 0 2 2	2	24/24	
40	Dark gray silt with trace clay, ML, low plasticity, damp					21		2 1 1 2	2	24/24	
	Dark gray silty clay, CL, medium plasticity, damp, medium stiff				420						
	Dark gray silt with trace clay, ML, low plasticity, damp, medium stiff					22		2 2 2 3	4	24/24	
45						23		1 1 2 3	3	24/24	
	@ 47 ft few diatomaceous/shells				415	24		0 0 2 2	2	24/24	
						25		0 1 2 2	3	10/24	
50						26		3 4 4 7	8	14/24	
	Dark gray, fine to medium sand, trace coarse sand, SM				410	27			0	24/24	
						28		1 3 5 7	8	24/24	
55	@ 56 ft changes to some coarse sand, SM-SP				405	29		7 6 7 6	13	24/24	
	Dark gray, medium sand with some fine and coarse sand, SP, wet					30		3 3 9 1	12	24/24	
60											

CONTRACTOR TSC
EQUIPMENT CME 75
DRILL MTHD HOLLOWSTEM AUGER
DIAMETER 6-inch
LOGGER C. CHRISTENSON **REVIEWER** L. CARR

NORTHING 1688814.68
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GS FORM: WELL BORE 01/04

BOREHOLE LOG

BORING MW-51 **SHEET** 3 OF 3
START DRILL DATE February 4, 2020 **ELEVATION DATA:**
FINISH DRILL DATE February 4, 2020 **GROUND SURF. (Ft)** 461.50
LOCATION PUTNAM COUNTY, HENNEPIN IL **TOP OF CASING (Ft)** 464.80
PROJECT HENNEPIN POWER STATION **DATUM** NAVD 1988
NUMBER CHE8400

DEPTH (ft-bgs)	DESCRIPTION 1) Unit/Formation, Mem. 6) Plasticity 2) USCS Name 7) Density/Consistency 3) Color 8) Structure 4) Moisture 9) Other (Mineralization, Discoloration, Odor, etc.) 5) Percent Grain Size	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE NO.	TYPE	BLOW COUNT	N-Value	RECOVERY (%)	COMMENTS 1) Rig Behavior 2) Air Monitoring
	Dark gray, medium sand with some fine and coarse sand, SP, wet							1 1 3 4			
					400	31			4	2/24	
	@ 62 ft, changes to few fine gravel, fine sand absent, SW							5 7 13 18			
						32			20	24/24	
65								5 8 14 17			
						33			22	24/24	
	Dark gray, medium-fine sand with some coarse sand, SW				395	34		3 10			
	@ 67 ft lens of medium gravel								13	12/12	
	End of boring at 67 ft.										
70					390						
75					385						
80					380						
85					375						
90											

CONTRACTOR TSC
EQUIPMENT CME 75
DRILL MTHD HOLLOWSTEM AUGER
DIAMETER 6-inch
LOGGER C. CHRISTENSON **REVIEWER** L. CARR

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COORDINATE SYSTEM:
STATE PLANE ILLINOIS WEST

NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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APPENDIX B
35 I.A.C. § 845 Multi-Site Statistical Analysis Plan

Date
April 1, 2025

Project No.
1940110241

35 I.A.C § 845 MULTI-SITE STATISTICAL ANALYSIS PLAN

RAMBOLL Bright ideas. Sustainable change.

35 I.A.C § 845 MULTI-SITE STATISTICAL ANALYSIS PLAN

Project no.	**1940110241**
Recipient	**Vistra Corp**
Document type	**Statistical Analysis Plan**
Revision	**FINAL**
Date	**April 1, 2025**
Prepared by	**Rachel Banoff and Alison O'Connor**
Checked by	**Eric J. Tlachac, PE**
Approved by	**Brian G. Hennings, PG**

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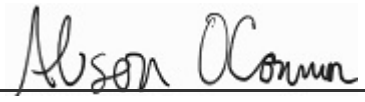
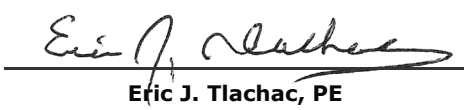
Environmental Engineer



Alison O'Connor
Senior Lead Consultant



Eric J. Tlachac, PE
Senior Managing Engineer

Brian G. Hennings, PG
Senior Managing Hydrogeologist

LICENSED PROFESSIONAL CERTIFICATIONS

This certification is based on the description of the statistical methods selected to evaluate groundwater as presented in the following 35 I.A.C. § 845 Multi-Site Statistical Analysis Plan. The procedures described in the plan will be used to establish background conditions and implement compliance and corrective action monitoring as necessary and required by 35 I.A.C. § 845.640, § 845.650, and § 845.680. The 35 I.A.C. § 845 Multi-Site Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in the United States Environmental Protection Agency (USEPA)'s *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* USEPA 2009), and is intended to provide a logical process and framework for conducting the statistical analysis of the data obtained during groundwater monitoring. In accordance with 35 I.A.C. § 845.640(f)(1), the statistical method chosen for analysis of background groundwater quality is the tolerance interval procedure for each constituent listed in 35 I.A.C. § 845.600(a)(1) at this CCR unit per 35 I.A.C. § 845.640(f)(1)(C). Groundwater Protection Standards (GWPS) will be established in accordance with 35 I.A.C. § 845.600(a) (greater of the background concentration or numerical limit specified in 35 I.A.C. § 845.600(a)(1)). The GWPS will be compared to the appropriate confidence interval for the observed concentrations for each constituent in each compliance well. Consistent with the *Unified Guidance*, the same general statistical method of confidence interval testing against a fixed GWPS is recommended in compliance and corrective action programs. Confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them.

Description of the statistical methods chosen for analysis of groundwater monitoring data and application of these methods for determining exceedances of the GWPS identified in 35 I.A.C. § 845.600(a) is provided in this 35 I.A.C. § 845 Multi-Site Statistical Analysis Plan.

35 I.A.C. § 845.640 Statistical Analysis (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the statistical methods summarized above and described in this document (35 I.A.C. § 845 Multi-Site Statistical Analysis Plan) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.

Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: April 1, 2025

35 I.A.C. § 845.640 Statistical Analysis (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the statistical methods described in this document (35 I.A.C. § 845 Multi-Site Statistical Analysis Plan) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.

Brian G. Hennings
Professional Geologist
196.001482
Illinois
Date: April 1, 2025

35 I.A.C. § 845.640 Statistical Analysis

I, Rachel A. Banoff, a qualified professional, certify that the statistical methods described in this document (35 I.A.C. § 845 Multi-Site Statistical Analysis Plan), are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.

Rachel A. Banoff, EIT
Project Statistician
Date: April 1, 2025

DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	April 1, 2025	• Original Document

DOCUMENT APPLICABILITY BY FACILITY OWNER

Table A. Document Applicability by Facility Owner

Facility & Owner	Unit ID	Unit Name
Baldwin Power Plant Dynegy Midwest Generation, LLC	601	Bottom Ash Pond
	605	Fly Ash Pond System
Coffeen Power Plant Illinois Power Generating Company	101	Ash Pond No. 1
	102	Ash Pond No. 2
	103	GMF Gypsum Stack Pond
	104	GMF Recycle Pond
Duck Creek Power Plant Illinois Power Resources Generating, LLC	201/202	Ash Pond No. 1 Ash Pond No. 2
	203	GMF Pond
	205	Bottom Ash Basin
Edwards Power Plant Illinois Power Resources Generating, LLC	301	Ash Pond
Hennepin Power Plant Dynegy Midwest Generation, LLC	802	Ash Pond No. 2
	803	East Ash Pond
	804	Old West Ash Pond
	802/805	Ash Pond No. 2 Ash Pond No. 4
Joppa Power Plant Electric Energy, Inc.	401	East Ash Pond
	403	West Ash Pond
Kincaid Power Plant Kincaid Generation, LLC	141	Ash Pond
Newton Power Plant Illinois Power Generating Company	501	Primary Ash Pond
Vermilion Power Plant Dynegy Midwest Generation, LLC	910	North Ash Pond
	911/912	Old East Ash Pond New East Ash Pond

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FIGURES (IN TEXT)

Figure 1	Flow chart illustrating the statistical methods used for calculating background under Compliance Monitoring
Figure 2	Flow chart illustrating the statistical methods used for calculating confidence intervals in Compliance Monitoring

ACRONYMS AND ABBREVIATIONS

%	percent
35 I.A.C.	Title 35 of the Illinois Administrative Code
CCR	coal combustion residuals
CI	confidence interval
DQR	Double Quantification Rule
GMP	Groundwater Monitoring Plan
GWPS	groundwater protection standard
IEPA	Illinois Environmental Protection Agency
LCL	lower confidence limit
LTL	lower tolerance limit
MDL	method detection limit
PQL	practical quantitation limit
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
SAP	Sampling and Analysis Plan
SI	surface impoundment
UCL	upper confidence limit
Unified Guidance	Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance (USEPA, 2009)
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit

1. INTRODUCTION

In April 2021, the Illinois Environmental Protection Agency (IEPA) issued a final rule for the regulation and management of coal combustion residuals (CCR) in surface impoundments (SIs) under the Standards for the Disposal of CCR in Surface Impoundments: Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845. Facilities regulated under 35 I.A.C. § 845 are required to develop and sample a groundwater monitoring well system to evaluate whether impounded CCR materials are impacting groundwater quality. The groundwater quality evaluation must include certification from a qualified professional engineer that the selected statistical method is appropriate for evaluating groundwater monitoring data for the CCR surface impoundment. The procedures described in the evaluation will be used to establish background conditions and implement Compliance and Corrective Action Monitoring as necessary and required by 35 I.A.C. § 845.640, § 845.650, § 845.680, and § 845.780. This Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in United States Environmental Protection Agency's (USEPA's) Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (Unified Guidance) (USEPA, 2009).[1]

1.1 Statistical Analysis Objectives

This Multi-Site Statistical Analysis Plan provides a framework for conducting the statistical analyses of groundwater data collected during operation, post-closure care, and corrective action monitoring (if required). This Multi-Site Statistical Analysis Plan does not include procedures for groundwater sample collection and analysis conducted in accordance with the Multi-Site Sampling and Analysis Plan (SAP; Ramboll, 2022) or data quality evaluation conducted in accordance with the Multi-Site Quality Assurance Project Plan (QAPP; Ramboll, 2022).[2]

1.2 Statistical Analysis Plan Approach

The analyses described in this document are intended to support monitoring programs described in detail in the CCR unit-specific Operating Permit Groundwater Monitoring Plans (GMPs), Closure Construction Permit GMPs, and Corrective Action GMPs. When necessary and contingent upon equivalent statistical power, an alternative test consistent with the performance standards in 35 I.A.C. § 845.640(g), not included in this Statistical Analysis Plan, may be chosen due to site-specific data requirements.

35 I.A.C. § 845 outlines three phases of groundwater monitoring:

- Baseline Monitoring in accordance with 35 I.A.C. § 845.650(b)(1)
- Compliance Monitoring in accordance with 35 I.A.C. § 845.650 and 35 I.A.C. § 845.780(b)
- Corrective Action Monitoring in accordance with 35 I.A.C. § 845.680(a)

Each phase of the groundwater monitoring program requires specific statistical procedures to accomplish the intended purpose. During the first phase, background groundwater quality will be established, utilizing upgradient and background wells. Compliance Monitoring, which

[1] Despite being currently archived on USEPA's website, the Unified Guidance remains a valid reference for developing a statistical analysis plan (personal communication with Alison O'Connor, February 11, 2025).

[2] The Multi-Site Sampling and Analysis Plan and Multi-Site Quality Assurance Project plan are living documents which are subject to routine evaluation and updates in accordance with USEPA recommended best practices (USEPA 2020; USEPA 2023).

encompasses data collection and statistical evaluation conducted during unit operation and the post-closure care period, will then evaluate whether exceedances occur for 20 required constituents (per 35 I.A.C. § 845.600(a)(1)) relative to the groundwater protection standard (GWPS) established by 35 I.A.C. § 845.600. Corrective Action Monitoring evaluates remedy progress and completion and will be initiated upon implementation of the Corrective Action GMP.

2. GROUNDWATER DATA EVALUATION AND STATISTICAL ASSUMPTIONS

The following subsections outline the statistical tests and procedures utilized to evaluate data collected for consistency with statistical assumptions and evaluate data distribution. These methods may be used in any phase of groundwater monitoring.

2.1 Sample Independence

Independence of sample results is a major assumption for most statistical analyses. To ensure physical independence of groundwater sampling results, the minimum time between sampling events must be longer than the time required for groundwater to move through the monitoring well. Therefore, the minimum time interval between sampling events is a function of the groundwater velocity and well bore volume (diameter of the well and surrounding filter pack). The sampling schedules for Baseline Monitoring, Compliance Monitoring, and Corrective Action Monitoring are specified in 35 I.A.C. § 845 and may conflict with the statistical assumption of independence of sample results.

2.2 Non-Detect Data Processing

Groundwater sample analysis results below the reporting limit (RL), also referred to as the practical quantitation limit (PQL), will not be used in statistical calculations due to the inherent uncertainty in results that are estimated between the method detection limit (MDL) and RL/PQL, and error assumptions inherent to the statistical calculations. Results below the RL/PQL will be considered non-detect data. For statistical characterization evaluations (*e.g.*, distribution testing, and trend analysis), non-detects were replaced with the half of the RL for the analysis. For statistical test procedures that involve the calculation of a mean and standard deviation (as described in **Section 3**):

- If the frequency of non-detect data are less than or equal to 15 percent (%), half of the RL will be substituted for these data.
- If the non-detect frequency is greater than 15% and less than or equal to 50% and the data are normally or log-normally distributed (**Section 2.3**), the Kaplan-Meier method will be used to estimate the mean and standard deviation adjusted for the presence of left-censored values.
- If the non-detect frequency is greater than 50% or data are not normally or log-normally distributed (**Section 2.3**), a non-parametric test or calculation will be used.

2.3 Testing for Normality

In accordance with 35 I.A.C. § 845.640(g)(1), "the statistical method used to evaluate groundwater monitoring data must be appropriate for the distribution of constituents". The Unified Guidance document recommends the Shapiro-Wilk normality test for sample sizes of 50 or less, and the Shapiro-Francia normality test for sample sizes greater than 50. Log-transformation of datasets to achieve normal distributions is preferred to using non-parametric methods. However, if data normality cannot be achieved through log transformation, a non-parametric method is used.

2.4 Outlier Evaluation and Management

Groundwater analytical data may be screened for the existence of outliers using methods described by the Unified Guidance. Outliers are extreme data points that may represent an anomaly or erroneous data point. To test for outliers, one or more of the following outlier tests will be utilized:

- Dixon's test, for well-constituent pairs with less than 25 samples, assumes normally distributed data.
- Rosner's test, for well-constituent pairs with more than 20 samples, assumes normally distributed data.
- Grubb's test for well-constituent pairs with seven or more samples, assumes normally distributed data.

In addition, time series, box-whisker plots, and probability plots will be used to provide visual tools to identify potential outliers, and evaluation of seasonal, spatial, or temporal variability for both normally and non-normally distributed data.

When necessary, a confirmatory sample will be collected to allow the facility to distinguish between an outlier and a true release from the facility (35 I.A.C. § 845.650(d)). If re-sampling is necessary, this sample will be collected within 60 days following outlier identification. Rigorous data validation and review is preferred to formal outlier testing and exclusion to ensure that all data used in statistical evaluations is representative of field conditions. Quality control/quality assurance data are collected and data verification is completed in accordance with the QAPP. Project staff familiar with the site and historical data will review the data generated each quarter and facilitate additional validation as needed. Data quality control, groundwater geochemistry, and sampling procedures will be evaluated as potential sources of error leading to an outlier result. Exclusion of potential outliers without an identified source of error may be considered only for data that could cause extremely elevated background concentrations.

2.5 Trend Analysis

Statistical analyses confirming the lack of trend are a fundamental step to confirm the assumption that groundwater quality values (*i.e.,* constituent means) are stationary or constant over time. These analyses allow for evaluation of variation in the background and compliance data for each constituent over time. A statistically significant increasing trend in the background data could indicate an existing release from the CCR unit or alternative source, requiring further investigation. In addition, statistically significant trending background data can result in increased standard deviation and, therefore, greater prediction or tolerance limits. Consequently, the increased prediction or tolerance limit will have less statistical power or ability to identify a release from a CCR unit.

A linear regression, coupled with a t-test for slope significance at a 95% confidence level (or 0.05 significance level), may be used on datasets for each constituent with few non-detects and a normally distributed variance of the mean to evaluate time trends. The Theil-Sen trend line, coupled with the Mann-Kendall test for slope significance at a 95% confidence level (or 0.05 significance level), may be used for datasets with frequent non-detects or non-normal variance. Similarly, trend analyses could also be used on compliance data to evaluate a possible release from the CCR unit.

2.6 Spatial Variation

Spatial trends and/or variation between background wells could indicate an existing release from a CCR unit. If the spatial variability is not due to an existing release, intrawell comparisons in compliance wells may be used to account for spatial variability and monitor for a future release. However, the CCR units being monitored have been placed into service prior to the start of groundwater monitoring and it is unknown whether a previous release has occurred. Accordingly, intrawell comparisons in compliance wells cannot be used to determine the occurrence of a future release, and interwell comparisons between compliance wells and background wells will be used.

2.7 Temporal Variation

Time series plots can be used to identify temporal dependence. Potentially significant temporal components of variability can be identified by graphing single constituent data from multiple wells together on a time series plot. With temporal dependence, the time series plot has a pattern of parallel traces, in which the individual wells will tend to rise and fall together across the sequence of sampling dates. Time series plots can be helpful by plotting multiple constituents over time for the same well, or averaging values for each constituent across wells on each sampling event and then plotting the averages over time. In either case, the plots can signify whether the general concentration pattern over time is simultaneously observed for different constituents. If so, it may indicate that a group of constituents is highly correlated in groundwater or that the same artifacts of sampling and/or lab analysis impacted the results of several monitoring parameters.

2.8 Updating Background

Updating the background dataset periodically by adding recent results to an existing background dataset can improve the statistical power and accuracy of the statistical analysis, especially for non-parametric prediction intervals. The Unified Guidance recommends updating statistical limits (background) when at least four to eight new measurements (every 2 to 4 years under a semiannual monitoring program or 1 to 2 years under a quarterly monitoring program) are available for comparison to historical data. Methods discussed in **Section 2.4** and professional judgement will be used to evaluate whether any individual data points appear to drive an anomalously high background level. A t-test for equal means (if normal data distribution) or a Mann-Whitney or Wilcoxon test for equal medians (if non-normal data distribution) will be conducted to verify that the two groups of background sample populations are statistically different prior to updating any background datasets. A 0.05 significance level will be utilized when evaluating the two populations, with the null hypothesis that the two populations have equal means or medians. In addition, time series graphs or other trend evaluation statistics (such as a Mann-Kendall test) will be conducted on the new background dataset to verify the absence of a release or changing groundwater quality. If the tests indicate that there are no statistical differences between the two background populations, the new data will be combined with the existing dataset. If the two populations are found to be different, the data will be reviewed to evaluate the cause of the difference. If the differences appear to be caused by a release (*i.e.,* if the new data are significantly higher, or lower for pH), then the previous background dataset may continue to be used. Furthermore, verified outliers will not be added to an existing background dataset. Spatial variability among background wells will also be assessed when background datasets are updated to determine whether pooling data is appropriate.

3. COMPLIANCE MONITORING PROGRAM

Compliance Monitoring encompasses data collection and statistical evaluation conducted during unit operation (35 I.A.C. § 845.640 and 845.650) and the post-closure care period (35 I.A.C. § 845.780). Compliance Monitoring is designed to evaluate whether concentrations of constituents listed in 35 I.A.C. § 845.600(a)(1) in compliance wells exceed GWPS or background in a statistically significant manner.

3.1 Monitoring Program Outline

3.1.1 Establish Background and GWPS

A site-specific GWPS will be established for constituents listed in 35 I.A.C. § 845.600(a)(1) for each CCR unit. The GWPS will be the concentration specified in 35 I.A.C. § 845.600(a)(1), unless the background concentration is greater. For this exception, background concentrations will be used to define the GWPS. Background concentrations will be calculated using a parametric or non-parametric upper tolerance limit (UTL), depending on the data distribution, consistent with 35 I.A.C. § 845.640(f)(1)(C). The procedure for calculating a UTL is outlined in **Figure 1** and described in **Section 3.2**. If only one background result is detected, that value will be used as the UTL.

3.1.2 Evaluate Background and GWPS Exceedances

Per 35 I.A.C. § 845.610(b)(3), groundwater monitoring data from compliance monitoring wells will be evaluated for statistically significant exceedances over background and the site-specific GWPS. In accordance with recommendation in the Unified Guidance for compliance monitoring, exceedances are evaluated by comparing a confidence interval (CI) to a fixed standard. The null hypothesis of this comparison is that compliance well groundwater concentrations do not exceed the standard unless the statistical test indicates otherwise.

GWPS exceedances will be determined by comparing the lower confidence limit (LCL) of the compliance well concentrations to the GWPS, except for pH where the LCL will be compared to the upper end of the GWPS range, and the upper confidence limit (UCL) compared to the low end of the GWPS range. A GWPS exceedance is determined if the LCL is greater than the GWPS, and, for pH, either the LCL is greater than the upper end of the GWPS range or the UCL is less than the low end of the GWPS range. The method of calculating the CI (outlined in **Figure 2** and described in **Section 3.3**) will be determined by sample size, trends in the data, and data normality. The significance level (alpha) for this calculation will be fixed at 0.01 (99% confidence) as recommended by Unified Guidance. If there are too few data points to calculate an LCL (a minimum of four data points is typically required), the most recent data point will be compared to the GWPS.

In the event that statistical analyses identify an exceedance of the GWPS for one or more parameters, the exceedance parameters and wells of concern may be immediately re-sampled. Compliance Monitoring statistics will be updated using the verification resample. If the Compliance Monitoring statistics using the compliance verification resample data result in an exceedance of the GWPS, the exceedance is confirmed.

Comparison of groundwater monitoring data to background is required by 35 I.A.C. § 845.610(3)(B), but these background "exceedances" do not carry any compliance implications.

Background exceedances will be determined by comparing the LCL of the compliance well concentrations to the background UTL, with the exception of pH where the UCL of the compliance well concentrations will also be compared to the background lower tolerance limit (LTL). A background exceedance is determined if the LCL is greater than the background UTL, or, for pH, either the LCL is greater than the UTL or the UCL is less than the LTL. If there are too few data points to calculate an LCL (a minimum of four data points is required), the most recent data point will be compared to the background UTL (and LTL for pH).

Additionally, an exceedance of either background or GWPS will be identified if the constituent monitored was not detected in all previous samples at a compliance well and the two most recent samples have both detections and exceed the GPWS (or are less than the low end of the GWPS range for pH) or background UTL (or are less than the LTL for pH).

3.2 Upper Tolerance Limit

The method for calculating a UTL depends primarily on the proportion of non-detects and the data distribution (**Figure 1**). A parametric UTL will be used to calculate the GWPS when the background data are normally distributed and have a non-detect frequency of 50% or less. The Unified Guidance recommends 95% confidence level and 95% coverage (95/95 tolerance interval). When the non-detect frequency is 15% or less, half the RL will be substituted for non-detects (simple substitution), and the normal mean and standard deviation will be calculated. The Kaplan-Meier method will be used when the detection frequency is between 15% and 50%. The Kaplan-Meier method assesses the linearity of a censored probability plot to determine whether the background sample can be approximately normalized. If so, then the Kaplan-Meier method will be used to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. The Kaplan-Meier estimate of the mean and standard deviation will be substituted for the sample mean and standard deviation.

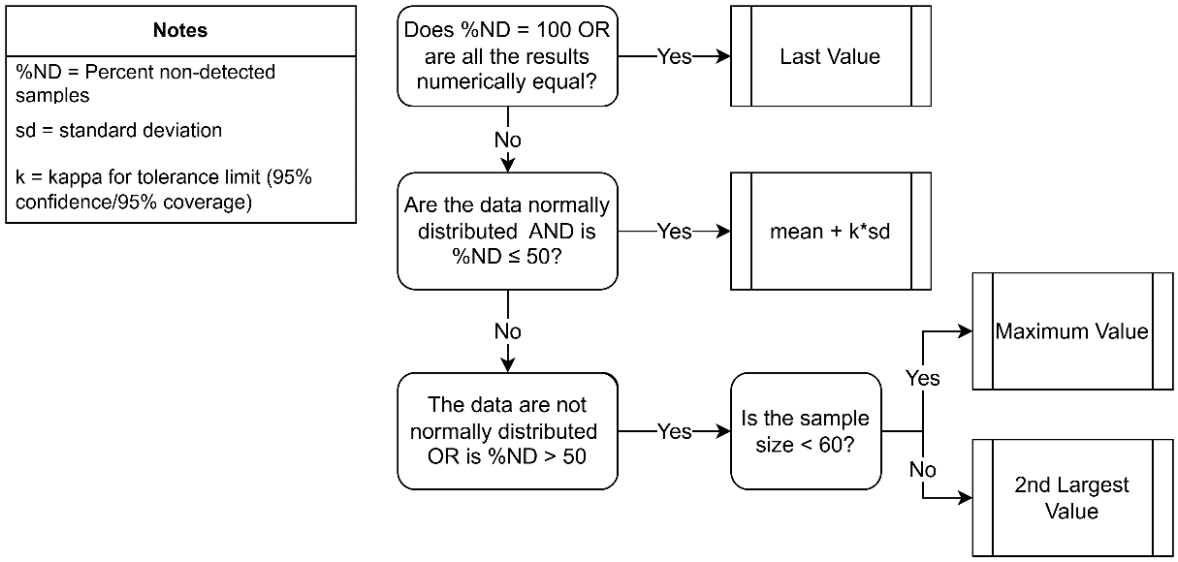

Figure 1. Flow chart illustrating the statistical methods used for calculating background under Compliance Monitoring.

The parametric UTL on a future mean will be calculated from the background dataset as follows:

$$UTL = \overline{x} + \kappa\,(n, \gamma, \alpha - 1) \cdot s$$

$\overline{x}$ = background sample mean

s = background sample standard deviation

$\kappa\,(n, \gamma, \alpha - 1)$ = one-sided normal tolerance factor based on the chosen coverage (γ) and confidence level (α -1) and the size of the background dataset (n). Values may be calculated per Millard (2013) or looked up in Table 17-3 in Appendix D of the Unified Guidance.

If the UTL is constructed on the logarithms of original observations to achieve normality, where $\overline{y}$ and s_y are the log-mean and log-standard deviation, the limit will be exponentiated for back-transformation to the concentration scale as follows:

$$TL = \exp\left[\overline{y} + \kappa\,(n, \gamma, \alpha - 1) \cdot s_y\right]$$

$\overline{y}$ = background sample log-mean

s_y = background sample log-standard deviation

If the background data set is non-parametric or has a non-detect frequency greater than 50%, a non-parametric UTL is used. The maximum concentration is used as the non-parametric UTL for sample sizes less than 60 and the second largest concentration is used as the non-parametric UTL for sample sizes greater than or equal to 60. As described in the Unified Guidance, the advantages include the resulting UTL reflecting actual concentration magnitudes, and the UTL more likely representing a detected concentration (unless all the data were non-detect).

3.3 Confidence Intervals

The method for calculating a CI depends on whether or not there is a trend in the data, the proportion of non-detects, and the data distribution (**Figure 2**). The following sections describe the procedure for calculating the CI in each case.

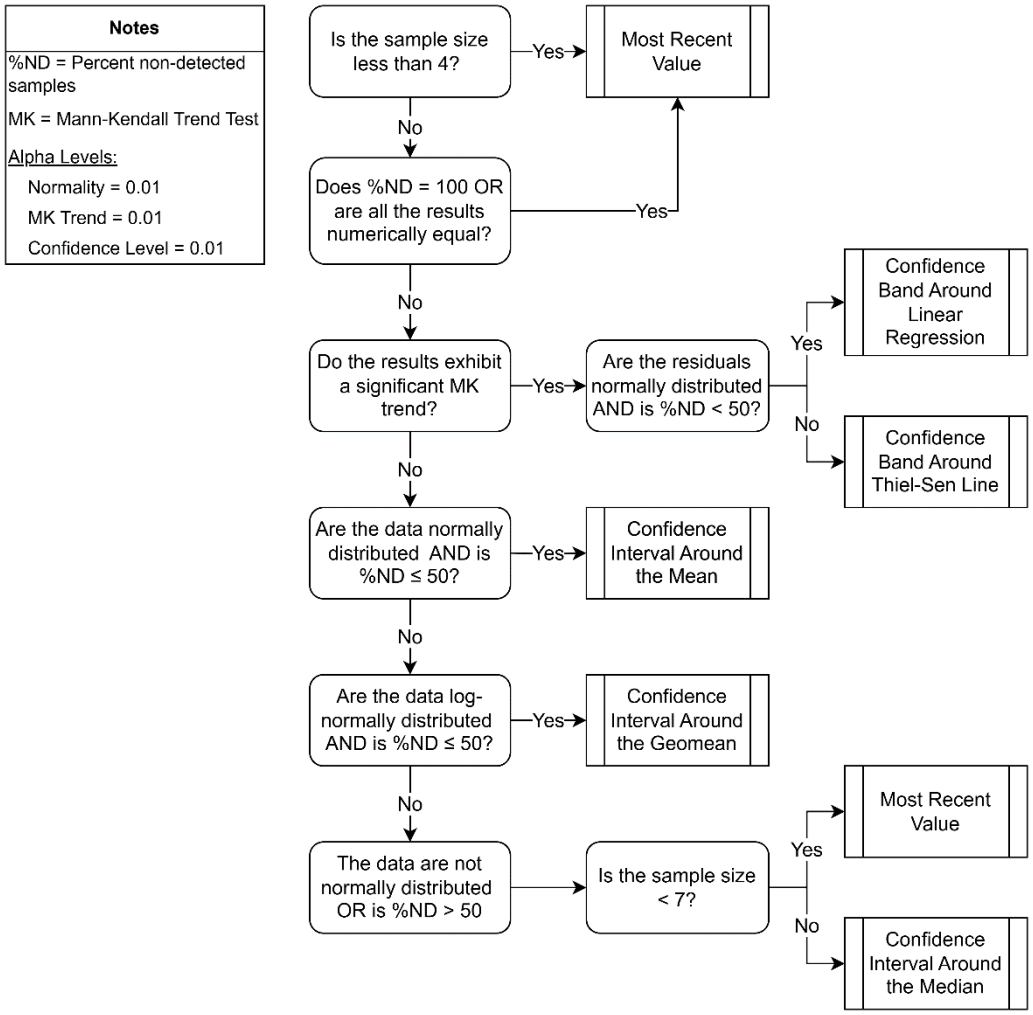

Figure 2. Flow chart illustrating the statistical methods used for calculating confidence intervals in Compliance Monitoring.

3.3.1 Confidence Intervals Around Trending Data

If compliance data exhibit a statistically significant trend based on results from a Mann-Kendall trend test and consists of a sufficient sample size (see below), CIs accounting for trends will be constructed to account for the trend-induced variation. If this is not accounted for, a wider CI will inevitably be calculated for a given confidence level and sample size (n). A wider CI will result in less statistical power, or ability to demonstrate an exceedance or return to compliance. When a linear trend line has been estimated, a series of CIs is estimated at each point along the trend. This creates a simultaneous confidence band that follows the trend line. As the underlying population mean increases or decreases, the confidence band also increases to reflect this change at that point in time.

Linear regression will be used when the compliance data set consists of at least eight samples, the frequency of non-detects is below 50%, and residuals around the trend line are normally distributed. The linear regression of concentration against sampling date (time) will be computed as follows:

$$\hat{b} = \sum_{i=1}^{n} (t_i - \overline{t}) \cdot x_i / (n-1) \cdot s_t^2$$

x_i = i^{th} concentration value and

t_i = i^{th} sampling date

$\overline{t}$ = sampling mean date

s_t^2 = variance of the sampling dates

This estimate leads to the following regression equation:

$$\hat{x} = \overline{x} + \hat{b} \cdot (t - \overline{t})$$

$\overline{x}$ = mean concentration level

$\hat{x}$ = estimated mean concentration at time t

The regression residuals will also be computed at each sampling event to ensure uniformity and lack of significant skewness. Regression residuals will be computed at each sampling event as follows:

$$r_i = x_i - \hat{x}_i$$

The estimated variance around the regression line, or mean squared error, will be computed as follows:

$$s_e^2 = \frac{1}{n-2} \sum_{i=1}^{n} r_i^2$$

The CI around a linear regression trend line given confidence level (1-α) and a point in time (t_0), will be computed as follows:

$$LCL_{1-\alpha} = \hat{x}_0 - \sqrt{2s_e^2 \cdot F_{1-2\alpha,2,n-1} \cdot \left[\frac{1}{n} + \frac{(t_0 - \overline{t})^2}{(n-1) \cdot s_t^2}\right]}$$

$$UCL_{1-\alpha} = \hat{x}_0 - \sqrt{2s_e^2 \cdot F_{1-2\alpha,2,n-2} \cdot \left[\frac{1}{n} + \frac{(t_0 - \overline{t})^2}{(n-1) \cdot s_t^2}\right]}$$

$\hat{x}_0$ = estimated mean concentration from the regression equation at time t_0

$F_{1-2\alpha,2,n-2}$ = upper (1-2α)th percentage point from an *F*-distribution with 2 and (*n*-2) degrees of freedom

If the compliance data set consists of at least seven samples but has a non-detect frequency greater than 50% or the residuals are not normally distributed, the Thiel-Sen trend line will be used as a non-parametric alternative to linear regression for calculation of the CI. The Thiel-Sen trend line estimates the median concentration over time by combining the median pairwise slope with the median concentration value and the median sample date. To compute the Thiel-Sen line,

the data will first be ordered by sampling event x_1, x_2, x_n. All possible distinct pairs of measurements (x_i, x_j) for $j > i$ will be considered and the simple pairwise slope estimate will be computed for each pair as follows:

$$m_{ij} = (x_j - x_i)/(j - i)$$

With a sample size of n, there will be a total of $N = n(n\text{-}1)/2$ pairwise estimates m_{ij}. If a given observation is a non-detect, half the RL will be substituted. The N pairwise slope estimates (m_{ij}) will be ordered from least to greatest (renamed $m_{(1)}$, $m_{(2)}$,..$m_{(N)}$). The Thiel-Sen estimate of slope (Q) will be calculated as the median value of the list depending on whether N is even or odd as follows:

$$Q = \begin{cases} m_{([N+1]/2)} \; if \; N \; is \; odd \\ (m_{(N/2)} + m_{([N+2]/2)})/2 \; if \; N \; is \; even \end{cases}$$

The sample concentration magnitude will be ordered from least to greatest, $x_{(1)}$, $x_{(2)}$, to $x_{(n)}$ and the median concentration will be calculated as follows:

$$\tilde{x} = \begin{cases} x_{([n+1]/2)} \; if \; n \; is \; odd \\ (x_{(n/2)} + x_{([n+2]/2)})/2 \; if \; n \; is \; even \end{cases}$$

The median sampling date ($\tilde{t}$) with ordered times ($t_{(1)}$, $t_{(2)}$, to $t_{(n)}$) will also be determined in this way. The Thiel-Sen trend line will then be computed for an estimate at any time (t) of the expected median concentration (x) as follows:

$$x = \tilde{x} + Q \cdot (\mathrm{t} - \tilde{t}) = (\tilde{x} - Q \cdot \tilde{t}) + Q \cdot \mathrm{t}$$

To construct a confidence band around the Thiel-Sen line, sample pairs (t_i, x_i) will be formed with a sample date (t_i) and the concentration measurement from that date (x_i). Bootstrap samples (B) will be formed by repeatedly sampling n pairs at random with replacement from the original sample pairs. This will be repeated 500 times. For each bootstrap sample, a Thiel-Sen trend line will be constructed using the equation above. A series of equally spaced t_j values will be identified along the range of sampling dates represented in the original sample, j=1 to m. The Thiel-Sen trend line associated with each bootstrap replicate will be used to compute an estimated concentration ($\hat{x}_j^B$). A CI will be constructed for the lower αth percentile $\hat{x}_j^{[\alpha]}$from the distribution of estimated concentrations at each time point (t_j). For a UCL, compute the upper (1-α)th percentile, $\hat{x}_j^{[1-\alpha]}$ at each t_j; for an LCL, compute the lower αth percentile, $\hat{x}_j^{[\alpha]}$ at each t_j.

3.3.2 Parametric Confidence Intervals around a Mean

If compliance data do not show a trend and are normal or log-normal, one-sided parametric CIs around a sample mean will be constructed for each constituent and well pair. The LCL will be calculated as:

$$LCL_{1-\alpha} = \overline{x} - t_{1-\alpha,n-1} \cdot \frac{s}{\sqrt{n}}$$

The UCL will be calculated as:

$$UCL_{1-\alpha} = \overline{x} + t_{1-\alpha,n-1} \cdot \frac{s}{\sqrt{n}}$$

$\overline{x}$ = compliance sample mean

s = compliance sample standard deviation

n = compliance sample size

$t_{1-\alpha,n-1}$ = obtained from a Student's t-table with (n–1) degrees of freedom at the chosen alpha level (0.01) (Table 16-1 in Appendix D of the Unified Guidance)

If compliance data are distributed lognormally, the LCL will be computed around the lognormal geometric mean as:

$$LCL_{1-\alpha} = \exp\left(\overline{y} - t_{1-\alpha,n-1} \cdot \frac{s_y}{\sqrt{n}}\right)$$

The UCL will be computed around the lognormal geometric mean as:

$$UCL_{1-\alpha} = \exp\left(\overline{y} + t_{1-\alpha,n-1} \cdot \frac{s_y}{\sqrt{n}}\right)$$

$\overline{y}$ = compliance sample log-mean

s_y = compliance sample log-standard deviation

3.3.3 Non-Parametric Confidence Intervals around a Median

Non-parametric confidence intervals around the median will be computed if the compliance data do not show a trend and contain greater than 50% non-detects or are non-normally distributed. The mathematical algorithm used to construct non-parametric CIs is based on the probability p that any randomly-selected measurement in a sample of n concentration measurements will be less than an unknown p x 100th percentile of interest (where P is between 0 and 1). Then the probability that the measurement will exceed the p x 100th percentile is (1–p). The number of sample values falling below the p x 100th percentile out of a set of n should follow a binomial distribution with parameters n and success probability p, where 'success' is defined as the event that a sample measurement is below the p x 100th percentile. The probability that the interval formed by a given pair of order statistics will contain the percentile of interest will then be determined by a cumulative binomial distribution *Bin(x;n,p)*, representing the probability of x or fewer successes occurring in n trials with success probability p. P will be set to 0.50 for an interval around the median. In accordance with the Unified Guidance, a confidence interval around the median will only be calculated if at least seven data points are available.

The sample size n will be ordered from least to greatest. Given p = 0.50, candidate interval endpoints will be chosen by ordered data values with ranks rounded upward to the next higher integers. The ranks of the endpoint will be denoted L^* and U* and are calculated using the following equations (Conover, 1999, p. 144):

$$L^* = np - Z_{1-\alpha}\sqrt{np(1-p)}$$

$$U^* = np + Z_{1-\alpha}\sqrt{np(1-p)}$$

4. CORRECTIVE ACTION MONITORING PROGRAM

Corrective Action Monitoring is performed after a corrective action remedy has been selected and implemented. 35 I.A.C. § 845.680(a)(1) specifies that the corrective action groundwater monitoring program must meet the requirements listed in 35 I.A.C. § 845.650 (*i.e.*, Compliance Monitoring), document the effectiveness of the selected remedy, and demonstrate compliance with the GWPS. Post-Closure Care monitoring as described in **Section 3** will operate concurrently with Corrective Action Monitoring, fulfilling the requirements of 35 I.A.C. § 845.650. This document describes the statistical methods used to document the progress of the selected remedy and demonstrate compliance with the GWPS.

Evaluation of corrective action remedy effectiveness will occur in three phases: remedy progress evaluation, stability evaluation, and attainment evaluation (USEPA, 1992).

1. Remedy progress evaluation occurs after implementation of corrective actions to assess if the remedy is functioning as anticipated.
2. The stability evaluation, which occurs after treatment has been concluded and a re-equilibration period has elapsed, assesses if a new post-treatment steady state in the groundwater has been reached.
3. Attainment evaluation occurs after a new steady state has been achieved and assesses if COC concentrations are below the GWPS.

In accordance with the Unified Guidance, these evaluations only apply to constituents which have previous exceedances of the GWPS. Constituents without previous GWPS exceedances continue to be evaluated according to Compliance Monitoring (per **Section 3**). The Corrective Action GMP for each unit describes the detailed approach to remedy effectiveness evaluation and reporting. Statistical evaluations used in each of these three phases are described below.

4.1 Remedy Progress Evaluation

The goal of remedy progress evaluation is to determine if a groundwater remedy is on track to achieve cleanup standards within the proposed time frame and to inform adaptive management decisions if performance metrics are not achieved. Evaluations of remedy effectiveness include:

- Comparison of the central tendency (*i.e.*, mean or median) of data from corrective action monitoring wells to the GWPS
- Trend analysis of average concentrations in individual wells and in a plume

Unlike Compliance Monitoring, remedy progress evaluation does not result in the determination of exceedances. Instead, the results from these analyses are used to evaluate performance metrics described in the site-specific Corrective Action GMP.

4.1.1 Central Tendency

The two most common central tendency measures of a data set are the sample mean and sample median. The sample mean best represents the central tendency of normally-distributed data; therefore, the mean will be used to represent the tendency if the data are approximately normally distributed and the frequency of non-detects is below 50%. The sample mean is given by the arithmetic average of each value in the sample:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$\bar{x}$ = sample mean

n = sample count

x_i = i^{th} observation of x

The sample median is the 50th percentile of values in a sample and represents the midpoint of the ordered list of values. Because it is based on rank-order, the sample median is insensitive to data distribution; therefore, the median will be used if the data are not normally distributed or the frequency of non-detects is 50% or greater. The sample median is determined by arranging all values in order and selecting the middle value (or, if an even number of values exists, the mean of the two middle values).

4.1.2 Trend of Average Concentration in Individual Wells and in a Plume

Insight into remedy progress can be gained by evaluating changes in concentration at both the individual well and plume levels.

Trends at the individual well level are evaluated according to **Section 2.5**. To evaluate trends at the plume level, the trend on quarterly average concentrations is evaluated (per **Section 4.1.1**). Quarterly average concentrations in the plume are generated by calculating the mean or median as appropriate based on distribution (**Section 4.1.1**) of concentrations collected during a single sample event. Trend is then evaluated as described in **Section 2.5**. The magnitude of the trend (*i.e.*, slope) may be evaluated according to methods in **Section 3.3.1**.

4.2 Stability Evaluation

In order to evaluate ultimate effectiveness of the remedy, it is critical to evaluate if a new stable equilibrium has been reached after the implementation of corrective action (e.g., completion of source control or conclusion of groundwater extraction). Stability evaluation will be completed using trend analysis as described in **Section 2.5**.

4.3 Attainment Evaluation

Per 35 I.A.C. § 845.680(c), corrective action is considered complete when compliance with the GWPS has been demonstrated "at all points within the plume of contamination that lies beyond the waste boundary […] for a period of three consecutive years". Accordingly, attainment of the GWPS will be evaluated for well-constituent pairs previously determined to exceed the GWPS. This evaluation will include data collected after groundwater conditions have stabilized (**Section 4.2**).

The Unified Guidance recommends comparing a CI to the fixed GWPS to evaluate attainment of corrective action. The null hypothesis of this test is the reverse of that in Compliance Monitoring: corrective action well groundwater concentrations are assumed to exceed the GWPS unless the statistical test indicates otherwise. The CI will be calculated according to methods presented in **Section 3.3**. For pH, the only parameter with an upper and lower background and GWPS, the GWPS will be attained (*i.e.*, the null hypothesis rejected) when the CI falls within the range of the GWPS (*i.e.*, if the LCL of the CI is above the lower limit and the UCL is below the upper limit). For all other parameters, the GWPS will be attained when the UCL is below the GWPS. Once this

statistical evaluation indicates that GWPS has been met for three years (*i.e.*, that the null hypothesis is rejected), corrective action will be concluded.

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APPENDIX B2
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

OBG

Hydrogeologic Site Characterization Report

Hennepin West Ash Pond System

Hennepin, Illinois

Dynegy Midwest Generation, LLC

FINAL

December 20, 2017

Natural Resource Technology

AN OBG COMPANY

DECEMBER 20, 2017 | FINAL | PROJECT #2413

Hydrogeologic Site Characterization Report

Hennepin West Ash Pond System
Hennepin, Illinois

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G3 Class I Groundwater Quality Standards Monitoring Results – Organic Parameters

ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
bgs	below ground surface
CCR	coal combustion residual
CFR	Code of Federal Regulations
cm/s	centimeters per second
CWS	Community Water Supply
DMG	Dynegy Midwest Generation, Inc.
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
ft	feet
ft/ft	feet per feet
ft MSL	feet above Mean Sea Level
gal/day	gallons per day
IAC	Illinois Administrative Code
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ISGS	Illinois State Geological Survey
ISWS	Illinois State Water Survey
MDL	method detection limit
mg/L	milligram per liter
NRT	Natural Resource Technology, an OBG Company
PWS	Public Water Supply
S.U.	Standard Units
TDS	total dissolved solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WHPA	Wellhead Protection Area
WMA	Wildlife Management Area

1 INTRODUCTION

1.1 OVERVIEW

This Hydrogeologic Site Characterization Report was prepared by Natural Resource Technology, Inc., an OBG Company (NRT) in support of a Closure Plan for impoundments located at the Hennepin Power Station, Hennepin, Illinois which is owned by Dynegy Midwest Generation, LLC (DMG). This report and the Closure Plan apply to Coal Combustion Residuals (CCR) surface impoundments associated with the Hennepin West Ash Pond System and not to any of the other impoundments present on the Site (i.e. East Ash Pond System). However, information gathered to evaluate other CCR units on site regarding geology, hydrogeology, and groundwater quality is included, where appropriate. The Hennepin West Ash Pond System includes the following components:

Old West Ash Pond (which includes Pond No.1: 9.3 acres and Pond No. 3: 16.4 acres)

- Old West Polishing Pond: 4.7 acres [Polishing Pond]

Numerous hydrogeologic investigations have been performed concerning the CCR Units located at the Site. The information presented in this site characterization report includes recent data collected to comply with the Federal CCR Rule (40 CFR Part 257) as well as comprehensive data collection and evaluations from prior hydrogeologic investigation reports, including, but not limited to, the following:

- ***Hydrogeologic Study, Existing Ash Ponds, Hennepin Power Plant, Illinois Power Company, Hennepin, Illinois. John Mathes & Associates, Inc.; April 19, 1983.*** Five monitoring wells were installed, currently designated as wells 21 through 25. Monitoring wells 21 through 24 are downgradient of the West Ash Pond System and well 25 is an upgradient well located south of the impoundment. Grain size analyses were performed on soil samples.
- ***Investigation of Site Closure Options at Illinois Power Company's West Ash Impoundment. Report No. STMI/135/97-01. Science & Technology Management, Inc.; September, 1997.*** A supplemental hydrogeologic characterization was conducted to further characterize the West Ash Pond System, develop a groundwater flow and transport model and evaluate three alternative closure options using the model. Seven new permanent monitoring wells (26, 27, 30, 31, 32, 33, 34) and three new temporary leachate wells (L1, L3, L4) were installed around and within the impoundment. Field permeability tests were conducted on seven wells.
- ***Model Recalibration and Prediction of Closure Options for the West Ash Impoundment; Hennepin Power Station Putnam County, Illinois. Natural Resource Technology, Inc.; October, 2002.*** NRT drilled four soil borings within the ash impoundment (A1, A3, 23S, L5), installed monitoring well 35 along the south berm of Pond No. 3, well 36 south of Pond No. 1, and installed one leachate well L5 within the east end of Pond No. 3 in support of a groundwater flow and transport model for predicting future boron concentrations. The principal objective of the additional boring and well installation was to better define the depth of the ash ponds and determine the thickness of saturated ash. Additional groundwater quality data within the impoundment and along the south side the Old West Ash Pond was collected from the new wells for recalibrating the 1997 STMI groundwater model.
- ***Water Well Survey, Dynegy Midwest Generation, Hennepin Power Station, Hennepin, Illinois. Natural Resource Technology and Kelron Environmental; June 3, 2009.*** A water well survey was performed in accordance with the "Right to Know" Potable Water Well Survey procedures of 35 Illinois Administrative Code 1600.210(b)(1) and 1600.210(b)(2). The purpose of this survey was to identify water wells located within 2,500 feet of DMG's Hennepin Power Station property boundary.
- ***Assessment of Potential for Groundwater Impact on Identified Water Wells, Dynegy Midwest Generation, Hennepin Power Station, Hennepin, Illinois. Natural Resource Technology and Kelron Environmental; August 26, 2009.*** An assessment of the potential for impact of the ash impoundment on water quality of potable water wells identified in the water well survey.

- ***Hydrogeologic Summary and Groundwater Quality Assessment, West Ash Pond System, Hennepin Power Station, Hennepin, Illinois. Natural Resource Technology, Inc., July 24, 2014.*** The summary, including four quarters of groundwater quality monitoring, was conducted to develop information necessary to recalibrate the existing groundwater model of the West Ash Pond System and evaluate closure alternatives for the impoundment. This report is a compendium and reanalysis of information from three previous reports prepared for the West Ash Pond System along with an assessment of the most recent groundwater data collected from a network of 16 wells (14 monitoring wells and 2 leachate wells) in 2013 and 2014.
- ***Closure Alternatives Evaluation, West Ash Pond System, Hennepin Power Station, Hennepin, Illinois. Natural Resource Technology, Inc., July 24, 2014.*** This evaluation documented alternatives for closure of the West Ash Pond System, based on their effectiveness, implementation feasibility, and construction and maintenance costs. Groundwater transport modeling was completed to assess the effects of alternatives on surrounding groundwater quality. Implementation feasibility and costs were presented along with a recommended alternative.
- ***Monitoring Well 49 Installation. Natural Resource Technology, Inc., July 6, 2015.*** Documents the installation of CCR monitoring network Well 49.
- ***30% Design Data Report for Dynegy Hennepin Power Station; West Polishing Pond, West Ash Pond, East Ash Pond and Ash Pond No. 2 CCR Units. AECOM, January 12, 2016.*** The data package included summary tables, geotechnical laboratory data and exploratory logs for 32 auger borings, 38 CPT soundings and 7 standpipe piezometers installed at selected locations around the West Ash Pond System.
- ***Old West Polishing Pond Subsurface Investigation, Hennepin Power Station, Hennepin, Illinois. Civil & Environmental Consultants, Inc. (CEC), April 1, 2016.*** Data package included logs for 9 piston sampling and push probe borings along with two impoundment cross-sections within the Old West Polishing Pond of the West Ash Pond System.
- ***Closure Work Plan Annual Report, Hennepin Power Station, West Ash Pond System: Nos. 1 and 3. Dynegy Operating Company. Natural Resource Technology, Inc., October 21, 2016.*** In accordance with the Closure Work Plan approved by the Illinois EPA (November 8, 1996), DMG is required to perform groundwater monitoring and prepare annual reports for the Old West Ash Pond System. These annual reports have been submitted to the Illinois EPA from October 2000 through October 2016. Although the number of monitoring wells, sampling frequency, and water quality parameters has changed, these annual reports have documented the groundwater levels, flow, and water quality at the West Ash Pond System for all of the monitoring events conducted over a 16-year period.
- ***Subsurface Investigation Within West Ash Ponds 1 and 3. CEC, March 2017.*** Data package included boring logs for 20 auger borings, four impoundment cross-sections, well construction logs for 6 ash leachate wells and leachate elevations within the West Ash Pond System.

In conjunction with this report, a Groundwater Monitoring Plan and a Groundwater Management Zone Application are being prepared to support the closure of the West Ash Pond Complex. In addition, the groundwater flow and transport models were updated to evaluate the effect of various ash pond closure scenarios on groundwater quality and to predict the fate and transport of CCR leachate components (NRT, 2017c). Modeling has also been conducted to enable estimation of the time required for hydrostatic equilibrium of groundwater to be achieved beneath the West Ash Pond Complex (NRT, 2017d).

1.2 SITE LOCATION AND BACKGROUND

The West Ash Pond System is located in the northeast quarter of Section 27, Township 33 North, Range 2 West, Putnam County, Illinois and approximately 3 miles north-northeast of the Village of Hennepin (Figure 1). The impoundments are situated less than 200 feet south of the Illinois River and approximately one mile east of the Big Bend, where the river shifts course from predominantly west to predominantly south. The impoundment is bordered to the southeast by farm fields (i.e. corn and soybeans) with scattered clumps of rows or trees; to the southwest and west by low lying floodplains within the Donnelley Wildlife Management Area (Donnelley WMA)

administered by the Illinois Department of Natural Resources (IDNR); and to the east by the power generating facility (Figure 2).

Ponds are maintained within the Donnelley WMA for migratory waterfowl. Water levels in these ponds are maintained by a system of pumps operated during migration season, with water pumped from the Illinois River through a channel that runs immediately west of the Old West Polishing Pond. The Donnelley WMA is predominantly a swampy area vegetated by grasses and trees.

The eastern third of the impoundment is on a terrace about 15 feet higher than normal river stage. The western two-thirds are on lowlands that are about 5 to 10 feet higher than normal river stage.

1.3 SITE HISTORY

The Hennepin Power Station had two coal-fired units constructed in 1953 and 1959 with a capacity of 210 MW. The coal source changed several times since the station was constructed; however, all coal ash disposed to the West Ash Pond System is derived from Illinois coal.

DMG operated the West Ash Pond System at the Hennepin Power Station from 1952 through 1996. The impoundment consists of two units, all of which are now out-of-service. The Old West Ash Pond which includes Pond No. 1, at the eastern end of the impoundment, which primarily consists of bottom ash and slag and Pond No. 3, in the central portion of the impoundment, which contains mixed coal ash. The Old West Polishing Pond is located at the western end of the impoundment. All of the ponds are bermed. The berms, which are 15 feet above grade, were constructed from locally occurring sandy soils. The entire west impoundment covers an area of approximately 30.4 acres.

During operation, service water was used to sluice fly ash, bottom ash, and low-volume wastes to the impoundment. There was initially a surface water discharge from this impoundment which ceased after the impoundment was reworked in 1989. At the time the impoundment was removed from service in late 1996, there was no surface water discharge and all sluice water ex-filtrated via evapotranspiration, seepage through the berms, or leakage through the base of the ponds.

Coal ash sluiced to this impoundment was a by-product of high-sulfur Illinois coal. The operational history of the West Ash Pond System is as follows:

- 1952 – 1955: Construction of Old West Ash Pond, Pond No. 1. Berms constructed from locally sandy materials to an original elevation (since modified) of 457 feet.
- 1968: Construction of Old West Ash Pond, Pond No. 3. Berms were constructed to an elevation of 457 feet.
- 1979: Berms surrounding the Old West Ash Pond raised by 3 feet to elevation of 460 feet.
- 1988 – 1989: Ponds No. 1 and No. 3 within the Old West Ash Pond were consolidated and divided into primary and secondary cells, and the berm around the primary portion was raised 5 feet to an elevation of 465 feet. It was after this consolidation that surface water discharge from the impoundment ceased.
- December 1996: West Ash Pond System Ponds No. 1 and No. 3 were removed from service.

The West Ash Pond System was not capped following removal from service in order to facilitate future mining and beneficial re-use of the ash. The impoundment is partially dewatered by gravity drainage, although pumps were used to complete the dewatering process in 1998. The ash is currently dry over most of the surface through most of the year except for (i) the Old West Polishing Pond, which always contains water; and, (ii) the western end of the Old West Ash Pond, Pond No. 3, where runoff water collects and is ponded most of the year.

The ash at the surface of the Old West Ash Pond supports some vegetation. The surface topography of ash in, Pond No. 1 is uneven with no pronounced slope. The top of ash in Pond No. 3 slopes downward from the east, where the sluiced ash inlet was located, to the west. Top of ash elevation in all three ponds is lower than the surrounding berms, providing full containment. There are no controls to collect storm water so all runoff collects in the lowest portion of each pond, where it evaporates or infiltrates through the ash.

2 REGIONAL AND LOCAL GEOLOGY

2.1 TOPOGRAPHY

There are three geomorphic features dominant in the immediate vicinity of the Hennepin Power Station: an upper river terrace at an elevation of about 500 to 550 feet, a lower river terrace at an elevation of about 450 to 460 feet, and the current river valley filled with alluvium to an elevation of about 445 feet. The power station and eastern portion of the west impoundment (Old West Ash Pond, Pond No. 1) are on the narrow lower terrace between the Illinois River and the uplands. The western portion of the impoundment (most of Old West Ash Pond, Pond No. 3 and Old West Polishing Pond) overlies alluvium.

2.2 REGIONAL GEOMORPHOLOGY

The Hennepin Power Station is in the Bloomington Ridged Plain Section of the Central Lowland Province. The Bloomington Ridged Plain includes most of the Wisconsinan Stage moraines and is characterized by low, broad morainic ridges with intervening stretches of relatively flat or gently rolling ground moraine. Drainage is generally in the initial stages of development, and most streams follow, and are eroding, in constructional depressions, many of which cross morainic ridges. The valleys of principal streams are large and have floodplains bordered by valley-train terraces. The Illinois River has a broad, flat-bottomed valley with steep walls and is bordered by numerous steep-walled valleys with steep gradients.

2.3 SOILS

Surficial soils at the West Ash Pond System and vicinity are shown on Figure 3, based on the soil survey performed in Putnam County in 1986 (Soil Conservation Service, May 1992). Former soils underlying the impoundment are identified as Moundprairie Silty Clay Loam, wet. The Moundprairie series soils consist of poorly drained, moderately permeable soils on floodplains. These soils formed in alluvium. This soil association is well suited for and used as habitat for wetland wildlife. These soils are unsuitable for dwellings and only moderately suitable for cultivated crops, due to shallow water table and flooding.

The area west of the Old West Polishing Pond is designated Moundprairie Silty Clay Loam, frequently flooded. Areas south of the Old West Polishing Pond and Pond No. 3 are also designated as wet or frequently flooded Moundprairie Silty Clay Loam. South of the eastern end of the impoundment (i.e. south of Pond No. 1) are several units, including: Rodman Gravelly Sandy Loam, 12 – 30% slopes; Landes Fine Sandy Loam, occasionally flooded; Ade Loamy Fine Sand, 1 – 7% slopes; and, Dakota Loam, 0 – 2 % slopes. The power station and coal pile area located east of the impoundment are classified as urban land.

2.4 BEDROCK

2.4.1 Lithology

The uppermost bedrock near the Hennepin Power Station, including the West Ash Pond System, is the Pennsylvanian Carbondale Formation (Kolata, 2005), which consists of shale with thin limestone, sandstone, and coal beds (Figure 4). The bedrock surface elevation in the vicinity of the Site is between 400 and 450 feet (Willman et al., 1967). Three deeper borings around the perimeter of the East Ash Pond System confirm the presence of shale bedrock between elevations 400 and 410. Water well logs at the power plant indicate shale bedrock at an elevation of roughly 350.

The thickness of the Pennsylvanian rocks range from 150 feet in the western part of Putnam County to more than 525 feet along the eastern margin of the county (Woller, 1976). In the vicinity of the Site, the Pennsylvanian rocks have an estimated thickness of approximately 300 to 400 feet. Beneath the Pennsylvanian rocks are Mississippian and Devonian-age interbedded layers of limestone and shale over Silurian-age dolomite. The dolomite generally ranges in thickness from 410 to 505 feet in the immediate region (Willman, 1942; Frankie, 2002). Crevassing in the unit varies widely and well yields are inconsistent.

Deeper bedrock units beneath the Silurian-age dolomite consist of the following in descending order (Woller, 1976; Frankie, 2002):

- Maquoketa Shale Group of Ordovician age, composed primarily of blue to green shales with some limestone and dolomite layers, occurs at depths of less than 1,000 feet in the northwest part of Putnam County to 1,200 feet in southern Putnam County, with a thickness generally ranging from 155 to 240 feet. This shale is an aquitard between the Silurian dolomite and deeper dolomite and sandstone aquifers.
- Ordovician age dolomite and sandstone aquifers, including the following:
  - Galena-Platteville Dolomite Group at depths of about 1,150 feet in northwest Putnam County to about 1,400 feet in the southeast, ranging in thickness from 320 to 380 feet
  - Glenwood-St. Peter Sandstone at depths of about 1,450 feet in west Putnam County near the site to 1,750 feet in the southeast part of the county, ranging in thickness from about 120 to 170 feet
  - Dolomite with some shale and sandstone beds below depths of 1,750 to 1,800 feet near the site, principally consisting of the Shakopee (130 to 150 feet thick), New Richmond (approximately 165 feet thick), and the Oneota (approximately 215 feet thick) formations
  - Cambrian age dolomite and sandstone aquifers, including the Ironton-Galesville and Elmhurst-Mt. Simon formations
  - Precambrian age igneous and metamorphic

Based on the directory of coal mines for Putnam County (ISGS, 2006), the nearest coal mines in the vicinity of the site are located approximately 3 miles to the northeast and 4 miles to the southeast. These mines, identified as #8 and #298, are both abandoned underground shaft mines that used the longwall method of mining, essentially removing all of the coal. The #8 mine, called the Lacey Mine, was active from 1883 to 1890. The coal seam at this location ranged from 28 to 42 inches in thickness. The #298 mine, called the St. Paul Mine, and later the Prairie State Mine, operated from 1905 to 1925 and from 1930 to 1939. The coal seam at this location ranged from 42 to 66 inches in thickness.

The coal mined is called the Colchester Seam, also known as the No. 2 and LaSalle Seam. The Colchester Seam is located within the lower portion of the Carbondale Formation, which is the shallowest coal mined in the region. In the vicinity of the site, the Colchester Coal occurs at a depth of approximately 200 to 300 feet.

2.4.2 Structure

The major geologic structural features around Illinois are shown on Figure 5. The Hennepin Power Station is located within a relatively stable region of the continent within the north-central portion of the Illinois Basin. Rock units to the northeast of the Site form the La Salle Anticlinorium where folds are expressed in synclines, anticlines, arches, and monoclines present in the area (Nelson 1995; Anderson 1988). The Paleozoic bedrock strata, consisting of Pennsylvanian and older rocks, have a southwestern regional dip of approximately 15 to 30 feet per mile due to the effects of the anticlinorium. Variations to the bedrock dip occur in areas where there are local structures. The anticlinorium has subparallel anticlines, domes, monoclines, and synclines, which can change local dip and strike of bedrock units (Nelson, 1995).

2.4.3 Seismic Setting

The Sandwich Fault Zone is located approximately 35 miles northeast of the Site (Figure 5). Vertical displacement on the Sandwich Fault Zone ranges from 150 to 800 feet. The fault zone is downthrown to the northeast. Due to the depth of burial by Quaternary sediments and the lack of well or seismic data, detailed information about the fault zone is unavailable. Although depicted as a single fault on this map, evidence from surrounding counties indicates that the Sandwich Fault Zone is a complex configuration of many faults of varying direction and amount of displacement (Kolata, 1976).

The Plum River Fault Zone is a 112 mile long, east-west trending zone of high-angle faulting in east-central Iowa and northwest Illinois, roughly 60 miles northwest of the Site. The north side of the fault zone is downthrown,

with documented net vertical displacements of Silurian strata up to 270 feet. The physical relationships of Pennsylvanian deposits to the Plum River Fault Zone are not known with sufficient precision to preclude up to 33 feet of post-Pennsylvanian displacement. Historic data are inadequate to evaluate the potential for seismic hazard associated with the Plum River Fault Zone (Bunker, B.J., G.A. Ludvigson, B.J. Witzke, 1985). United States Geological Survey (USGS) seismic hazard maps show no enhanced ground acceleration in the Plum River Fault Zone vicinity.

2.5 UNLITHIFIED DEPOSITS GEOLOGY

2.5.1 General Unlithified Geology

The unlithified geologic deposits covering bedrock in the region surrounding the West Ash Pond System are derived from recent river deposition (alluvium), glacial outwash, and glacial till deposits. Total unlithified (drift) thickness ranges from 50 to 200 feet, generally becoming thicker with distance from the Illinois River southward from the impoundment. The geologic history of the Illinois River Valley was described in detail by Willman (1973), Hansel (1996), and Frankie (2002).

The Illinoian and Wisconsinan glaciers repeatedly moved over the area. The Illinois River established its present position during the Woodfordian substage of Wisconsinan glaciation, which covered the area as far south as Peoria. Wisconsinan drift lies directly on bedrock as a result of repeated Woodfordian glacial episodes eroding earlier deposits of loess and glacial drift.

During the glacial retreats from the Hennepin area, numerous moraines were deposited across the Illinois Valley. Large areas between these moraines and/or the glaciers subsequently flooded from meltwaters. One such lake was glacial Lake Illinois, which formed behind the Bloomington Moraine, crossing the Illinois River valley near Peoria. Rapid melting and drainage from this area (Kankakee Flood) deepened and widened the valley, cutting an extensive terrace at an elevation of 500 to 550 feet about 14,500 years ago. These deposits (Henry Formation) are mostly fine gravel and pebbly sand and may be as much as 150 to 200 feet thick in the large terrace on which the city of Hennepin is located (areas shown as 'gh' on Figure 6), along with the eastern (i.e. East Ash Pond System) and southeastern portion of the Hennepin Power Station property.

Another major flooded area formed behind the Tinley Moraine creating Lake Chicago. During downcutting of the Lake Chicago outlet about 3,000 years ago, the Chicago Outlet River deposited coarse gravel in bars on the eroded surfaces. The lower river terrace that underlies the eastern end of the west impoundment (Pond No. 1) includes deposits of the Chicago Outlet River. These deposits commonly occur about 20 to 40 feet above the Illinois River and may be up to about 50 feet in thickness. They are generally coarser and more uniformly sorted than the higher terrace deposits that occur immediately south of the Site.

The Illinois River is currently shallowly entrenched in glacial outwash and the Chicago Outlet River deposits. Lateral erosion by the river has developed a floodplain and deposited alluvium (Cahokia Alluvium) in abandoned channels. Alluvial deposits of the modern Illinois River consist largely of clayey silt and sandy silt with lenses of sand and gravel. The alluvium, where present, is 20 to 40 feet thick, overlying thick deposits of sand and gravel of the Henry Formation. These areas (shown as 'al' on Figure 6), are located beneath the Old West Polishing Pond, most of Pond No. 3, and areas to the west and southwest of the West Ash Pond System.

2.5.2 Detailed Site Lithology

Borings performed at the West Ash Pond System and vicinity are shown on Figure 7. Boring logs are provided in Appendix A. The four principal stratigraphic layers encountered at the West Ash Pond System and adjacent areas are:

1. Fill - coal combustion residuals (CCRs) consisting primarily of fly ash with lesser amounts of bottom ash and slag. This layer also includes the constructed fill berms around the ash ponds, which contain variable admixtures of CCRs and re-worked native silt, clay and sand
2. Alluvial fine grained silts and clays, classified as Cahokia Alluvium

3. Alluvial fine to medium sands
4. Sand and gravel with boulders, deposited by glacial meltwaters and classified as Henry Formation

The river-laid deposits are classified as Cahokia Alluvium. The Henry Formation sands and gravels make up the upper and lower terraces, and fill the valley beneath the alluvium. A fifth stratigraphic layer (Layer 5) – loamy and sandy diamicton (i.e. till) of the Wedron or Glasford Formation – was encountered at one location (Boring 32) approximately 2,560 feet (½ mile) south of the western end of the impoundment.

The stratigraphy of unlithified materials underlying the Henry Formation is uncertain, but it is assumed based on nearby borings at the power plant, East Ash Pond System, and vicinity that the Henry Formation most likely sits directly on top of bedrock in the vicinity of the West Ash Pond System. However, based on the identification of till approximately ½ mile south of the impoundment, it is possible that at some locations either till or an older sand formation, the Sankoty Sand, lies between the Henry Formation sand and gravel and bedrock.

The west impoundment lies over both glacial deposits (Henry Formation) and alluvium (Cahokia Alluvium). Pond No. 1 lies on top of lower terrace glacial deposits. The eastern portion of Pond No. 3 overlies alluvial sand, while the western portion of Pond No. 3 and the Old West Polishing Pond overlay silty clay alluvial channel fill deposits (Figure 8). Borings have been performed within the ash ponds to assess ash thickness and underlying soil types (CEC, 2016, 2017). West-east cross-section lines A-A' and B-B', and north-south cross-section lines C-C' and D-D', are shown on Figures 9 and 10, respectively.

Cross-section line A-A' through the central portion of the West Ash Pond System begins at Boring 34 (west of the impoundment) with silty and organic alluvial clays (Layer 2) that are 26.5 feet thick and underlain by over 11 feet of fine to medium grained alluvial sands (Layer 3). At the west end of the Old West Polishing Pond (Boring 21) are approximately 10 feet of CCRs (Layer 1) underlain by 34 feet of clay and silt (Layer 2) and greater than 8 feet of fine sand (Layer 3). At the west end of Pond No. 3 at Boring L1 there are 25 feet of CCRs underlain by more than 17 feet of silty clay and silt deposits of Layer 2. In the center of Pond No. 3 at Boring L3 there are 14.5 feet of CCRs underlain by 10.5 feet of fine sand (Layer 3) and greater than 25 feet of sand and gravel (Layer 4). The east end of Pond 3 contains 17 to 18 feet of CCRs underlain by 9 feet of silty clay and clayey silt at Boring L5 (Layer 2) and at least 1.5 feet of clayey silt and silty fine sand (Layer 3) at Boring A3, underlain by sand and gravel (Layer 4). The center of Pond No. 1 (Boring L2) has 25 feet of CCRs underlain by 3.5 feet of fine silty sand (Layer 3) and greater than 17.5 feet of gravel with sand (Layer 4).

West-east cross-section line B-B', located south of the ash impoundment, has a similar areal and vertical lithology to line A-A' with the exception that there is no Layer 1 with CCRs. The west end at borings 33 and 27 has thick silty clay and clayey silt deposits (Layer 2) ranging in thickness from 24 to 35 feet, underlain by up to 9 feet of silty, fine to medium sand (Layer 3), and sand and gravel (Layer 4). Moving eastward, Layer 2 is absent at borings 30/31 and Layer 3 is 17 feet thick above Layer 4. At borings 25/26 there is 4 feet of sandy silt (Layer 2) and no Layer 3 above the sand and gravel of Layer 4. Finally, at Boring 36, which is located south of the eastern end of the West Ash Pond System, there are 4 feet of silt (Layer 2) and 6 feet of fine sand (Layer 3) above the sand and gravel of Layer 4.

Cross-Sections C-C' and D-D' both show the thick CCR and fill deposits along the west and central portions of Pond No. 3, respectively, which are underlain by 17 to 25 feet of silty clay and clay of Layer 2. Layer 3 (fine to medium sand) is 8 feet thick at borings 24/L4 on the west side of Pond No. 3 and ranges from 0 feet closer to the river to 10.5 feet thick beneath the middle of Pond No. 3. South of the impoundment at borings 30/31 (cross-section C-C') and borings 25/26 (cross-section D-D') there is no Layer 2 present at borings 30/31 and a 4 foot thickness at borings 25/26. Layer 3 is 17 feet thick at borings 30/31 and is absent at borings 25/26, where Layer 2 lies directly above Layer 4.

3 REGIONAL AND LOCAL HYDROGEOLOGY

3.1 BEDROCK – REGIONAL AND LOCAL

The Pennsylvanian rocks in the region are not considered a municipal or subdivision water supply source (Gibb, 1979). Water-bearing openings are extremely variable from place to place and are best developed near the surface in thin limestones and sandstones, when present within the predominantly shale formation. In the bedrock upland areas away from the Illinois River, farm and domestic water supplies are obtained locally from sandstone and creviced limestone in the upper 250 feet of these rocks (Woller, 1976). When present, the limestone and sandstone units yield less than 10 gallons per minute (gpm) (Visocky et. al, 1985). Water quality within the bedrock varies considerably and it becomes highly mineralized with increasing depth. As a result, the Pennsylvanian bedrock is not a reliable source of groundwater.

The Pennsylvanian rocks generally have low porosity and hydraulic conductivity. The porosity of shale typically ranges from 1 to 20 percent (Walton, 1988). Representative horizontal hydraulic conductivity for shale typically ranges from 5×10^{-6} to 5×10^{-10} centimeters per second (cm/s). Representative vertical hydraulic conductivity ranges for shale are 5×10^{-8} to 5×10^{-12} cm/s (Walton, 1988).

Recharge to the Pennsylvanian rocks is derived locally from vertical leakage through the glacial drift and other unlithified materials that are in turn recharged from precipitation.

Deeper bedrock units beneath the Pennsylvanian rocks and their water-bearing properties (Woller, 1976) are as follows:

- Silurian dolomite, which may provide water to wells in moderate quantities from cracks and crevices, but is too mineralized for most uses.
- Maquoketa Group of Ordovician age composed of non-water-bearing shales and acts as an aquitard between the Silurian dolomite and deeper water-bearing units.
- Cambrian-Ordovician Aquifer (a/k/a Midwest Bedrock Aquigroup), composed of the Ironton-Galesville aquifer at the base of this group up through the Glenwood-St. Peter Sandstones. These formations are the major bedrock aquifer and principal water producing zones in the region capable of yielding moderate quantities of groundwater (Visocky et. al, 1985).

In the region surrounding the site, these bedrock aquifers provide municipal water supply sources. The villages of Granville and Standard, about five miles southeast of the Site, both obtain their water supply from the Galena-Platteville Dolomite and Glenwood-St. Peter Sandstone, with wells ranging in depth from 1,740 to 1,793 feet. Pumping rates range from about 60 to 150 gpm.

As noted earlier, the Pennsylvanian-age Carbondale Formation defines the base of the unlithified deposits (and uppermost aquifer) underlying the West Ash Pond System and is regarded as the first confining unit beneath the uppermost aquifer. Water well logs at the power plant indicate shale bedrock at an elevation of roughly 350. In the vicinity of the Hennepin Power Station the Pennsylvanian rocks have an estimated thickness of approximately 300 to 400 feet. The Pennsylvanian rocks of this area contain little or no usable water and are seldom considered for even domestic water supply purposes due to generally low effective porosity and hydraulic conductivity (Gibb, 1979).

3.2 UNLITHIFIED DEPOSITS - REGIONAL

Regional groundwater flow in the unlithified deposits above the shale bedrock discharges into the Illinois River. Depth to the water table is typically greater than 20 feet below ground surface around the Site. The water table elevation can vary significantly, depending on the river stage. During flood stages, exfiltration from the river may temporarily recharge groundwater close to the river and the water table beneath the West Ash Pond System and adjacent areas of the floodplain may rise to levels mimicking river elevations.

The Henry Formation deposits have high hydraulic conductivity compared to the underlying bedrock. Pump test and specific capacity data were obtained for five high capacity industrial and municipal wells screened in the unlithified deposits along the Illinois River within several miles of the Hennepin Power Station (ISWS, 1989). Hydraulic conductivity of the Henry Formation sand and gravel ranged from 5 x 10^{-2} cm/s to 3 x 10^{-1} cm/s, with a median of 1 x 10^{-1} cm/s. Pumping rates ranged from 125 to 1,570 gpm and the tests were conducted over periods ranging from 30 minutes to 24 hours. Effective porosity typically ranges from 20 to 35 percent for poorly sorted sand and gravel alluvial deposits (Walton, 1988; Fetter, 1980).

Hydraulic conductivity of the alluvial deposits, generally consisting of lower permeability materials (i.e. silt, silty sand, and clay), will typically be several orders of magnitude lower than the more permeable outwash sand and gravel deposits of the Henry Formation. However, no published regional data is available specifically for the shallow alluvial deposits. Silt, clay, and mixtures of sand, silt, and clay typically have horizontal hydraulic conductivity ranging from 10^{-4} to 10^{-7} cm/s (USDI, 1981; Fetter, 1980).

3.3 UNLITHIFIED DEPOSITS – SITE SPECIFIC

The four water-bearing layers encountered at the West Ash Pond System and adjacent areas are: (1) Fill (Unit 1) - CCRs, consisting primarily of fly ash with lesser amounts of bottom ash and slag; (2) fine grained silts and clays (Cahokia Alluvium); (3) fine to medium sands (Cahokia Alluvium); and, (4) sand and gravel with boulders (Henry Formation). The Cahokia Alluvium and Henry Formation together comprise the uppermost aquifer (Unit 2) at the West Ash Pond System and extend from the water table to the bedrock. The underlying shale bedrock has low hydraulic conductivity and defines the lower boundary of the uppermost aquifer. The till is also a confining unit and rests unconformably on top of the shale bedrock; however, the closest this unit has been observed relative to the impoundment is approximately ½ mile south of the Old West Ash Polishing Pond.

Lithologic Layers/Sublayer		Hydrogeologic Unit Designation		
ID	**General Description**	**ID**	**Name**	**Description: Materials**
1a	Mixed Fill, Sand, Silt, Clay	**1**	Fill Unit	Coal Combustion Residuals: Fly Ash, Bottom Ash, Slag
1b	Old West Ash Ponds No. 1 and No. 3 – Fill – Coal Combustion Residuals and Constructed Berms			
2	Alluvial Silts and Clays (Cahokia Alluvium)	**2**	Uppermost Aquifer Unit	Mixed Alluvial Deposits: Clay, Silt, and Sand
3	Alluvial Sands (Cahokia Alluvium)			
4	Glacial Outwash – Sand and Gravel (Henry Formation			Outwash Deposits: Sand and Gravel
5	Till – Loamy and Sandy Diamictons (Wedron or Glasford Formation)	**3**	Till Confining Unit	Silty Clay with Trace Sand
6	Pennsylvanian Bedrock (Carbondale Formation)		Bedrock Confining Unit	Shale, Minor Limestone and Sandstone, Coal

*Till identified at one location – boring for monitoring well 32, located approximately 2,560 feet south of West Ash Pond System. No till identified beneath or within 2,500 feet of impoundment.

As previously discussed, the Henry Formation sand and gravel and the alluvial sands are very permeable, while the alluvial silts and clays have relatively low permeability.

3.3.1 Water Table Elevation and Groundwater Flow

Monitoring wells installed at the West Ash Pond System are shown on Figure 11. Well construction details are provided in Appendix A and summarized on Table 1.

Groundwater elevation data is available beginning in 1993. The Illinois River is the local and regional groundwater discharge area under normal river stage. River stage is usually lowest during the months of August through October. During normal river stage, a slight groundwater mound occurs within the West Ash Pond

System with radial flow north toward the river as well as flow to the southwest that eventually discharges into the river west of the impoundments. Surface water elevations are managed within the conservation area (Donnelley WMA) located west and southwest of the impoundment. Wells 32, 33, and 34 are within the conservation area. The water table contour map for December 10, 2013 (Figure 12) is representative of groundwater flow conditions during normal Illinois River stage elevation of approximately 441 ft.

The river basin experiences annual spring flooding during the months of March, April, May, and sometimes June, while lesser flooding occasionally occurs during autumn. River stage during high precipitation and/or flood events seasonally rises above adjacent groundwater elevations and in low lying areas of the floodplain, particularly within the Donnelley WMA at wells 32, 33, and 34. During these events, the river temporarily recharges the aquifer and groundwater flow direction close to the river reverses. Horizontal gradients across the Site become flat. The water table contour map for March 18, 2015 (Figure 13) is representative of groundwater flow conditions during flood stage, with an approximate river elevation of 446 ft. These groundwater flow reversals are limited in duration and extent.

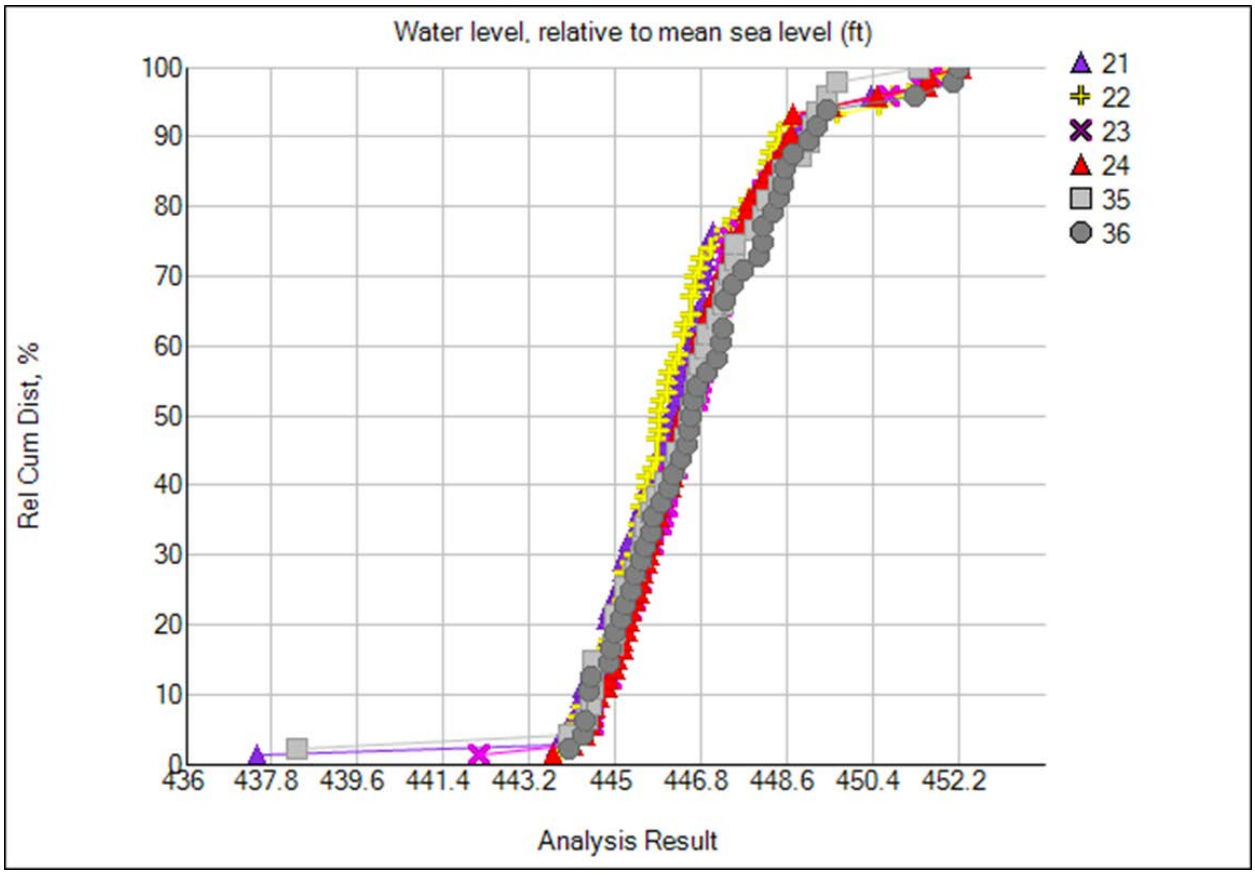
Horizontal hydraulic gradients from the West Ash Pond System to off-site areas ranges from 0.001 foot per foot (ft/ft) during Illinois River flood stage to about 0.005 ft/ft during normal river stage.

Appendix B provides additional water table contour maps prepared for the Closure Work Plan Annual Reports during the years 2013 through 2016.

3.3.2 Saturated Ash

Soil boring logs performed within Pond No. 1 and Pond No.3 (CEC, 2017) indicate the base of the ash is variable but generally rises from west to east. The ash elevation is as low as approximately 441 feet at the west end of Pond No. 3 and rises to 447 feet in the northeast portion of Pond No. 1 (Figure 8).

The Illinois River and the sand and gravel aquifer underlying the West Ash Pond are hydraulically connected. Groundwater hydrographs recorded on the south berm of East Ash Pond No. 2 (Hennepin East Ash Pond System) show that groundwater elevations respond rapidly to higher river elevations associated with major flood events (STMI, June, 1996). As shown in the graph below, the average measured groundwater elevation at the West Ash Ponds (50% occurrence) is 446.3 ft based on 23 years of monitoring data. Ninety percent of measured groundwater elevations (10% occurrence) occur at and below 449.2 ft. The highest groundwater elevations observed have averaged about 451.5 ft.



The above recurrence interval of groundwater elevations is biased low because the monitoring wells are measured on a quarterly basis and measurement dates may not coincide with maximum river flood events.

Based on the above, it can be anticipated that a large portion of the West Ash Pond System base elevations will become saturated when groundwater levels rise to the 10% recurrence interval elevation of 449.2 ft. Illinois River flood elevations are discussed further in Section 3.4.

3.3.3 Hydraulic Conductivity

3.3.3.1 Field Hydraulic Conductivity

Based on the field permeability tests and calculations on seven wells at the West Ash Pond System (Table 2), hydraulic conductivity ranges from 1.2 x 10^{-2} cm/s for the most permeable gravel deposits of the Henry Formation to 1.3 x 10^{-4} cm/s for the least permeable deposits (silt) of the of the Cahokia Alluvium. The geometric mean hydraulic conductivity of wells finished in sand and/or gravel (alluvial or glacial) is 6.0 x 10^{-3} cm/s. The geometric mean hydraulic conductivity of wells finished only in gravel (i.e. Henry Formation) is 1.7 x 10^{-2} cm/s. The lowest permeability occurred in the alluvial silt, with a hydraulic conductivity of 1.3 x 10^{-4} cm/s. The hydraulic conductivity test analysis and results are provided in Appendix C1.

Pump test data from the fire well installed at the power plant in 1968 was also available to estimate the permeability of the Henry Formation. This fire well is located at the southwest corner of the plant and was drilled to a depth of 112 feet, terminating on shale. The lower 30 feet of the well is screened within unlithified deposits. The well log is contained in 'Water Well Survey' (Kelron/NRT; June 3, 2009). The pump test hydraulic conductivity result reported by Mathes (1983) was 1.3 x 10^{-1} cm/s (Table 2).

3.3.3.2 Laboratory Hydraulic Conductivity

Two samples were collected by AECOM for laboratory hydraulic conductivity tests (ASTM D 5084). HEN-B010 was located on the south berm of Pond 3. HEN-B017 was located on the west berm of the Old West Polishing Pond.

Sample Location	Sample Depth (ft bgs)	Description	Hydraulic Conductivity (cm/sec)
HEN-B010	10.0 ft – 11.5 ft	Very dark gray fly ash with sand and gravel	1.16×10^{-5}
HEN-B017	5.0 ft – 7.0 ft	Very dark gray lean clay with sand	6.79×10^{-7}

Laboratory hydraulic conductivity test results are provided in Appendix C2. Other geotechnical test results on soil samples are provided in Appendix D.

3.3.3.3 Groundwater Velocity

Groundwater velocity was calculated in the vicinity of the West Ash Pond System under normal flow conditions where the aquifer discharges to the Illinois River using the following formula:

$$\text{velocity} = \frac{(\text{hydraulic conductivity})\ (\text{hydraulic gradient})}{\text{effective porosity}}$$

For representative conditions existing in June and September, 2013 the calculated velocities were as follows:

Flow Path	Average Hydraulic Conductivity (cm/sec)	Hydraulic Gradient	Effective Porosity	Velocity (ft/day)[1]
Well 21 to Well 34	1.7×10^{-2}	0.005	0.22	1.1
Well 21 to Well 34	6.0 x 10-3	0.001	0.22	0.1
Well 27 to Well 33	6.0×10^{-3}	0.005	0.22	0.4
Well 27 to Well 33	1.7×10^{-2}	0.001	0.22	0.2

[1] cm/sec x 2,835 = feet/day

For the range in hydraulic conductivities and hydraulic gradients observed, the calculated velocities away from the impoundment range from 0.1 to 1.1 ft/day (37 to 401 ft/yr).

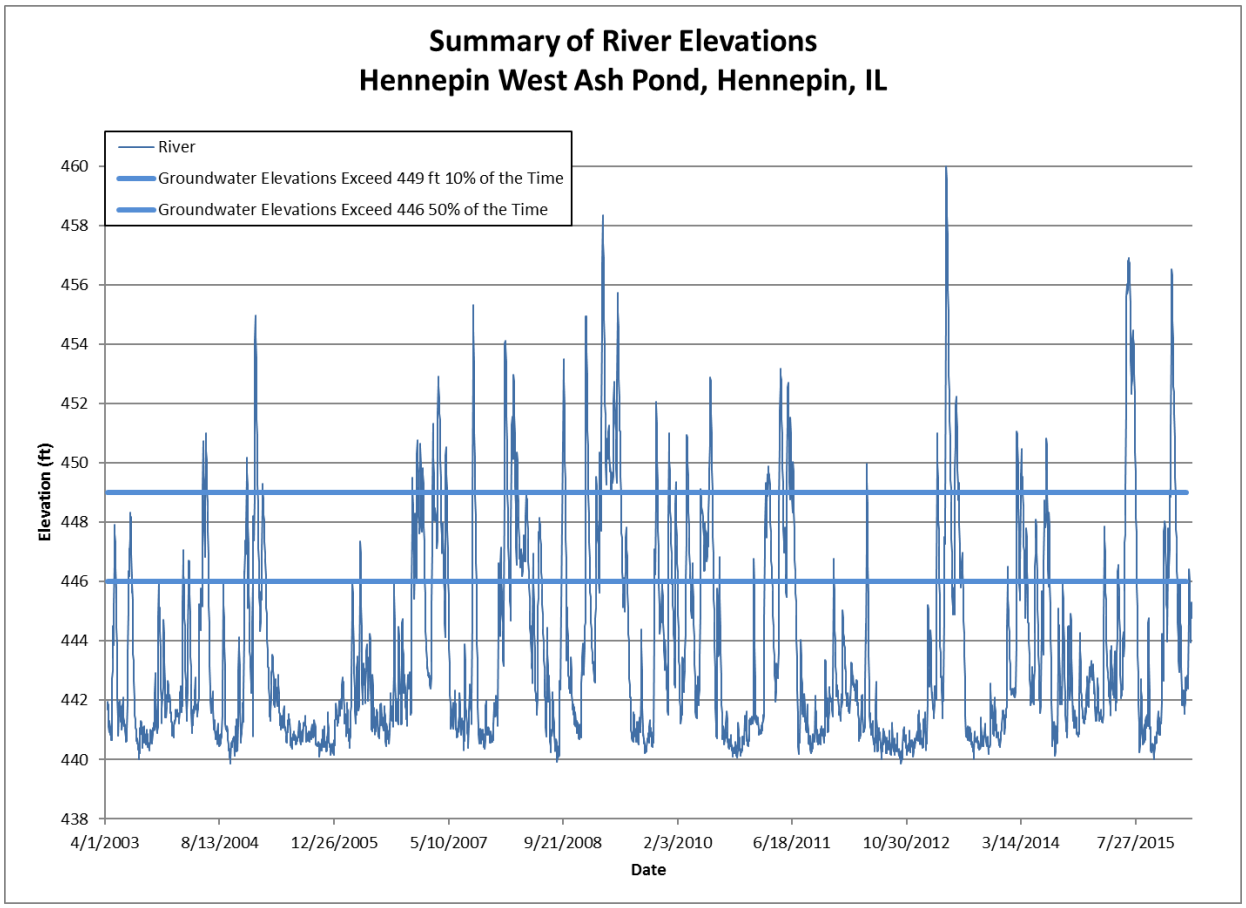
3.3.4 Groundwater Classification

Per Illinois Administrative Code (IAC) Title 35, Section 620.210, groundwater within the Uppermost Aquifer at the West Ash Pond System meets the definition of a Class I, Potable Resource Groundwater based on the following criteria:

- Groundwater in the uppermost aquifer extends 10 feet or more below the land surface
- Hydraulic conductivity exceeds the 1 x 10-4 cm/s criterion (Table 2)

3.4 SURFACE WATER HYDROLOGY

The predominant surface water body in the region is the Illinois River and associated lowland backwater lakes. The Illinois River is located directly adjacent to and down-gradient from the West Ash Pond System under normal flow conditions. River elevation data collected at Hennepin Power are shown below for the period 2003 through 2016.



Bordering the north perimeter of the west impoundment, the river has a normal pool elevation of about 441 ft. A FEMA Flood Insurance Rate Map for Putnam County (Map No. 17155C0015E; Effective Date: February 4, 2011) is attached in Appendix E and can also be viewed online at: http://www.illinoisfloodmaps.org/DFIRMpdf/putnam/putnam_fin_0025.jpg.

The base flood elevation value of 462 feet is located through the center of the Old West Ash Pond's Pond No. 3. As identified on the 2011 FEMA map, the floodway boundary encompasses the entire area of the Old West Ash Pond except for Pond No. 1. However, the berms of the impoundment were raised in 1979 and 1988-1989, with only the Old West Polishing Pond remaining subject to flooding at the 462 foot elevation. The flood hazard areas shown on the map are defined as those areas subject to inundation by the 1% annual chance flood (i.e. 100-year flood), also known as the base flood, that has a 1% chance of being equaled or exceeded in any given year.

3.5 WATER WELL SURVEY

A comprehensive water well survey was conducted by NRT and Kelron (2009a) for a 2,500-foot radius around the entire Hennepin Power Station property boundary, inclusive of the West Ash Pond System (Appendix F). Based on State of Illinois records obtained from the Illinois EPA, Illinois State Geological Survey (ISGS), and Illinois State Water Survey (ISWS) there are only two wells located outside of the Hennepin Power Station property boundary and within 2,500 feet of the West Ash Pond System. The two wells, constructed in 1844 and 1922 to depths of 30 and 17 feet bgs, respectively, according to State of Illinois records, have been verified and were most likely abandoned decades ago. There are no homes, farms or other potential users present at the two locations. There are also no public water supply (PWS), community water supply (CWS) or non-CWS wells or wellhead protection areas (WHPAs) within 2,500 feet of the West Ash Pond System.

Within the plant property boundary, and within 2,500 feet of the West Ash Pond System, there are four wells owned by DMG, all of which are non-potable and non-contact industrial wells.

An assessment of the potential for groundwater impact to water wells, as identified in the water well survey (NRT and Kelron, 2009b) demonstrated that there are no existing off-site water wells, potable or non-potable, that are likely to be impacted by groundwater from the West Ash Pond System or the Hennepin Power Station.

4 GROUNDWATER QUALITY

4.1 SUMMARY OF GROUNDWATER MONITORING ACTIVITIES

4.1.1 Groundwater Monitoring – Illinois EPA Closure Work Plan

Groundwater sampling at the West Ash Pond System was initiated in 1983; however, consistent data collection began in 1996 in accordance with the Closure Work Plan approved by the Illinois EPA on November 8, 1996. The 1996 Closure Work Plan required DMG to sample groundwater quarterly at the West Ash Pond System and to submit the data in an annual report. Requested modifications to the 1996 Closure Work Plan were approved by the Illinois EPA on January 27, 2005 and included the following:

- Reduce monitoring frequency for wells on a quarterly schedule to semiannually;
- Reduce reporting of data to the Illinois EPA on disc to semiannually; and,
- Remove parameters from the monitoring program that do not have a groundwater standard, with the exception of water elevation.

The current Illinois EPA groundwater monitoring program consists of collecting samples from 3 background wells (32, 33, 34) and 9 downgradient wells (21 through 27, 30, 31). Samples are collected semi-annually except for background wells 33 and 34, which are sampled annually. Groundwater samples are analyzed for the following parameters:

Field Parameters		
Ph	**Temperature**	
Specific Conductivity	**Groundwater Elevation (ft)**	
Laboratory Parameters		
Boron (Dissolved)	**Iron (Dissolved)**	**Sulfate (Total)**
Chloride (Total)	**Manganese (Dissolved)**	**Total Dissolved Solids (TDS)**

Time concentration plots showing the results of the above monitoring are provided in Appendix G1. Four additional monitoring wells (L3, L5, 35 and 36) have been monitored periodically for groundwater elevation only. The monitoring well locations are shown on Figure 11.

Groundwater monitoring results are reported to the Illinois EPA annually in accordance with the approved Closure Work Plan. The most recent data and analysis were submitted in '*2016 Closure Work Plan Annual Report* (NRT, October 21, 2016).

Additional groundwater monitoring was initiated for four quarters (June [Q2] 2013 through March [Q1] 2014) at the above 12 well locations to assess compliance with the IAC 35 Part 620 Section 410 *Groundwater Quality Standards for Class I: Potable Resource Groundwater*. Sampling was conducted for an expanded list of parameters that included the following:

Field Parameters	
Ph	**Temperature**
Specific Conductivity	**Turbidity**

Laboratory Parameters			
Inorganics (Total)			
Chloride	Fluoride	Nitrite	Sulfate
Cyanide	Nitrate	Perchlorate	TDS
Metals (Total and Dissolved)			
Antimony	Cadmium	Lead	Silver
Arsenic	Chromium	Manganese	Thallium
Barium	Cobalt	Mercury	Vanadium
Beryllium	Copper	Nickel	Zinc
Boron	Iron	Selenium	
Organic Compounds			
Volatile Organic Compounds	Polychlorinated Biphenyls (PCBs)		
Semi-Volatile Organic Compounds	Specialized Organic Parameters: Endohall, Ethyl Dibromide (EDB) and 1,2-Dibromo-3-Chloropropane (DBCB)		
Chlorinated Pesticides			
Chlorinated Herbicides			

The groundwater quality results for the above field, inorganic and organic parameters listed in IAC 35 Part 620 Section 410 (except for Radium 224/226) for the four quarters of monitoring are provided in Appendices F2 and F3, respectively.

4.1.2 40 CFR Part 257 Monitoring

Groundwater data collection under the CCR Rule was initiated in fourth quarter, 2015. The CCR Rule monitoring network consists of background/upgradient monitoring wells 32 and 34, and downgradient monitoring wells 21, 22, 23, 24, 35, and 49. Monitoring well 49 was installed by NRT in July, 2015 (Appendix A3) on the north berm of Old West Ash Pond to supplement the CCR Rule groundwater monitoring network. Monitoring of this well commenced in 2016. Parameters tested under the initial CCR Rule groundwater monitoring requirements include Appendix III and Appendix IV parameters (see below). All existing groundwater monitoring wells are measured at least annually for groundwater elevation.

40 CFR Part 257 Monitoring			
Appendix III Parameters (Total, except TDS)			
Boron	Chloride	pH	TDS
Calcium	Fluoride	Sulfate	
Appendix IV Parameters (Total)			
Antimony	Cadmium	Lead	Selenium
Arsenic	Chromium	Lithium	Thallium
Barium	Cobalt	Mercury	Radium 226/228
Beryllium	Fluoride	Molybdenum	
Field Parameters			
Dissolved Oxygen	Specific Conductivity	Turbidity	pH

Data collected under the CCR Rule groundwater monitoring program will be available when CCR reporting begins in January 2018. Following the completion of eight quarterly sampling events, the monitoring program will be modified so that the analytical parameters and sampling frequency are appropriate to the objectives and requirements of the CCR Rule.

4.2 GROUNDWATER MONITORING RESULTS AND ANALYSIS – ILLINOIS EPA CLOSURE WORK PLAN PARAMETERS

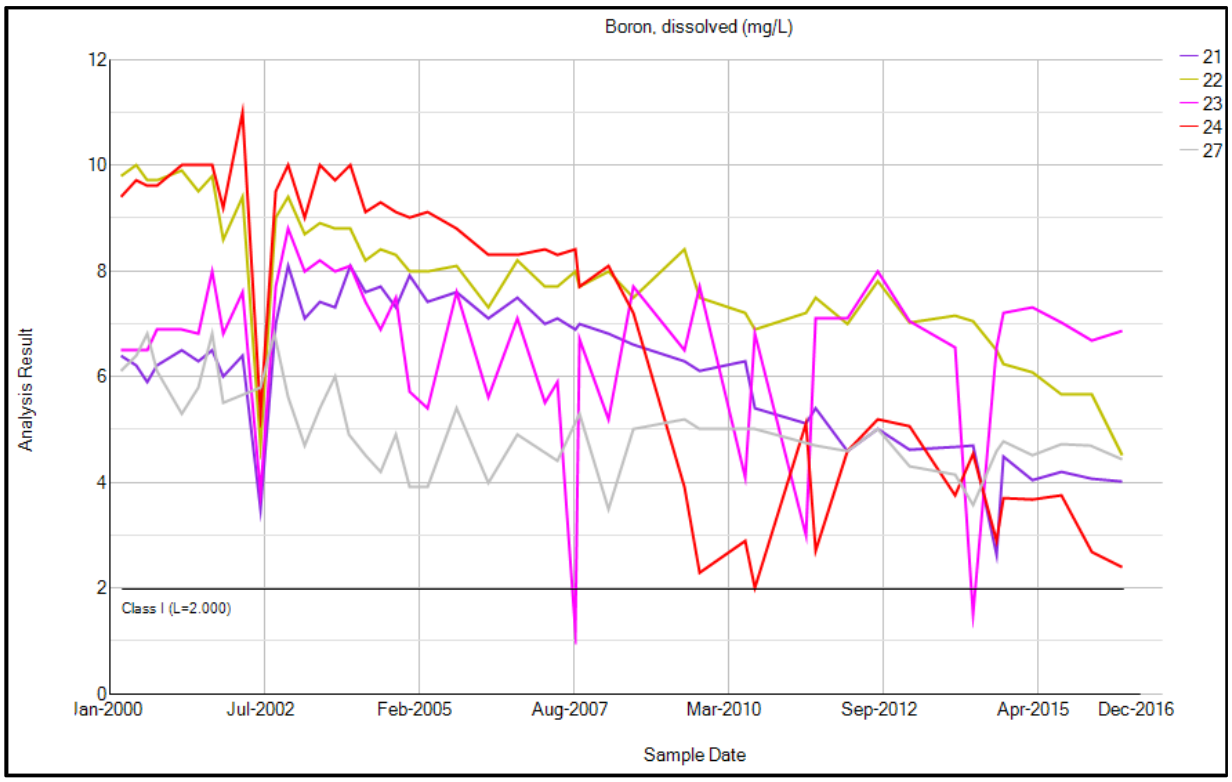
A summary of the number of groundwater quality exceedances at each well, and the date of the last exceedance, are provided in Table 3. The parameters observed in groundwater with exceedances of Class I standards during the most recent 2016 Closure Work Plan sampling event included boron, iron, manganese and sulfate. Time

versus parameter concentration plots for the Illinois EPA parameters over the period 2005 through 2016 are provided in Appendix G1. These parameters are discussed in greater detail below.

4.2.1 Boron

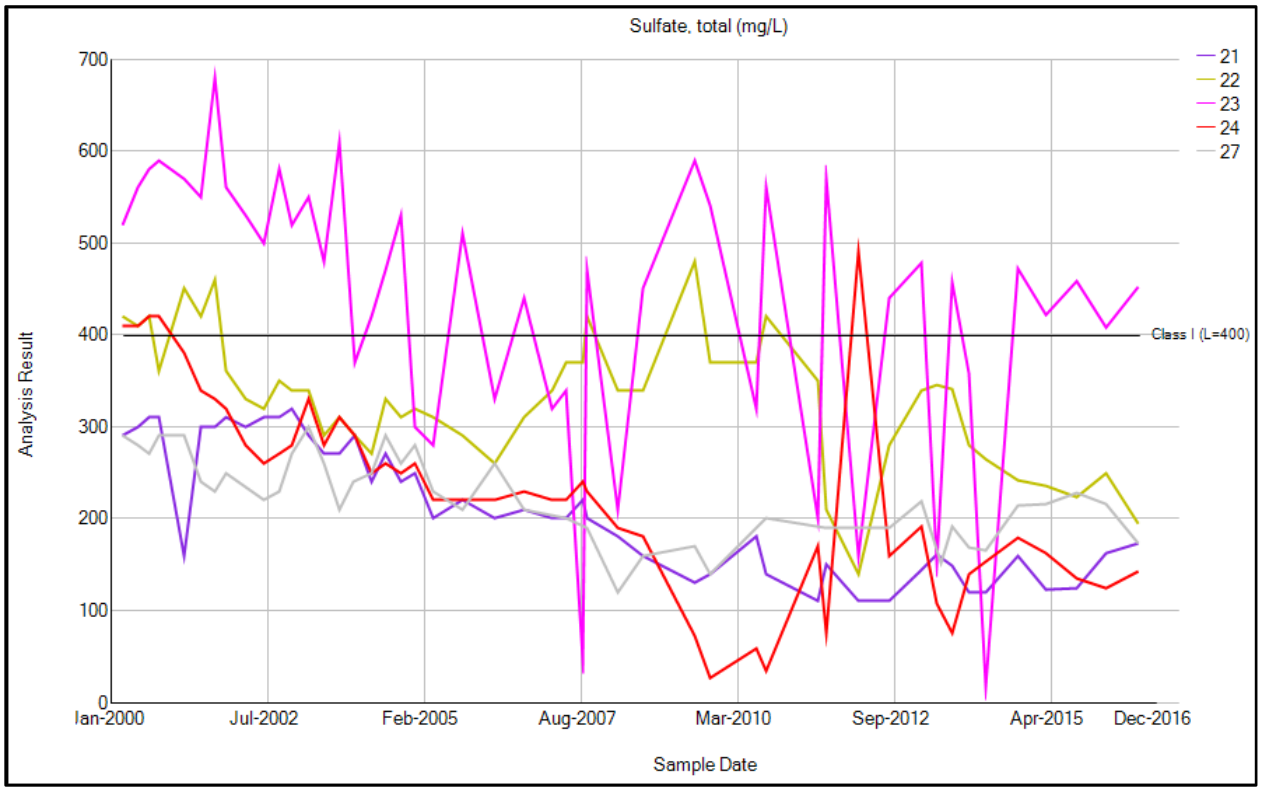
Boron is a primary indicator parameter for CCR leachate impacts on groundwater quality. Boron exceeds the 2 milligrams per Liter (mg/L) standard at 5 of the 12 monitoring wells as shown on Figure 14. Exceedances occur in wells 21 through 24 on the West Ash Pond System berms and well 27, located south of the Old West Polishing Pond. None of the other monitoring wells have had a boron exceedance since 1996, or prior to the removal of the west impoundment from service.

Boron concentrations in downgradient monitoring wells 21 through 24 and 27 have been trending downward (see Table 4 and graph below) since the impoundment was removed from service in 1996. For the period of January 2000 – September 2016, the five downgradient wells have had downward (i.e. negative) concentrations trends:



4.2.2 Sulfate

Sulfate is also a primary indicator parameter of CCR leachate impacts on groundwater quality. Since the impoundment was removed from service in 1996, sulfate concentrations at the five downgradient wells (21 through 24 and 27) have been trending downward (see graph below) and decreased from their peak by 22 to 69 percent (Table 4). Exceedances of the Class I groundwater standard for sulfate are continuing to be observed at well 23 between the river and the impoundments. Sulfate concentrations in the four wells to the south (wells 25, 26, 30, and 31) have also declined by 38 to 54 percent from their peak (i.e. post-1996) concentrations.



4.2.3 Iron

Iron is a redox-sensitive parameter that typically has low concentration in oxic groundwater and elevated concentration in reduced groundwater. Iron concentrations greater than 1 mg/L in neutral pH groundwater are indicative of strongly reduced conditions.

Iron concentrations in wells 22 and 23 are typically lower than 0.2 mg/L, indicating oxic conditions are prevalent at these monitoring points. Conversely, iron concentrations were typically greater than 2 mg/L in monitoring wells 21 and 34, indicative of persistent strongly reducing conditions. Other wells had variable iron concentrations, indicating that redox conditions varied over the course of the year. Well 25 had its only recorded exceedance in June 2013 during a period of flooding along the Illinois River. Other wells (22, 23, 26, 27, 30, 31, 32) also had unusually high iron concentrations during this period, suggesting that flood conditions affected geochemical conditions and iron concentrations,

Iron has been monitored since 1995. Concentrations higher than the Class I standard were frequently observed at wells 24 (1995 through 2000), 33 (through 2013), and 34 (through 2016), and there was only one exceedance in another monitoring well, well 26 in 2005. Based on concentrations before and after the exceedance at well 26, this value appears to be an outlier (Table 3). These observations indicate that the exceedance observed in well 25 in Q2 2013 likely represents an unusual event, while the exceedances in background wells 33 and 34 are normal.

Elevated concentrations of iron do not correlate to the CCR leachate indicator parameters of boron and sulfate, and are not caused by a release from the West Ash Pond System. The observed variability in iron concentrations in groundwater sampled from different parts of the area are controlled by variations in groundwater geochemistry rather than a release from the West Ash Pond System.

4.2.4 Manganese

Like iron, manganese is controlled by geochemical conditions, and its concentration distribution in groundwater is not due to a release from the West Ash Pond System. Elevated concentrations of manganese do not correlate

to CCR leachate indicator parameters boron and sulfate. Exceedances of the manganese Class I groundwater quality standard (0.15 mg/L) occurred in 2016 at downgradient monitoring well 23 as well as south wells 27 and 31 and background well 34.

These highly variable manganese concentrations are due to variable geochemical conditions rather than a release from the West Ash Pond System. Detailed discussions of the manganese geochemistry in wells at the West Ash Pond System are provided in the EPRI manganese research report submitted to the Illinois EPA on November 6, 2002 (EPRI, 2002).

4.2.5 pH

Median pH values at all 12 monitoring wells range from 6.88 to 7.71. There have been no exceedances of Class 1 Groundwater upper (pH 9.0) or lower (pH 6.5) standards at any monitoring wells since 2010 (Table 5).

4.2.6 TDS

Total Dissolved Solids (TDS) concentration trends generally mirror those of sulfate, which is a major anion that affects TDS concentrations. None of the wells monitored have exhibited a TDS exceedance of Class I standard (1,200 mg/L) since 1993, prior to closure of the West Ash Pond System in 1996 (Table 3).

4.2.7 Chloride

Chloride has not exceeded the 200 mg/L Class I standard in 19 years of monitoring except in one well in one sampling event. This exceedance occurred in 2013 (Table 3) and is an anomaly unrelated to any groundwater quality impacts attributable to the West Ash Pond System.

4.3 GROUNDWATER MONITORING RESULTS AND ANALYSIS – IAC 35 PART 620.410 PARAMETERS

Of the additional inorganic parameters monitored in 2013 and 2014, arsenic and selenium were detected above Class I groundwater quality standard in downgradient wells and may be related to CCRs. Arsenic also occurs in a background well and selenium was observed only one time at one well. Nitrate and lead exceedances occurred in background and/or south monitoring wells and are not related to CCR leachate. These parameters are discussed in greater detail below

4.3.1 Arsenic

Arsenic concentrations exceeded the Class I standard of 0.01 mg/L at three wells: downgradient wells 21 and 24, with maximum concentrations of 0.0104 and 0.030 mg/L, respectively, and background well 33 had one exceedance with a concentration of 0.017 mg/L (Appendix G2). These three wells also had relatively high iron concentrations. High iron concentrations are indicative of reduced redox conditions in groundwater, and arsenic concentrations in groundwater can be naturally-occurring under these conditions. The arsenic concentration in background well 33 represents a naturally occurring condition. The two other downgradient monitoring wells (22 and 23), where iron concentrations are relatively low, suggesting less-reducing or perhaps oxic conditions, had arsenic concentrations below the method detection limit (MDL) during all four quarters. These observations suggest that the arsenic observed in wells 21 and 24 are naturally occurring rather than due to arsenic release from the West Ash Pond System.

4.3.2 Selenium

All samples analyzed from 12 monitoring wells during the four sampling events were below the MDL of 0.04 mg/L except in the December 2014 groundwater sample from well 24, located adjacent to the impoundments (Appendix G2). The observed concentration of 0.073 mg/L exceeded the Class I standard of 0.05 mg/L. This isolated detection near the detection limit indicates selenium is not a constituent of concern.

4.3.3 Lead

Out of 47 groundwater samples collected from 12 monitoring wells during the four sampling events, lead was detected once above the MDL (0.0075 to 0.008 mg/L) in the June 2013 groundwater sample from south monitoring well 25 at a concentration of 0.009 mg/L (Appendix G2). The Class I standard for lead is 0.0075 mg/L. Groundwater sampled during the June 2013 event at this well also had unusually high concentrations of

iron and manganese. The one-time lead exceedance at well 25 is related to geochemical changes in groundwater because of flooding along the Illinois River. The West Ash Pond System was not the source of lead observed in this sample.

4.3.4 Nitrate

Nitrate concentrations in groundwater exceeded the Class I standard of 10 mg/L at south monitoring wells 25 and 26 during at least one quarterly sampling event, with maximum concentrations of 12.2 and 15.1 mg/L (Appendix G2). Nitrate occurrence in groundwater at the West Ash Pond System is related to widespread use of nitrogen fertilizers upgradient of the site. Nitrate is a widespread and nonpoint source of contamination to shallow groundwater in the region and is not related to CCRs at the West Ash Pond System.

4.3.5 Other Inorganic Water Quality Parameters

None of the inorganic parameters listed in IAC 35 Part 620.410 monitored in 2013-2014 (Appendix G2) and not discussed above have exceedances of Class I groundwater standards that occur at downgradient monitoring wells at detectable or significant concentrations, or have concentrations in downgradient wells that can be attributed to CCR-impacts related to the West Ash Pond System. These parameters include the following:

4.3.5.1 Fluoride

No groundwater samples at any of the monitoring wells exceeded the Class I groundwater standard of 4 mg/L. Fluoride concentrations in the downgradient, south, and background monitoring well groups were within a similar range. Fluoride concentrations in groundwater in the vicinity of the West Ash Pond System are naturally occurring and not related to CCRs.

4.3.5.2 Cyanide (Total)

Cyanide was detected twice at the detection limit in the December 2013 and March 2014 groundwater sample from downgradient monitoring well 24 at a concentration of 0.008 and 0.007 mg/L, respectively. The Class I standard for cyanide is 0.2 mg/L. Cyanide is not a constituent of concern.

4.3.5.3 Perchlorate

Perchlorate was analyzed during the first quarterly sampling event, conducted in June 2013. Perchlorate was not detected at concentrations above the MDL of 0.004 mg/L. The Class I groundwater standard for perchlorate is 0.0049 mg/L. Perchlorate is not a constituent of concern.

4.3.6 Trace Elements

The following parameters were not detected above their MDL during the 2013 and 2014 sampling events:

Parameter	Method Detection Limit (MDL) (mg/L)	Class I Groundwater Standard (mg/L)
Antimony	0.005	0.006
Beryllium	0.001	0.004
Cadmium	0.002	0.005
Chromium	0.01	0.1
Cobalt	0.01	1.0
Copper	0.01	0.65
Mercury	0.0002	0.002
Silver	0.01	0.05
Thallium	0.002	0.002

Of the 47 samples collected, the following parameters were detected above their MDLs during the 2013 and 2014 sampling events. None of these parameters exceeded their Class I groundwater standards.

Parameter	Number of Detections	Maximum Concentration Detected (mg/L)	Class I Groundwater Standard (mg/L)
Barium	47	0.20	2.0
Nickel	1	0.0127	0.1
Vanadium	1	0.011	0.049
Zinc	9	0.048	5.0

4.3.7 Organic Water Quality Parameters

Organic water quality parameters listed in IAC Part 620, Section 410 were sampled and analyzed in all four quarters at the 12 monitoring wells. Laboratory analytical results for groundwater samples are summarized in Appendix G3. A summary of all detected organic parameters is listed by monitoring well and date in the table below. Although a few organic parameters were detected at eight of the twelve monitoring wells, there were no exceedances of the Class I groundwater standards and over 50 percent of the detected parameters were below quantitation limits (i.e. J-flag on the lab report). When detected, the parameters concentrations were well below Class I groundwater standards.

Detected Organic Parameters (mg/L)

Well Number	Parameter	Class I Standard (mg/L)	Q1 (June 2013)	Q2 (Sept. 2013)	Q3 (Dec. 2013)	Q4 (March 2014)
Background Monitoring Wells						
32	Acetone	6.3	-	0.007 J	-	-
	Atrazine	0.003	0.0001 J	-	0.00006 J	-
	Naphthalene	0.14	-	-	0.00013	-
	1,4-Dioxane	0.0077	-	-	-	0.00068 J
33	Acetone	6.3	-	0.007 J	-	-
	Atrazine	0.003	-	0.0002	-	-
	Naphthalene	0.14	0.00011	-	-	-
34	Acetone	0.19	NS	0.007 J	-	-
	1,4-Dioxane	0.0077	NS	-	-	0.00076 J
Downgradient Monitoring Wells						
21	None	NA	-	-	-	-
22	Bis 2-ethylhexyl phthalate	0.006	-	-	-	0.005 J
23	None	NA	-	-	-	-
24	Acetone	6.3	-	0.006 J	-	-
	1,4-Dioxane	0.0077	-	-	-	0.00069 J
	Phenol	0.1	-	0.052	-	-
	1,1,1-Trichloroethane	0.2	-	0.001 J	-	0.0084
	Trichlorofluoromethane	2.1	-	-	-	0.0044 J

Well Number	Parameter	Class I Standard (mg/L)	Q1 (June 2013)	Q2 (Sept. 2013)	Q3 (Dec. 2013)	Q4 (March 2014)	Well Number
South Monitoring Wells							
25	None	NA	-	-	-	-	
26	Atrazine	0.003	0.0004	-	0.00008 J	-	
27	Atrazine	0.003	0.0005	0.0001	0.00011	0.00008 J	
30	None	NA	-	-	-	-	
31	Atrazine	0.003	0.0002	-	0.0001	-	
	Naphthalene	0.14	0.00011	-	-	-	--

Notes:

- - Not detected in sample.
- J Analyte detected below quantitation limits.
- NS No sample collected on the date indicated due to flooding along the Illinois River.
- NA Not applicable. No organic parameters tested had a detected concentration in groundwater at this monitoring well during the four quarters of sampling from June 2013 through March 2014.

No detected organic parameters listed in the above table exceed their respective Class I groundwater standards as listed in IAC Part 620 Section 410.

The most frequently detected compounds were acetone, atrazine, 1,4-Dioxane, and naphthalene. Acetone was detected below quantitation limits in four samples, all collected on the same date during the 2nd quarter of monitoring in September 2013. The acetone is most likely a laboratory contaminant as it was only detected during one sampling event at concentrations below quantitation limits, and with no re-occurrence.

Atrazine is a common herbicide and was detected in two background monitoring wells (32 and 33) and three south monitoring wells (26, 27, and 31). Atrazine was detected in samples from two or more quarterly events at four of the five wells where it was reported. No downgradient wells had a detected concentration of Atrazine.

The compound 1,4-Dioxane was detected during one or more quarters in samples from three monitoring wells – background wells 32 and 34 and downgradient well 24.

Naphthalene was detected near the MDL of 0.0001 mg/L in samples from three monitoring wells – background wells 32 and 33 and south monitoring well 31. There were no detected concentrations of naphthalene in downgradient wells.

Four other organic compounds were detected at a lower frequency and at concentrations below their respective Class I groundwater standards: Bis 2-ethylhexyl phthalate, 1,1,1-trichloroethane, trichlorofluoromethane and phenol.

5 POTENTIAL IMPACTS TO THE ILLINOIS RIVER

As discussed previously in this report, groundwater flows north/northeast during baseflow conditions and groundwater from below the Hennepin West Ash Pond System discharges to the Illinois River. During baseflow conditions the groundwater discharging to the Illinois River has the potential to impact the river, increasing concentrations of the two primary CCR indicators for this site, boron and sulfate. Calculations for the potential impact from groundwater discharge to the Illinois River are provided in the tables below for boron and sulfate, respectively. The 7-day, 10-year low flow event (i.e. 7Q10) was used to estimate flow volume in the river and a mixing zone of 50 feet was used to determine dilution of the groundwater concentrations.

Conservative assumptions were used to calculate the resulting change in concentration to the Illinois River. Based on the calculations, groundwater discharge to the Illinois River could potentially increase concentrations of boron by 0.0034 mg/L and sulfate by 0.19 mg/L. Both concentrations are below their respective detection limits reported by the laboratory, indicating that changes in concentration would likely not be detected and impacts would be negligible.

Mixing Calculation Showing Effect of Boron Loading on Illinois River Quality at Low Flow

Baseflow		3515	cfs	Source: NPDES Permit IL0001554
	=	8.6E+09	L/day	
Boron loading rate				
Maximum Boron Concentration in Groundwater (CAvg)		8.5	mg/L	Maximum Concentration Well 23 - 6/2016
Hydraulic Conductivity (between Ash Complex and River)		0.0060	cm/s	Geometric mean of sand and gravel (Table 3)
Hydraulic Gradient		0.0050		Maximum included in report (Subsection 3.3.3.3)
Aquifer Thickness		50	ft	Estimated maximum depth of impacts in sand and gravel
Length of Ponds (max length, west to east)		2,500	ft	
Q = KIA				
K = Max Hydraulic Conductivity		2.0E-04	ft/s	
I = Hydraulic Gradient		0.00500		
A = Cross-Sectional Area		125,000	ft^2	
Q (per second)		0.12303	cfs	
Q (per day)		301,007.48	L/day	
Loading Rate (L)		2.6E+06	mg/day	= Cmax * Q
	L =	5.63	lb/day	
Boron concentration increase in Illinois River at low flow due to loading from West Ash Pond System				
	d_B =	3.0E-04	mg/L	= $L/Q_{7,10}$
Boron concentration increase near-shore in Illinois River at low flow due to loading from the West Ash Pond System				
Assumes loading distributed within 75 feet of shoreline		0.0034	mg/L	River is approximately 850 ft wide
Typical boron laboratory detection limit		0.01	mg/L	Source: Teklab Report 3/2016

Conclusion:

The calculated boron concentration increase in the Illinois River at ***low flow*** due to groundwater loading from the West Ash Pond System is less than half the typical boron detection limit, indicating that increases due to impacted discharge would not be detectable. These calculations indicate that the effects of boron loading in groundwater discharge to the Illinois River are negligible.

Mixing Calculation Showing Effect of Sulfate Loading on Illinois River Quality at Low Flow

Baseflow		3515	cfs	Source: NPDES Permit IL0001554
	=	8.6E+09	L/day	
Sulfate loading rate				
Maximum Sulfate Concentration in Groundwater (CAvg)		483	mg/L	Maximum Concentration Well 23 - 6/2016
Hydraulic Conductivity (between Ash Complex and River)		0.0060	cm/s	Geometric mean of sand and gravel (Table 3)
Hydraulic Gradient		0.0050		Maximum included in report (Subsection 3.3.3.3)
Aquifer Thickness		50	ft	Estimated maximum depth of impacts in sand and gravel
Length of Ponds (max length, west to east)		2,500	ft	
Q = KIA				
K = Max Hydraulic Conductivity		2.0E-04	ft/s	
I = Hydraulic Gradient		0.00500		
A = Cross-Sectional Area		125,000	ft^2	
Q (per second)		0.12303	cfs	
Q (per day)		301,007.48	L/day	
Loading Rate (L)		1.5E+08	mg/day	= Cmax * Q
	L =	319.85	lb/day	
Sulfate concentration increase in Illinois River at low flow due to loading from West Ash Pond System				
	d_B =	1.7E-02	mg/L	= $L/Q_{7,10}$
Sulfate concentration increase near-shore in Illinois River at low flow due to loading from the West Ash Pond System				
Assumes loading distributed within 75 feet of shoreline		0.1916	mg/L	River is approximately 850 ft wide
Typical sulfate laboratory detection limit		5	mg/L	Source: Teklab Report 3/2016

Conclusion:

The calculated sulfate concentration increase in the Illinois River at ***low flow*** due to groundwater loading from the West Ash Pond System is an order of magnitude less than the typical sulfate detection limit, indicating that increases due to impacted discharge would not be detectable. These calculations indicate that the effects of sulfate loading in groundwater discharge to the Illinois River are negligible.

6 CONCLUSIONS

Data acquired from prior investigations and activities at the West Ash Pond System were incorporated into this Hydrogeologic Site Characterization Report to provide a complete physical and chemical evaluation of the impoundments and vicinity. The site characterization findings are summarized below:

- The West Ash Pond System encompasses two ash ponds of approximately 30.4 acres total and were operational from 1952 through 1996.
- Three hydrogeologic units are present at the site:
  - Fill Unit, the uppermost unit, is comprised of CCRs – fly ash, bottom ash, and minor slag. In some areas, such as constructed berms, the Fill Unit has CCRs mixed with sand, silt, and clay. CCRs of the Fill Unit are found in all ponds – Old West Ash Pond (including Pond No. 1, Pond No. 3) and Old West Polishing Pond.
  - Uppermost Aquifer Unit is comprised of mixed alluvial deposits (clay, silt, and sand) which overlie coarser grained outwash sand and gravel deposits. This unit is the uppermost aquifer and primary groundwater transport pathway in the vicinity of the West Ash Pond System.
  - Bedrock Confining Unit is defined by Pennsylvanian age shale with minor layers of limestone, sandstone, and coal. This low permeability unit defines the lower boundary of the Uppermost Aquifer Unit.
- Median saturated ash thickness for the period of 2003 through 2013 ranged from no saturated ash at the northwest corner of Pond No. 1 (eastern portion of the Old West Ash Pond) to 6.6 feet of saturated ash at the western edge of Pond No. 3 (western portion of the Old West Ash Pond). Based on a representative median groundwater elevation of 447 feet and average base of ash elevation of 444 feet within Pond No. 3, the median saturated ash thickness is three feet. Conversely, since maximum groundwater elevations measured near Pond No. 1 are below the base of ash, it can be concluded that there is typically no saturated ash within Pond No. 1.
- The Illinois River is located directly adjacent to and downgradient from the West Ash Pond System. Flood events typically occur in March, April, May, and sometimes June, while lesser flooding occasionally occurs during autumn. Only the Old West Polishing Pond is subject to 100-year flooding at the base flood elevation value of 462 feet.
- The Illinois River is the regional groundwater discharge area, but localized groundwater flow directions that are westward and southward from the West Ash Pond System are present due to localized groundwater mounding under the impoundments. River stage during high precipitation and/or flood events seasonally rises above adjacent groundwater elevations and in low lying areas of the floodplain. During these events the river temporarily recharges the aquifer and groundwater flow direction close to the river reverses.
- Within the Uppermost Aquifer, the geometric mean hydraulic conductivity of wells finished in sand and gravel is 6×10^{-3} cm/s versus 2×10^{-3} cm/s for wells finished predominantly in gravel. The lowest measured hydraulic conductivity occurred in silt deposits with a value of 1×10^{-4} cm/s. Hydraulic conductivity was not measured in the Bedrock Confining Unit.
- Groundwater within the Uppermost Aquifer at the West Ash Pond System meets the definition of a Class I, Potable Resource Groundwater.
- The current Illinois EPA-approved groundwater monitoring program consists of collecting samples from 3 background wells (32, 33, 34) and 9 downgradient wells (21 through 27, 30, 31). Additional groundwater monitoring was initiated at these locations for an expanded list of parameters for four quarters (June 2013 through March 2014) to assess compliance with the IAC 35 Part 620 Section 410 Groundwater Quality Standards for Class I: Potable Resource Groundwater. The results of the groundwater monitoring program to-date indicate the following:
  - Parameters observed in groundwater that are derived from CCRs and exceeded Class I standards were boron and sulfate. Exceedances of Class I standards for boron and sulfate occur in monitoring wells

located immediately adjacent to the ash ponds and one downgradient well (27); these wells also exhibit decreasing boron and sulfate concentrations with time. Monitoring wells located further from the ash ponds, specifically wells 25, 26, 30, and 31 to the south, no longer exceed the Class I standard for boron and have not exceeded a standard since 1996. Based on these observations, the total mass-loading of coal-ash leachate constituents on the groundwater system continues to decline.

  - Arsenic and selenium detected in downgradient wells may be related to CCRs, but selenium was only detected on one occasion at one well located adjacent to the impoundments. Observed geochemical indicators and an arsenic exceedance in a background monitoring well suggest that arsenic may be naturally-occurring.
  - Parameters observed in groundwater that exceeded Class I standards but are not related to CCRs at the West Ash Pond System were iron, lead, manganese, and nitrate.
  - Other inorganic parameters detected occur at concentrations below their respective Class I groundwater standards: TDS, chloride, fluoride, cyanide, barium, nickel, vanadium, and zinc.
  - Antimony, beryllium, cadmium, chromium, cobalt, copper, mercury, silver, and thallium were not detected above their MDLs in any groundwater samples.
  - Organic constituents tested included volatile organic compounds, polychlorinated biphenyls, semi-volatile organic compounds, chlorinated pesticides, chlorinated herbicides and specialized organic parameters endothall, ethylene dibromide and 1,2-dibromo-3-chloropropane. None of organic constituents were detected at concentrations higher than their respective Class I standard.

- An assessment of potable and non-potable water wells for a 2,500-foot radius around the entire Hennepin Power Station property boundary demonstrated that there is no potential for groundwater impact to existing off-site wells from the West Ash Pond System or Hennepin Power Station.
- An evaluation was completed to determine potential CCR groundwater impacts on the Illinois River. The evaluation determined that the primary CCR indicator parameters for the West Ash Pond System, boron and sulfate, would have negligible impacts to the Illinois River.

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Tables

Table 1. Monitoring Well Construction Summary
Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Current Well and/or Boring Designation[1]	Year Constructed	Driller	Well Top Elevation [2]	Ground Elevation	Screen Top Depth (BGS)	Screen Bottom Depth (BGS)	Screen Top Elevation	Screen Bottom Elevation	Bottom of Well Elevation	Slotted Screen Length	Screen Diameter (Inches)	Formation Screened
21 (W-1)	Dec-1982	Mathes	459.34	459.8	49.0	59.0	410.8	400.8	400.2	10	2	sand
22 (W-2)	Dec-1982	Mathes	464.45	461.5	24.4	34.4	437.1	427.1	426.9	10	2	gravel
23 (W-3)	Dec-1982	Mathes	463.39	460.9	34.0	44.0	426.9	416.9	415.7	10	2	gravel
24 (W-4)	Dec-1982	Mathes	462.14	461.1	56.4	66.4	404.7	394.7	396.6	10	2	gravel
25 (W-5)	Dec-1982	Mathes	462.61	460.2	24.4	34.4	435.8	425.8	424.7	10	2	gravel
26	Aug-1995	STMI	462.70	459.4	11.0	21.0	448.4	438.4	433.7	10	2	gravel
27	Sep-1995	STMI	450.58	448.2	30.0	35.0	418.2	413.2	411.9	5	2	sand/gravel
30	Aug-1995	STMI	453.16	450.9	30.0	35.0	420.9	415.9	418.2	5	2	gravel
31	Aug-1995	STMI	453.13	450.9	5.0	15.0	445.9	435.9	435.2	10	2	sand
32	Aug-1996	STMI	451.38	448.7	7.0	17.0	441.7	431.7	431.4	10	2	sand/gravel
33	Aug-1996	STMI	449.71	447.8	37.5	42.5	410.3	405.3	406.2	5	2	sand
34	Aug-1996	STMI	449.56	448.2	30.0	35.0	418.2	413.2	413.2	5	2	sand
35	Sep-1999	NRT	454.83	451.5	8.0	18.0	443.5	433.5	433.9	10	2	sand
36	Sep-1999	NRT	462.02	459.7	18.0	28.0	441.7	431.7	431.8	10	2	sand/gravel
49	Jul-2015	NRT	468.17	465.8	35.0	45.0	430.8	420.8	420.8	10	2	sand/gravel
L1	Aug-1995	STMI	464.56	465.1	25.0	30.0	440.1	435.1	422.5	5	2	silt
L3	Sep-1995	STMI	462.18	459.3	7.5	12.5	451.8	446.8	433.3	5	2	ash
L4	Aug-1995	STMI	460.90	461.0	12.6	22.6	448.4	438.4	432.4	10	2	ash/silt
L5	Apr-2000	NRT	464.22	461.3	27.0	32.0	434.3	429.3	429.3	5	2	sand/gravel

Notes:

All depth and elevation measurements are in feet.

(1) Original well designations are in parentheses.

(2) Wells 25 through 33 were surveyed by Chastain (6/11/14); Other wells surveyed by IngenAE (11/21/16)

Mathes John Mathes and Associates, Inc.

NRT Natural Resource Technology, Inc.

STMI Science and Technology Management, Inc.

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Table 2. Field Hydraulic Conductivity
Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Well Identification	Analysis Method	Primary Lithology Within Screened Interval	Confidence Level [1]	Horizontal Hydraulic Conductivity (cm/sec)
22	Bouwer-Rice Confined	Gravel	1	1.20E-02
24	Bouwer-Rice Confined	Alluvial Sand	1	2.00E-02
26	Bouwer-Rice Unconfined	Gravel	2	1.20E-02
27	Bouwer-Rice Confined	Alluvial Sand	2	6.90E-03
30	Bouwer-Rice Unconfined	Gravel	1	3.32E-02
31	Bouwer-Rice Unconfined	Alluvial Sand	1	3.40E-03
L4	Bouwer-Rice Confined	Alluvial Silt	1	1.30E-04
Plant	Specific Capacity Analysis / ISWS [2]	Gravel	3	1.27E-01
Geometric Mean Hydraulic Conductivity		**Wells Finished in Sand & Gravel [3]**		**6.0E-03**
		Wells Finished in Gravel Only [3]		**1.7E-02**
		Wells Finished in Alluvial Sand Only [3]		**7.8E-03**
		Wells Finished in Alluvial Silt (i.e., L4)		**1.3E-04**

Notes:

See Appendix B for hydraulic conductivity test analyses. Tests and analyses are from STMI, 1997 (see references).

cm/sec centimeters per second

[1] Confidence in Hydraulic Conductivity Value: 1 = Good Recovery Curve and Analysis
2 = Recovery Curve Required Interpretation
3 = Estimated

[2] ISWS - Illinois State Water Survey Analysis based on pumping well data.

[3] Geometric mean hydraulic conductivity for confidence levels 1 and 2; mean values do not include Plant well.

Reference:

Bouwer-Rice Bouwer and Rice Analytical Method for Unconfined Aquifers, 1976. (note: also used for Confined Aquifers).

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Table 3. Summary of Exceedances of Class 1 Groundwater Standards
Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameters Submitted to the IEPA for Routine Groundwater Monitoring	Class 1 Standard	unit	Number of exceedances of Class 1 Groundwater Standards between December 1994 and September 2016 (and year of last exceedance)											
			Downgradient Wells				South Wells					Background Wells		
			21	22	23	24	25	26	27	30	31	32	33	34
Boron (d)	2	mg/L	**70 (2016)**	**71(2016)**	**69(2016)**	**70(2016)**	4(1996)	0	**63(2016)**	9(1996)	0	0	0	0
Chloride (t)	200	mg/L	0	0	0	0	0	0	0	0	1(2013)	0	0	0
Iron (d)	5	mg/L	0	0	0	25(2000)	0	1(2005)	0	0	0	0	9(2013)	**19(2016)**
Manganese (d)	0.15	mg/L	7(1997)	0	**50(2016)**	1(1994)	0	1(2005)	**63(2016)**	0	**16(2016)**	34(2014)	12(2013)	**26(2016)**
Sulfate (t)	400	mg/L	0	25(2010)	**52(2016)**	22(2012)	0	0	1(1996)	0	0	0	0	0
Total Dissolved Solids	1,200	mg/L	0	0	1(1996)	0	0	0	0	0	0	0	0	0
pH	6.50 / 9.00	Std. Units	1(2003)	9(2002)	0	3(2010)	0	0	0	0	0	1(2003)	1(2000)	2(2007)

Notes:
Bold notation for number of exceedances indicates the latest exceedance occurred during current monitoring period.
Current monitoring wells monitored semi-annually for reporting to the IEPA unless otherwise indicated.
(t) = total; (d) = dissolved

Table 4. Median Boron and Sulfate Concentrations - 1997 through 2016
Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Median Boron Concentration (mg/L)[1]																						% Change Since	
Well	Position	In Service[2]	1997	1998	1999	2000	2001	2002	2003	2004	2005*	05-06	06-07	07-08	08-09	09-10**	2011	2012	2013	2014	2015	2016	In Service[3]	Peak[4]
21	Downgradient	4.85	5.75	6.70	6.70	6.20	6.40	6.70	7.35	7.65	7.40	7.35	7.10	6.90	6.30	6.10	5.25	4.80	5.09	6.77	5.00	4.70	-3%	-39%
22	Downgradient	8.00	9.00	10.00	11.00	9.75	9.65	9.20	8.80	8.25	8.00	7.70	7.70	8.00	8.40	7.20	7.35	7.40	7.39	6.77	7.20	7.10	-11%	-35%
23	Downgradient	7.00	5.95	5.70	5.80	6.50	6.85	7.65	8.05	7.15	5.40	6.60	5.90	5.20	6.50	6.80	5.05	7.55	5.79	4.03	7.00	6.90	-1%	-14%
24	Downgradient	7.80	7.55	8.30	9.05	9.60	10.00	9.75	9.85	9.10	9.10	8.55	8.30	8.10	3.90	2.30	3.90	4.90	3.66	3.71	3.80	3.80	-51%	-62%
25	South	2.00	1.80	1.15	0.99	0.82	0.54	0.57	0.53	0.49	0.37	0.44	0.36	0.42	0.22	0.24	0.27	0.28	0.25	0.21	0.25	0.25	-88%	-88%
26	South	1.10	1.01	0.54	0.56	0.52	0.37	0.35	0.33	0.31	0.18	0.24	0.22	0.23	0.24	0.25	0.20	0.19	0.18	0.18	0.23	0.24	-78%	-78%
27	South	6.00	7.90	7.80	7.20	6.25	5.65	5.80	5.15	4.35	3.90	4.70	4.65	4.40	5.20	5.00	4.70	4.80	4.32	4.09	4.70	4.70	-22%	-41%
30	South	2.40	1.50	1.10	0.89	0.70	0.59	0.55	0.40	0.40	0.43	0.29	0.29	0.16	0.16	0.16	0.19	0.19	0.21	0.22	0.19	0.19	-92%	-92%
31	South	0.17	0.07	0.09	0.10	0.10	0.07	0.09	0.07	0.07	0.05	0.08	0.08	0.17	0.10	0.09	0.08	0.07	0.07	0.07	0.08	0.08	-53%	-53%
32	Background	0.12	0.05	0.07	0.11	0.10	0.09	0.11	0.10	0.13	0.11	0.13	0.14	0.12	0.09	0.08	0.07	0.07	0.08	0.09	0.09	0.08	-33%	-41%
33	Background	0.10	0.05	- -	0.05	0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.09	<0.05	<0.05	0.04	0.06	<0.05	<0.04	-60%	-60%
34	Background	0.10	0.05	0.07	0.06	0.07	0.06	0.06	0.06	0.06	0.07	0.09	0.09	0.09	0.09	0.13	0.09	0.11	0.10	0.11	0.10	0.11	10%	-15%

1. Shading indicates concentrations that are greater than Class I boron standard of 2.0 mg/L. Blank indicates no samples taken during that year.
2. Impoundment removed from service in December 1996.
3. In Service difference based on change in median concentration from In Service to 2016.
4. Peak difference based on change in median concentration from highest median observed during any period prior to 2016.
*March 2005 data through 2009, medians are calculated from July to June of the next year.

Median Sulfate Concentration (mg/L)1																						% Change Since	
Well	Position	In Service[2]	1997	1998	1999	2000	2001	2002	2003	2004	2005*	05-06	06-07	07-08	08-09	09-10**	2011	2012	2013	2014	2015	2016	In Service[3]	Peak[4]
21	Downgradient	225	260	285	305	305	300	310	280	245	200	210	200	200	145	140	130	110	149	112	140	142	-37%	-54%
22	Downgradient	370	660	585	525	415	435	335	300	315	310	275	340	370	410	370	280	210	341	256	340	310	-16%	-53%
23	Downgradient	480	510	445	510	570	565	525	515	445	280	420	340	210	520	540	385	300	456	240	445	445	-7%	-22%
24	Downgradient	390	430	450	445	415	335	275	300	255	220	220	220	230	127	35	123	325	108	123	147	141	-64%	-69%
25	South	97	100	66	59	52	54	47	47	47	40	47	50	55	56	51	46	39	38	38	46	46	-53%	-54%
26	South	57	65	54	37	45	41	38	39	40	36	43	41	42	46	36	34	33	29	47	41	41	-28%	-37%
27	South	315	340	345	325	285	245	230	250	270	230	235	205	155	165	170	190	190	192	188	190	190	-40%	-45%
30	South	140	120	100	95	100	91	81	86	86	75	86	73	81	70	68	77	86	72	81	75	75	-46%	-46%
31	South	43	49	44	46	38	35	31	35	37	29	36	39	35	47	45	43	57	54	89	53	55	28%	-38%
32	Background	91	96	83	83	105	83	68	88	81	77	79	81	61	65	61	65	77	102	83	73	72	-21%	-31%
33	Background	8	10	- -	<5	6	<5	5	<5	<5	<5	<5	8	11	<5	13	16	12	10	36	12	12	59%	-67%
34	Background	190	160	150	130	130	110	98	110	110	85	82	120	90	100	96	100	98	95.5	78	93	96	-49%	-49%

1. Shading indicates concentrations that are greater than Class I sulfate standard of 400 mg/L. Blank indicates no samples taken during that year.
2. Impoundment removed from service in December 1996.
3. In Service difference based on change in median concentration from In Service to 2016.
4. Peak difference based on change in median concentration from highest median observed during any period prior to 2016.
*March 2005 data through 2009, medians are calculated from July to June of the next year.
** 2009-2010 median based on samples collected in September 2009, June 2010, and August 2010.

Natural Resource Technology
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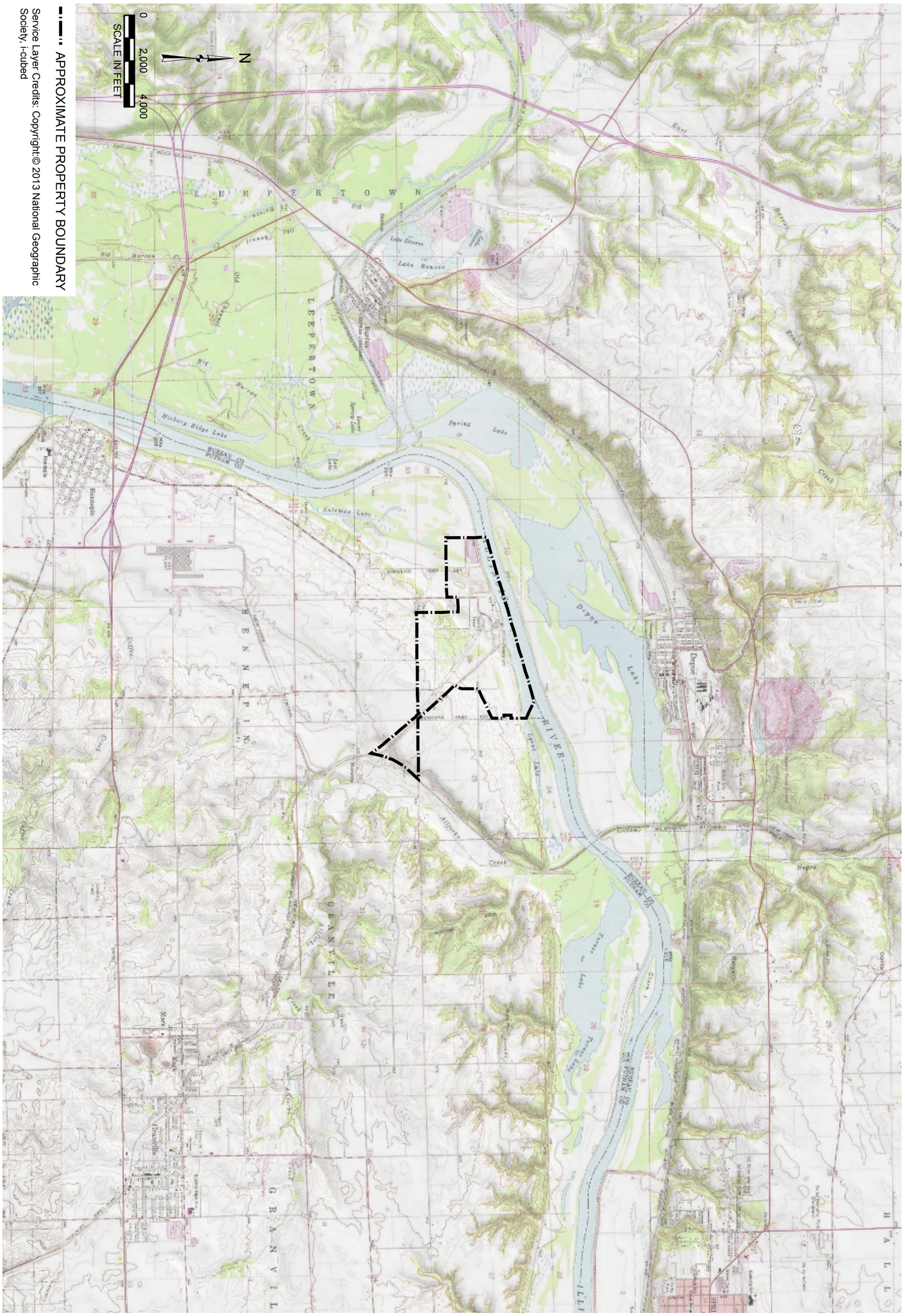
Figures



Natural Resource Technology
AN ODEG COMPANY

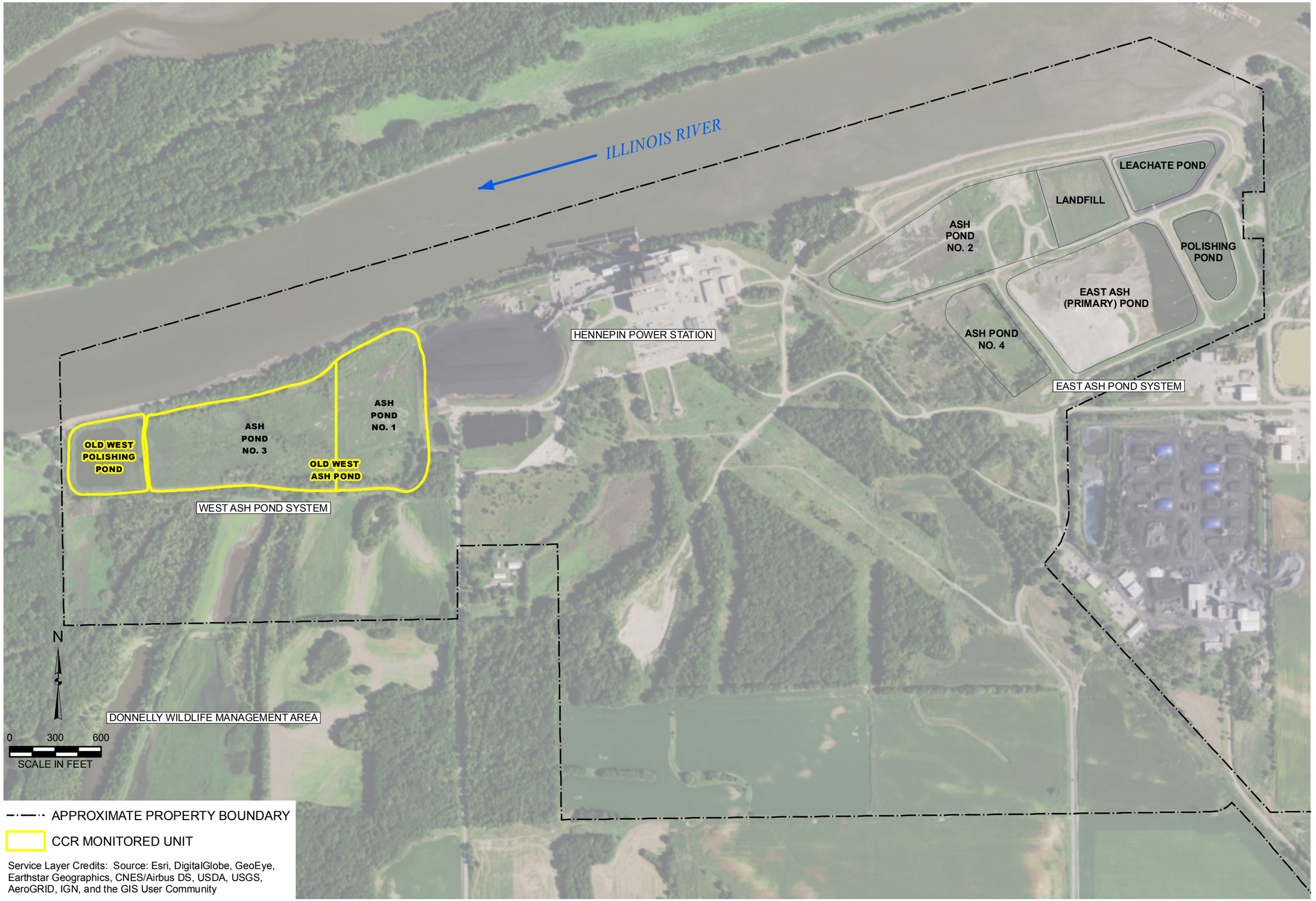
PROJECT NO: 2413

FIGURE NO: 1

SITE LOCATION MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

DRAWN BY/DATE:
SDS 8/29/17
REVIEWED BY/DATE:
RJK 8/30/17
APPROVED BY/DATE:
SJC 8/17/17



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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ASH IMPOUNDMENT LOCATION MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 2

Natural Resource Technology
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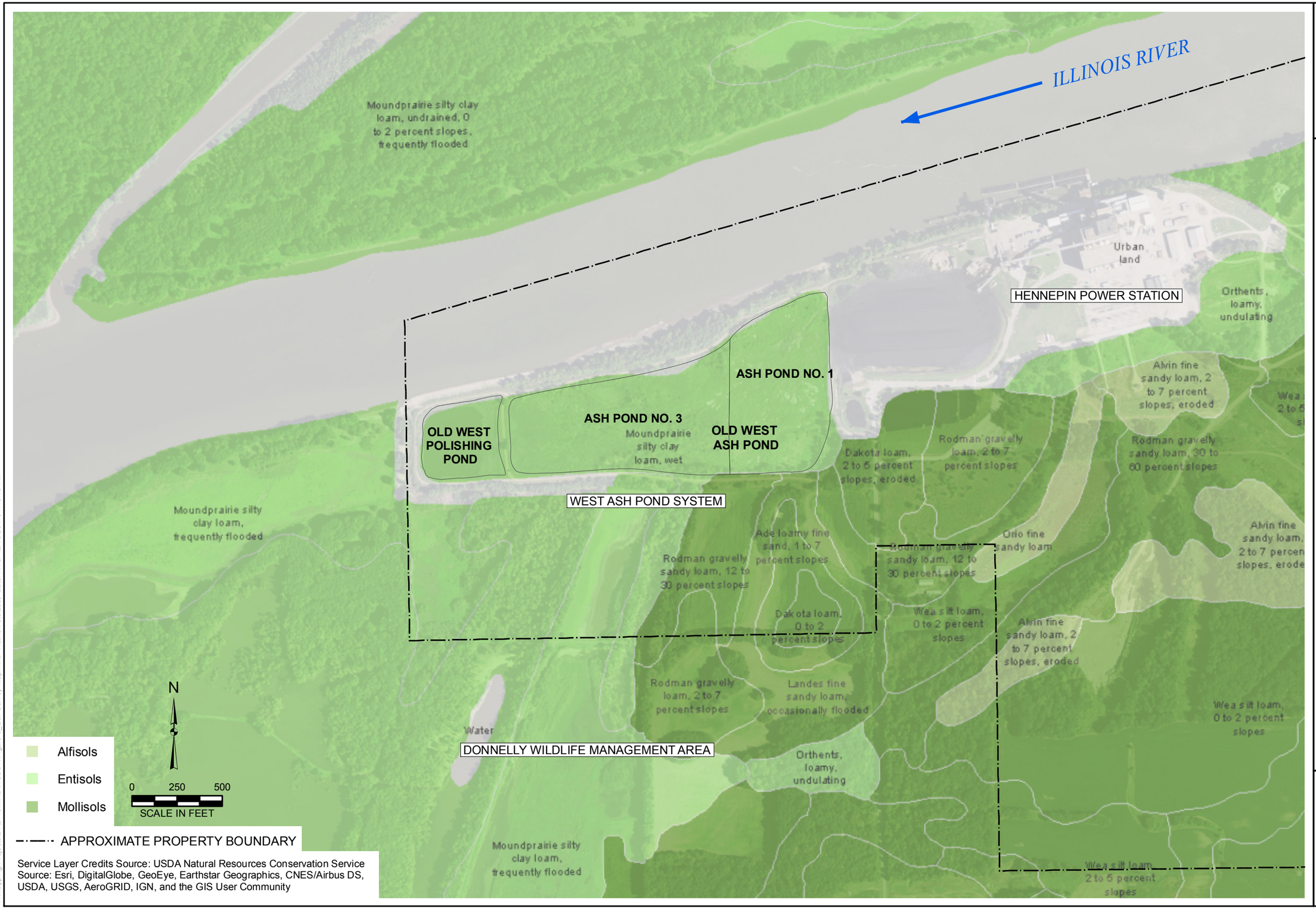
Y:\Mapping\Projects\2412413\MXD\HGSCR\Figure 2_Ash Impound Loc.mxd Author: stolzsd: Date/Time: 12/18/2017, 5:00:13 PM



Service Layer Credits Source: USDA Natural Resources Conservation Service
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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APPROVED BY/DATE: SJC 8/31/17

SOIL SURVEY MAP

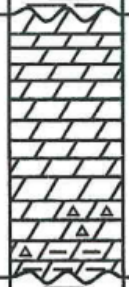
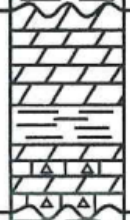
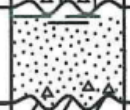
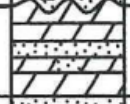
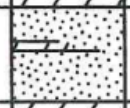
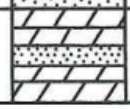
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 3

Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\2412413\MXD\HGSCR\Figure 3_Soil Survey Map.mxd Author: stolzsd Date/Time: 12/15/2017, 4:45:49 PM

SYSTEM or SERIES	HYDROGEOLOGIC UNITS	GRAPHIC LOG	ROCK TYPE	WATER-YIELDING CHARACTERISTICS
PLEISTOCENE	Drift (0–300 feet)		Unconsolidated glacial deposits, loess and alluvium (drift).	Water yields variable, largest from thick basal sand and gravel deposits (Sankoty Sand) in bedrock valleys.
PENNSYLVANIAN	(280–475 feet)		Mainly shale with thin sandstone, limestone, and coal beds.	Generally unfavorable as an aquifer. Locally, domestic and farm supplies obtained from thin limestone and sandstone beds. Casing usually required.
SILURIAN	Niagaran-Alexandrian (410–505 feet)		Dolomite; argillaceous near base, lower part cherty.	Generally yields poor quality water.
ORDOVICIAN	Maquoketa (155–240 feet)		Green to blue shale with limestone and dolomite beds.	Not water yielding at most places. Casing required.
	Galena-Platteville (320–380 feet)		Dolomite, with shaly zone near the middle; some limestone in the lower part.	Not important as an aquifer, Creviced dolomite probably yields some water. Water quality good.
	Glenwood-St. Peter (115–135 feet)		Sandstone, white, clean.	Dependable source of groundwater. Water quality good.
	Shakopee (130–150 feet)		Dolomite, with some shale and sandstone.	Not important as aquifer.
	New Richmond (165 feet ±)		Sandstone, with some dolomite.	May yield some water.
	Oneota (215 feet ±)		Dolomite, with some sandstone beds.	Not important as aquifer.

SOURCE NOTE: MODIFIED FROM "MCCOMAS, M.R. (1968), GEOLOGY RELATED TO LAND USE IN THE HENNEPIN REGION FIGURE 2, ILLINOIS STATE GEOLOGICAL SURVEY, CIRCULAR 422, CHAMPAIGN, ILLINOIS.

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APPROVED BY/DATE:
SJC 8/30/17

GENERALIZED STRATIGRAPHIC COLUMN FOR THE HENNEPIN AREA

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 4

Natural Resource Technology
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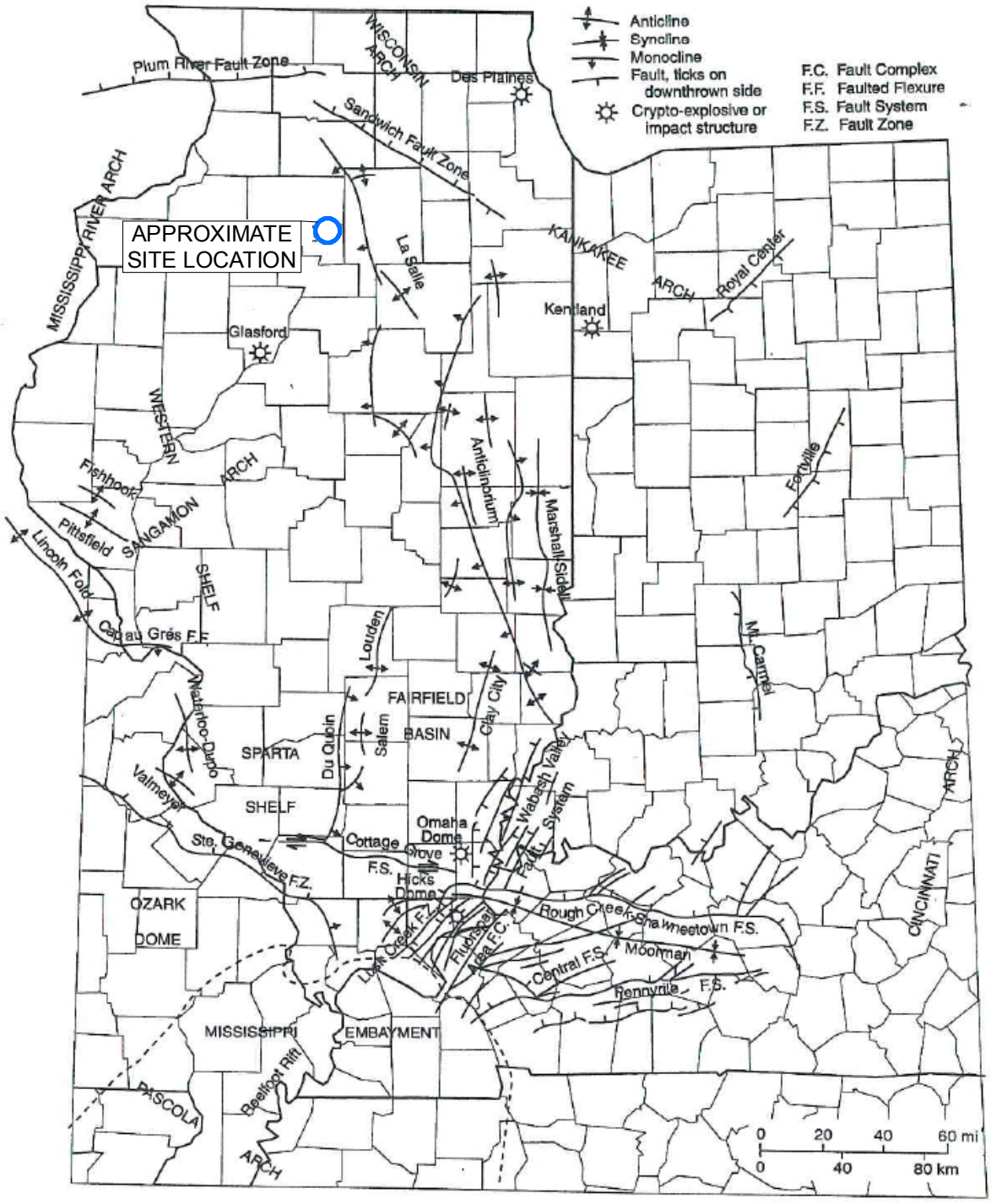
Y:\Mapping\Projects\2412413\MXD\HGSCR\Figure 4_Generalized Stratigraphic Column.mxd Author: stolzsd; Date/Time: 8/29/2017, 10:50:14 PM



SOURCE NOTE: MODIFIED FROM "NELSON, W.J. 1995, STRUCTURAL FEATURES IN ILLINOIS, ILLINOIS STATE GEOLOGICAL SURVEY, BULLETIN 100, CHAMPAIGN, ILLINOIS.

DRAWN BY/DATE:
SDS 8/29/17
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RJK 8/30/17
APPROVED BY/DATE:
SJC 8/30/17

MAJOR STRUCTURAL FEATURES OF ILLINOIS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 5

Natural Resource Technology
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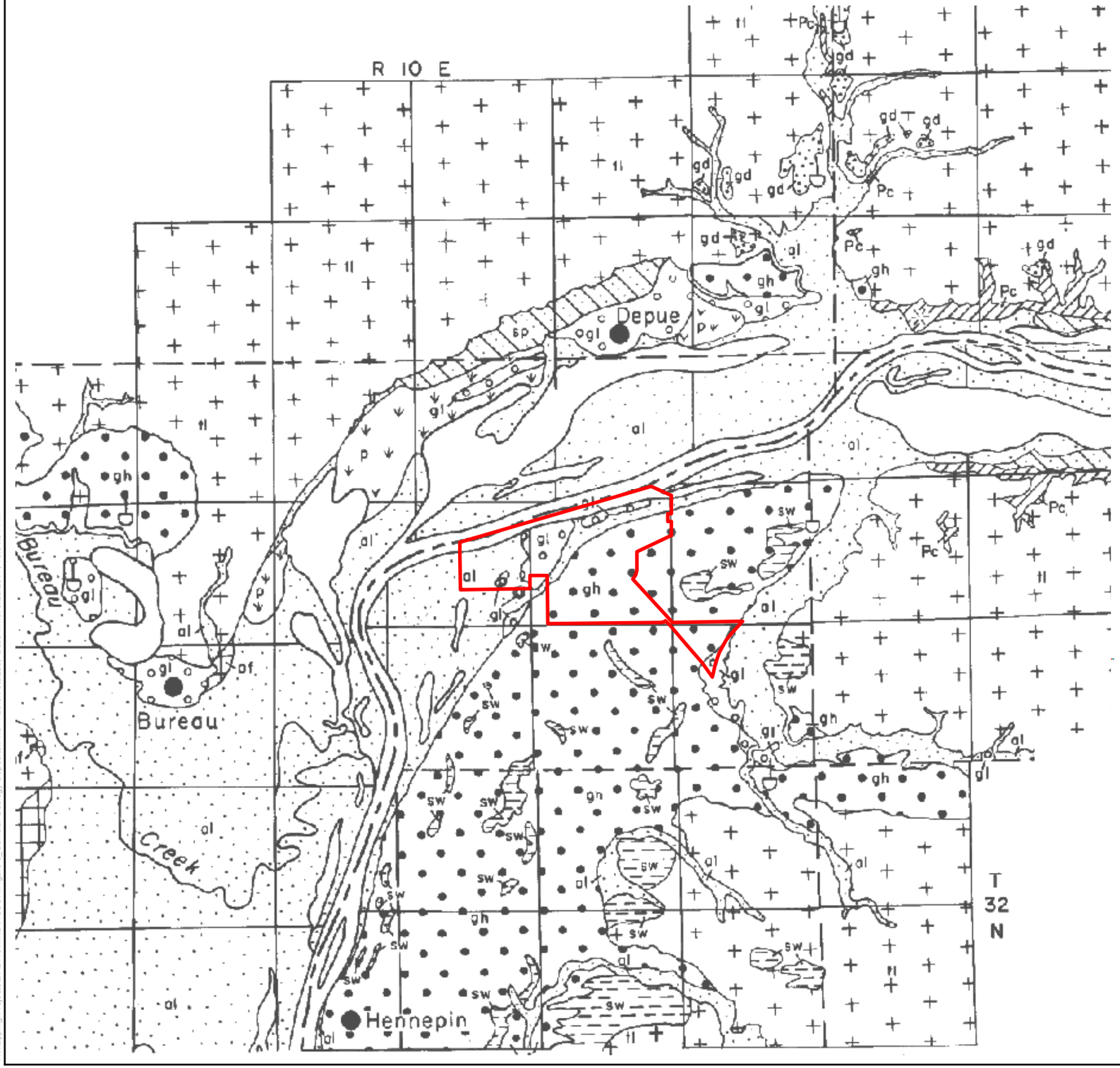
Y:\Mapping\Projects\2412413\MXD\HGSCR\Figure 5_Major Structural Features of Illinois.mxd Author: stolzed; Date/Time: 8/29/2017, 10:52:40 PM



ALLUVIUM. DEPOSITS OF MODERN RIVERS AND STREAMS IN FLOODPLAINS. LARGELY CLAYEY SILT AND SANDY SILT WITH LENSES OF SAND AND GRAVEL. GENERALLY LESS THAN 20 FEET THICK. IN THE ILLINOIS VALLEY WEST OF STARVED ROCK, IT IS AS MUCH AS 40 FEET THICK AND IT OVERLIES THICK DEPOSITS OF SAND AND GRAVEL OF THE HENRY FORMATION. IN THE ILLINOIS VALLEY EAST OF STARVED ROCK, IT IS LARGELY SAND AND GRAVEL 15–30 FEET THICK UNDER THIN SILT AND IT OVERLIES BEDROCK FORMATIONS. (CAHOKIA ALLUVIUM)

TILL. MOSTLY UNSORTED CALCAREOUS PEBBLY SILTY CLAY DEPOSITED BY GLACIERS. CONTAINS SCATTERED COBBLES AND BOULDERS AND, IN PLACES, LENSES OF SAND AND GRAVEL. GENERALLY 25–50 FEET THICK BUT AS MUCH AS 300 FEET THICK IN DEEP VALLEYS IN THE BEDROCK SURFACE, WHERE IT INCLUDES THE GLASFORD AND BANNER FORMATIONS. THE TILL HAS A THIN COVER OF CLAYEY SILT (RICHLAND LOESS), THE THICKNESS OF WHICH IS SHOWN ON THE SMALL INSET MAP. (WEDRON FORMATION)

HIGH–LEVEL TERRACES UNDERLAIN BY GLACIAL OUTWASH. SURFACES ARE 75–100 FEET ABOVE THE ILLINOIS RIVER. MOSTLY FINE GRAVEL AND PEBBLY SAND, BUT THE UPPER PART IS LOCALLY COARSER AND BOULDERY, AS ALONG ALLFORKS CREEK, NORTHEAST OF HENNEPIN. GENERALLY 10–30 FEET THICK IN THE TRIBUTARY VALLEYS, BUT AS MUCH AS 150–200 FEET THICK IN THE LARGE TERRACE ON WHICH HENNEPIN IS LOCATED. (HENRY FORMATION)

LOW–LEVEL TERRACES UNDERLAIN BY DEPOSITS OF THE CHICAGO OUTLET RIVER. SURFACES ARE COMMONLY 20–40 FEET ABOVE THE ILLINOIS RIVER. MOSTLY FINE TO COARSE GRAVEL, COARSER AND MORE UNIFORMLY SORTED THAN THE HIGH–TERRACE DEPOSITS. LARGELY 20–50 FEET THICK ALONG THE ILLINOIS VALLEY AND 10–20 FEET ALONG TRIBUTARIES. (HENRY FORMATION)

APPROXIMATE PROPERTY BOUNDARY

DRAWN BY/DATE: SDS 8/29/17
REVIEWED BY/DATE: RJK 8/30/17
APPROVED BY/DATE: SJC 8/30/17

SURFICIAL GEOLOGIC DEPOSITS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 6

Natural Resource Technology
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Y:\Mapping\Projects\2412413\MXD\HGSCR\Figure 6_Surficial Geology Deposits.mxd Author: stolzsd: Date/Time: 8/29/2017, 10:54:54 PM

MONITORING WELL AND BORING LOCATIONS

HYDROGEOLOGIC CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

DRAWN BY:	AGC	DATE: 02/15/2017
CHECKED BY:	NRK	DATE: 02/21/2017
APPROVED BY:	SJC	DATE: 08/25/2017

DRAWING NO: OBG MOD - 16448 CROSS SECTIONS

REFERENCE: .

Natural Resource Technology
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REFERENCES

1. SOURCE DRAWING DERIVED FROM CEC, INC.; PROJECT NUMBER 164-478, DRAWING NUMBER C200, DATED 3/27/17.
2. TOPOGRAPHIC INFORMATION BASED ON AERIAL SURVEY COMPLETED BY SURDEX ON AUGUST 17, 2015 AND TOPOGRAPHIC/BATHYMETRIC SURVEY COMPLETED BY WEAVER CONSULTANTS GROUP ON SEPTEMBER 22, 2015.
3. IMAGE PROVIDED BY GOOGLE EARTH, DATE OF IMAGE: SEPTEMBER 20,2015.

LEGEND

- WEST ASH POND SYSTEM LIMITS
- 450 EXISTING 10 FT CONTOUR
- 452 EXISTING 2 FT CONTOUR
- B13 CEC BORING LOCATION
- P-1 SOIL BORING BY OTHERS
- A A CROSS SECTION LOCATION

PROJECT NO.
2421

FIGURE NO.
7

Aug 31, 2017 - 1:53pm PLOTTED BY: OneUPn SAVED BY: OneUPn
K:\Projects\164-478 - Dynegy - Hennepin\Hydrogeologic Characterization\Figures\Figure 7 - Monitoring Well and Boring Locations.mxd
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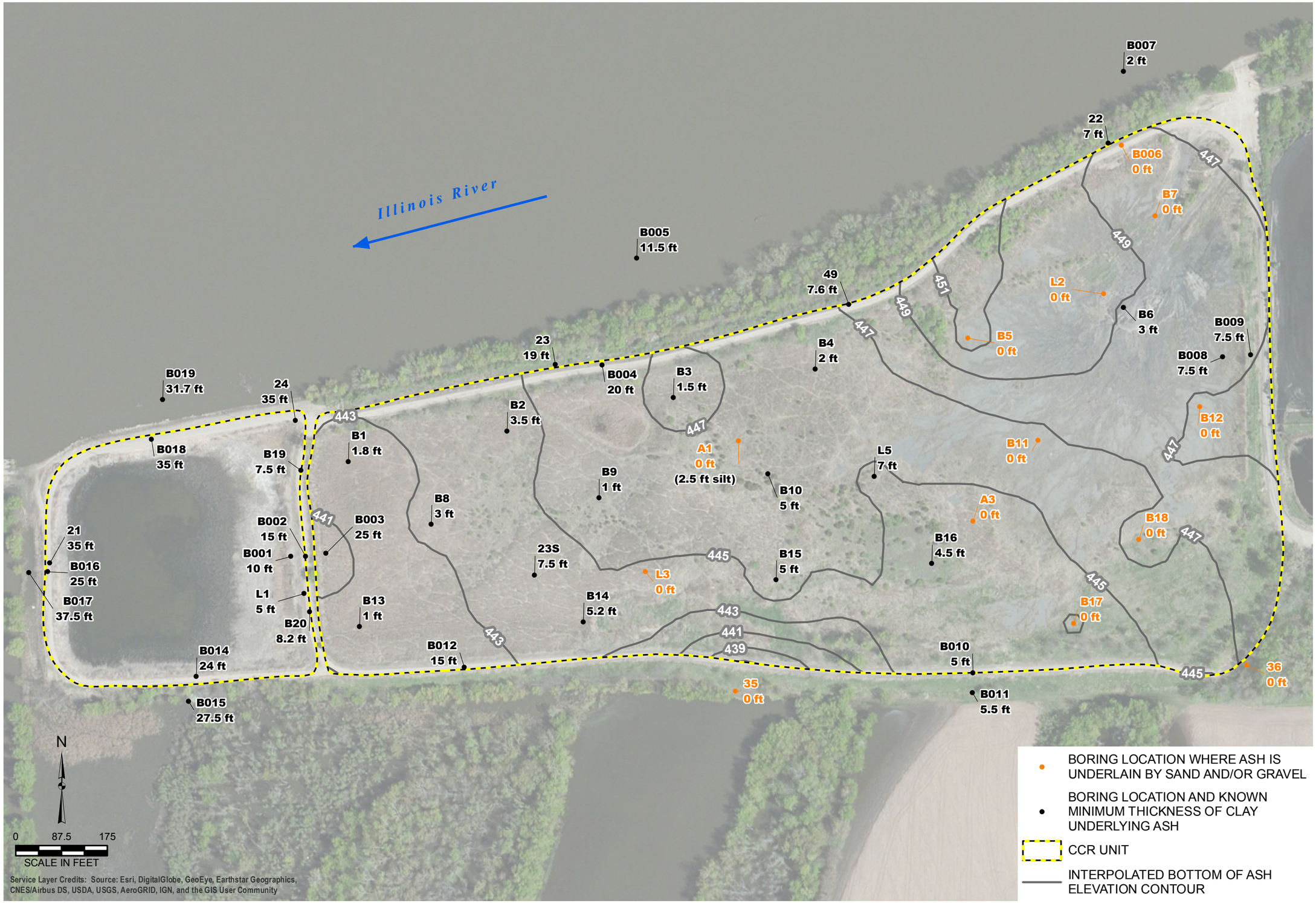


Y:\Mapping\Projects\242413\MXD\HGSCR\Figure 8_Known Min Thickness of Clay.mxd Author: stolzsd Date/Time: 12/18/2017 5:01:35 PM

DRAWN BY/DATE: SDS 8/29/17
REVIEWED BY/DATE: RJK 8/30/17
APPROVED BY/DATE: SJC 8/31/17

BOTTOM OF ASH ELEVATION CONTOUR MAP AND MINIMUM THICKNESS OF CLAY

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 8

Natural Resource Technology
AN OBG COMPANY

Aug 29, 2017 1:07pm PLOTTED BY: Oneill jm SAVED BY: Oneill jm
I:\Abbott-Nut.15090\STDS\GIS_NRT\Hennepin\OBG MOD - 164478-CV01-C100-Cross Sections.dwg A-A' & B-B'
IMAGES: .\Images\GoogleEarth Site.jpg;
XREFS:

REFERENCES

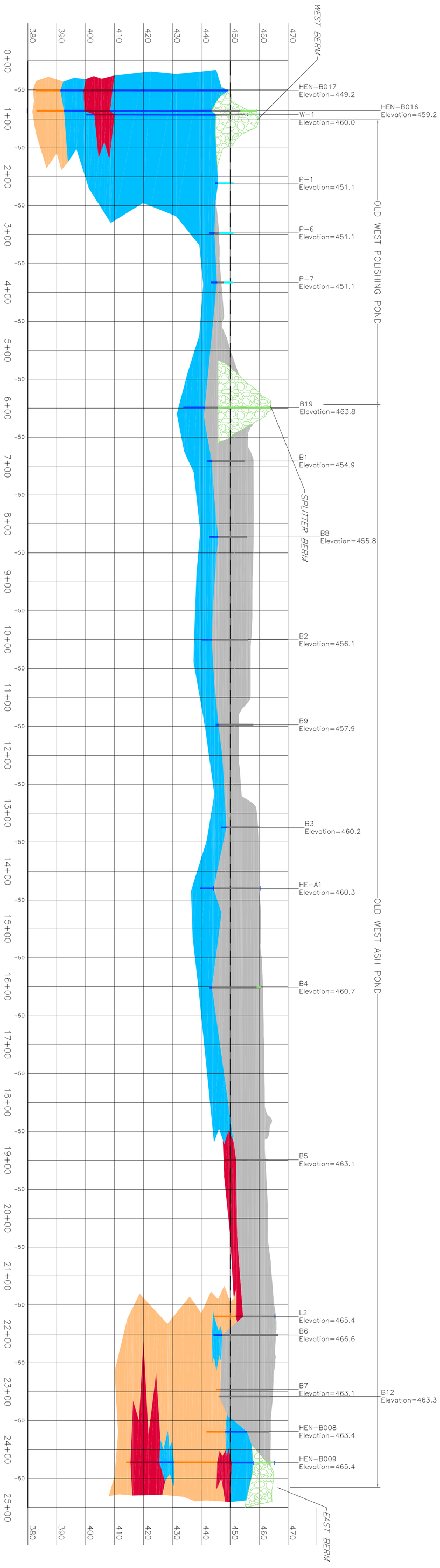
1. SOURCE DRAWING DERIVED FROM CEC, INC.; PROJECT NUMBER 164-478, DRAWING NUMBER C200, DATED 3/27/17.
2. TOP OF EXISTING GRADE BASED ON DATA PROVIDED BY WEAVER CONSULTING GROUP SURVEY (2015) AS PRESENTED BY CEC INC.
3. GEOLOGIC INTERPRETATIONS ARE BASED ON BORING LOGS PERFORMED BY CEC INC., AECOM, SCIENCE AND TECHNOLOGY MANAGEMENT INC., JOHN MATHES & ASSOCIATES INC., AND NATURAL RESOURCE TECHNOLOGY INC.

LEGEND

- MISCELLANEOUS BERM SOIL FILL
- CCR/ASH
- SILTS AND CLAYS (ALLUVIAL)
- SANDS WITH FINES (ALLUVIAL)
- SAND AND GRAVEL (GLACIAL OUTWASH)

GEOLOGIC CONDITIONS

1. THE TEST BORING INFORMATION PRESENTED HEREIN DEPICTS SUBSURFACE CONDITIONS AT THE TEST BORING LOCATIONS AND AT THE TIME OF DRILLING. SOIL CONDITIONS AT OTHER LOCATIONS MAY DIFFER.
2. GEOLOGIC CORRELATIONS BETWEEN TEST BORINGS ARE GENERALLY BASED ON STRAIGHT-LINE INTERPOLATION. ACTUAL CONDITIONS BETWEEN TEST BORINGS MAY DIFFER.



B PROFILE
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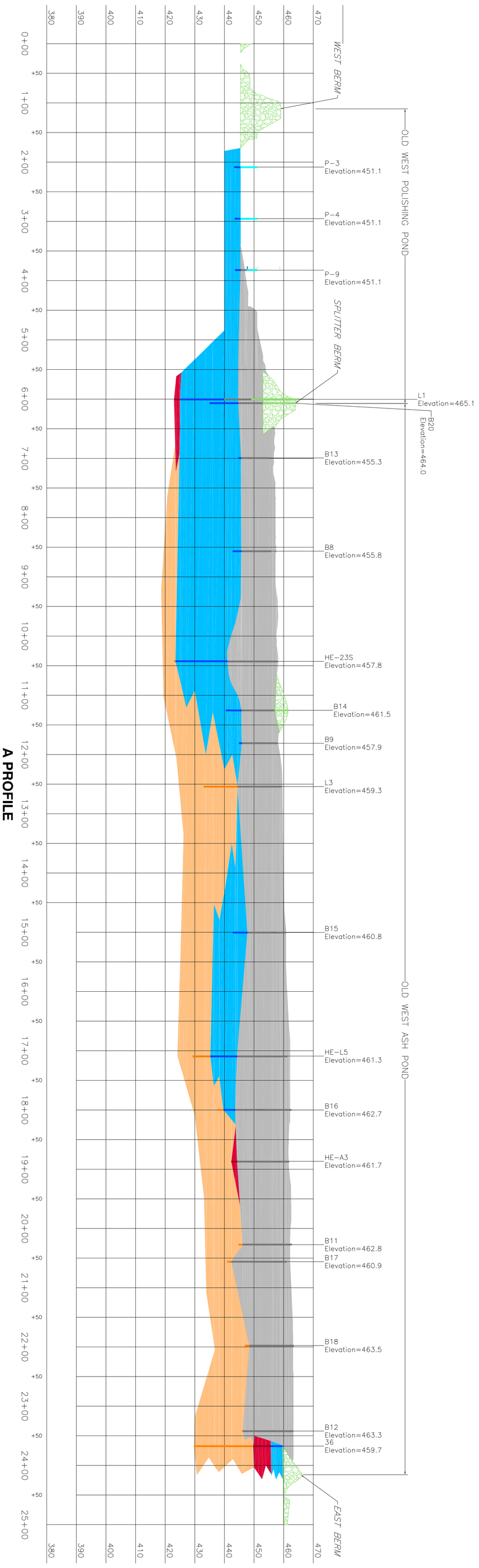

A PROFILE
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DRAWN BY:	AGC	DATE:	02/15/2017
CHECKED BY:	NRK	DATE:	02/21/2017
APPROVED BY:	SJC	DATE:	08/25/2017

DRAWING NO: OBG MOD - 16448 CROSS SECTIONS

REFERENCE: .

CROSS-SECTION A-A' AND B-B'

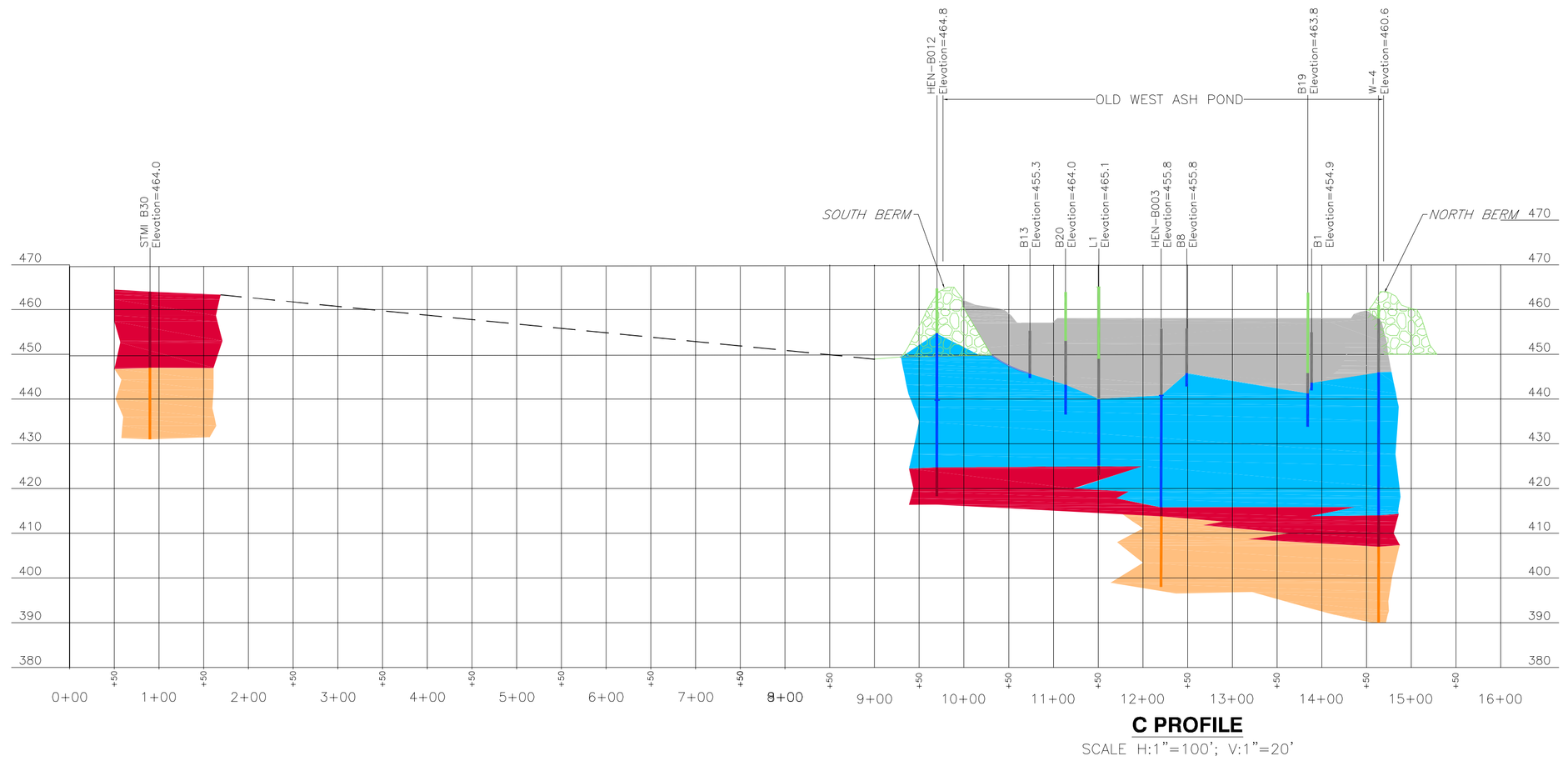
HYDROGEOLOGIC CHARACTERIZATION REPORT

WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

Natural Resource Technology
AN OBG COMPANY

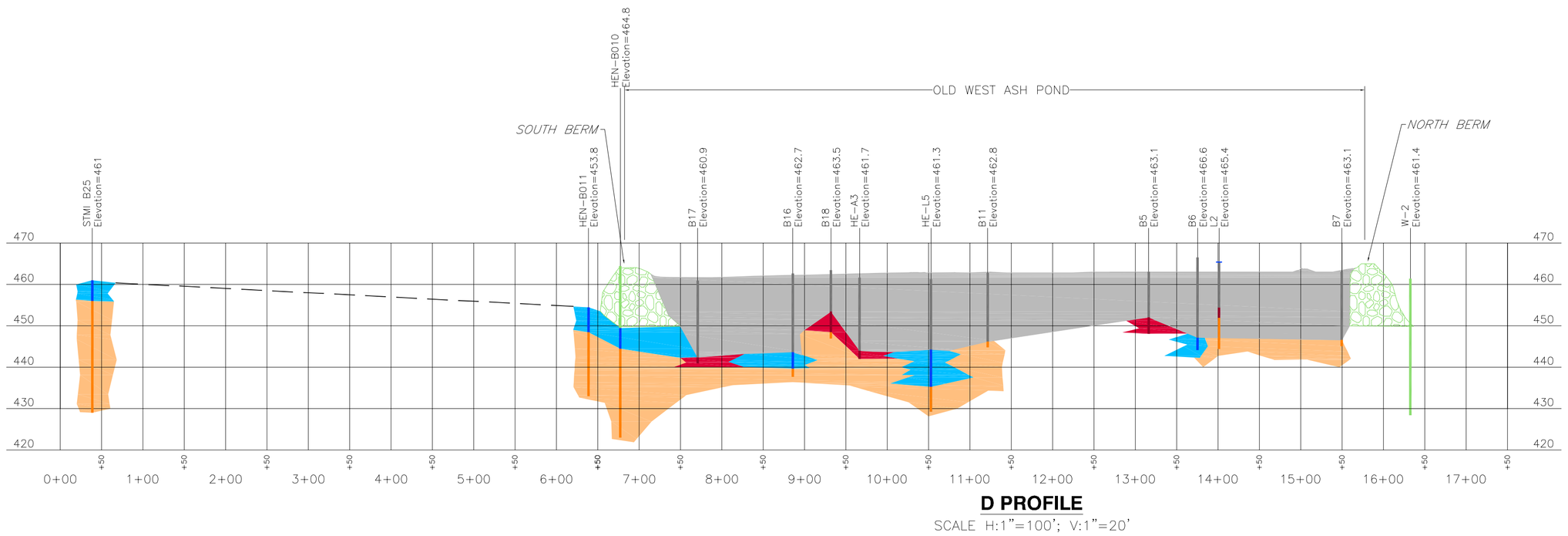
PROJECT NO. 2421

FIGURE NO. 9



C PROFILE

SCALE H:1"=100'; V:1"=20'



D PROFILE

SCALE H:1"=100'; V:1"=20'

REFERENCES

1. SOURCE DRAWING DERIVED FROM CEC, INC.; PROJECT NUMBER 164-478, DRAWING NUMBER C200, DATED 3/27/17.
2. TOP OF EXISTING GRADE BASED ON DATA PROVIDED BY WEAVER CONSULTING GROUP SURVEY (2015) AS PRESENTED BY CEC INC.
3. GEOLOGIC INTERPRETATIONS ARE BASED ON BORING LOGS PERFORMED BY CEC INC., AECOM, SCIENCE AND TECHNOLOGY MANAGEMENT INC., JOHN MATHES & ASSOCIATES INC., AND NATURAL RESOURCE TECHNOLOGY INC.

LEGEND

- MISCELLANEOUS BERM SOIL FILL
- CCR/ASH
- SILTS AND CLAYS (ALLUVIAL)
- SANDS WITH FINES (ALLUVIAL)
- SAND AND GRAVEL (GLACIAL OUTWASH)
- INTERPRETED NATURAL GROUND SURFACE OUTSIDE OF ASH POND

GEOLOGIC CONDITIONS

1. THE TEST BORING INFORMATION PRESENTED HEREIN DEPICTS SUBSURFACE CONDITIONS AT THE TEST BORING LOCATIONS AND AT THE TIME OF DRILLING. SOIL CONDITIONS AT OTHER LOCATIONS MAY DIFFER.
2. GEOLOGIC CORRELATIONS BETWEEN TEST BORINGS ARE GENERALLY BASED ON STRAIGHT-LINE INTERPOLATION. ACTUAL CONDITIONS BETWEEN TEST BORINGS MAY DIFFER.

DRAWN BY: AGC DATE: 02/15/2017
CHECKED BY: NRK DATE: 02/21/2017
APPROVED BY: SJC DATE: 08/25/2017
DRAWING NO: OBG MOD - 16448 CROSS SECTIONS
REFERENCE: .

CROSS-SECTION C-C' AND D-D'

HYDROGEOLOGIC CHARACTERIZATION REPORT

WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

Natural Resource Technology
AN OBG COMPANY

PROJECT NO.
2421

FIGURE NO.
10

Aug 29, 2017 - 1:06pm PLOTTED BY: OneillJm SAVED BY: OneillJm
File Name: I:\Projects\Dynegy\Hennepin\OBG MOD - 16447B-CIV01-C100-Cross Sections.dwg C-C' & D-D'
IMAGES: \\nrpjax1\Acad\Projects\Dynegy\Hennepin\OBG MOD - 16447B-CIV01-C100-Cross Sections.dwg C-C' & D-D'
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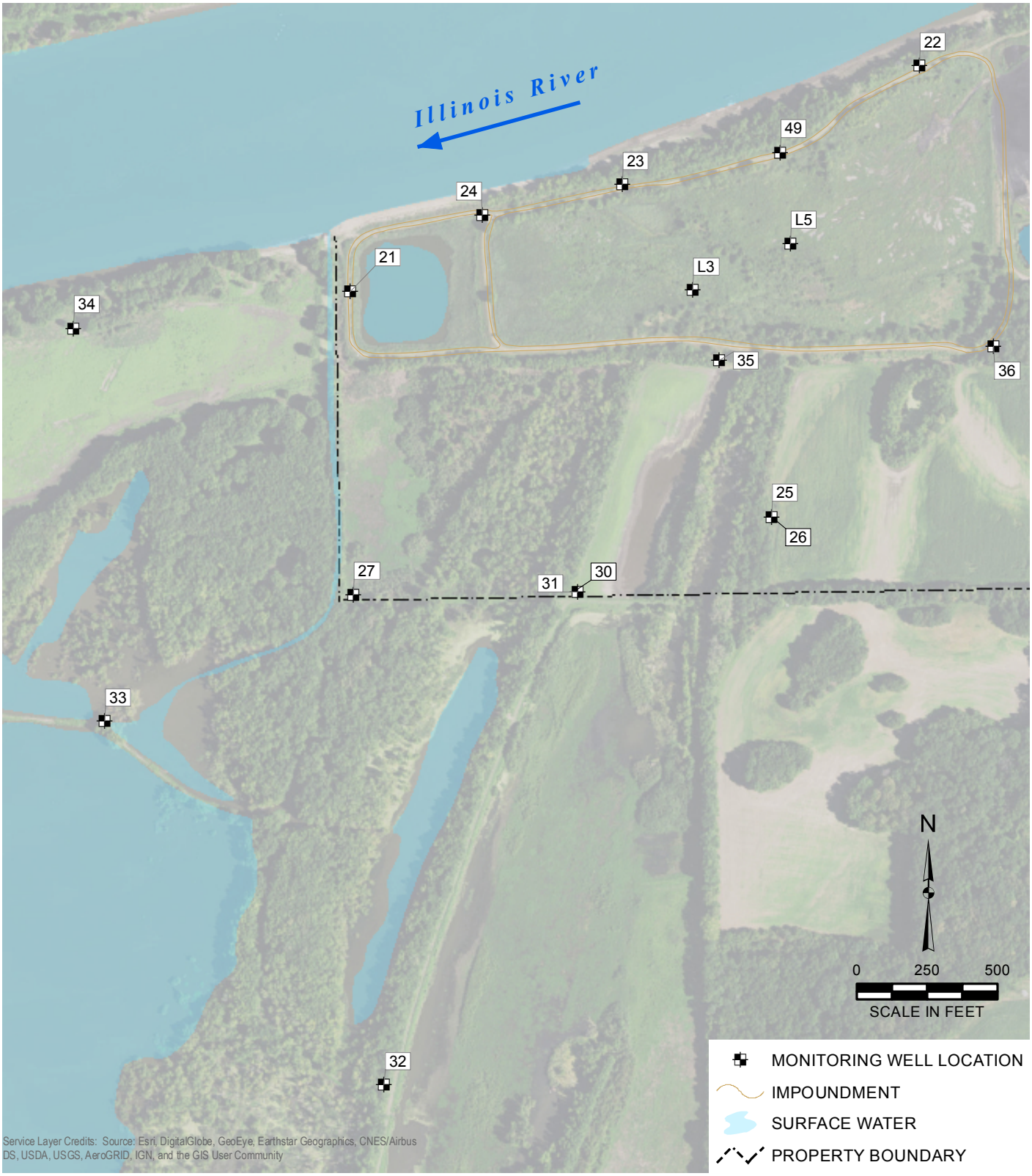


DRAWN BY/DATE:
SDS 8/29/17
REVIEWED BY/DATE:
RJK 8/30/17
APPROVED BY/DATE:
SJC 8/31/17

EXISTING MONITORING WELL LOCATIONS

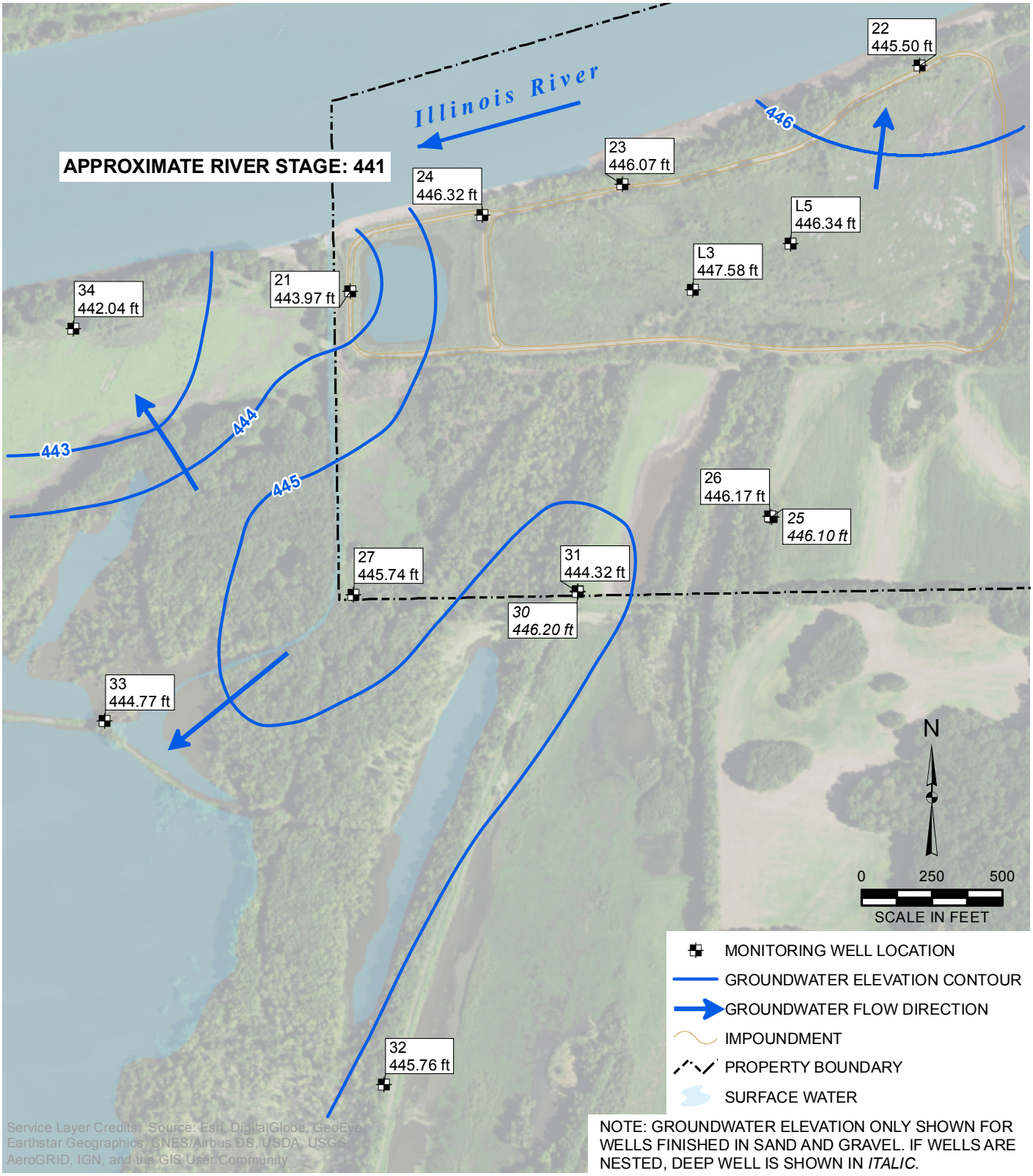
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 11

Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\2412413\MXD\HGSCR\Figure 11_Existing MW Locs.mxd Author: stolzsd; Date/Time: 8/31/2017, 1:06:46 PM



NOTE: GROUNDWATER ELEVATION ONLY SHOWN FOR WELLS FINISHED IN SAND AND GRAVEL. IF WELLS ARE NESTED, DEEP WELL IS SHOWN IN *ITALIC*.

Y:\Mapping\Projects\2412413\MXD\HGSCR\Figure 12_GWE Contour Map_Dec 2013.mxd Author: stolzsd; Date/Time: 8/31/2017, 1:08:25 PM

DRAWN BY/DATE:
SDS 8/29/17
REVIEWED BY/DATE:
RJK 8/30/17
APPROVED BY/DATE:
SJC 8/31/17

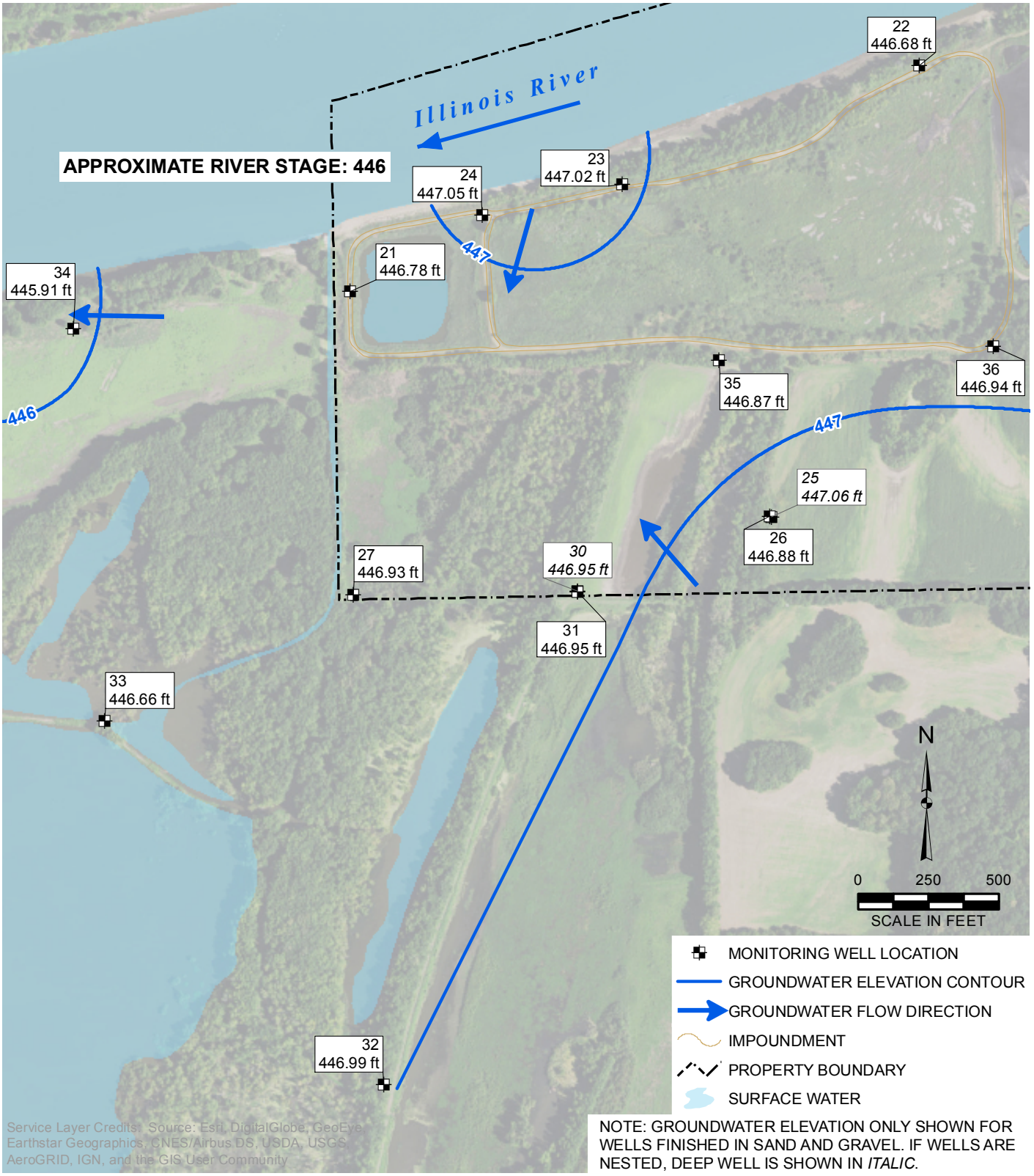
WATER TABLE CONTOUR MAP
DECEMBER 10, 2013

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 12

Natural Resource Technology
AN OBG COMPANY



NOTE: GROUNDWATER ELEVATION ONLY SHOWN FOR WELLS FINISHED IN SAND AND GRAVEL. IF WELLS ARE NESTED, DEEP WELL IS SHOWN IN *ITALIC*.

DRAWN BY/DATE:
SDS 8/29/17
REVIEWED BY/DATE:
RJK 8/30/17
APPROVED BY/DATE:
SJC 8/31/17

WATER TABLE CONTOUR MAP
MARCH 18, 2015

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 13

Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\2412413\MXD\HGSCR\Figure 13_GWE Contour Map_March 2015.mxd Author: stolzsd; Date/Time: 8/31/2017, 1:08:58 PM

Illinois River

22
5.7 mg/L

23
6.7 mg/L

24
2.7 mg/L

34
0.12 mg/L

21
4.1 mg/L

OLD WEST POLISHING POND

OLD WEST ASH POND

27
4.7 mg/L

31
0.06 mg/L

30
0.20 mg/L

26
0.33 mg/L

25
0.24 mg/L

33
0.04 mg/L

32
0.06 mg/L

N

0 225 450

SCALE IN FEET

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

NOTE:
THE CLASS I GROUNDWATER STANDARD FOR BORON IS 2 MG/L

MONITORING WELL LOCATIONS
IMPOUNDMENT
PROPERTY BOUNDARY
SURFACE WATER

DRAWN BY/DATE:
SDS 8/29/17
REVIEWED BY/DATE:
RJK 8/30/17
APPROVED BY/DATE:
SJC 8/31/17

BORON CONCENTRATIONS IN GROUNDWATER
MARCH 9, 2016

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO. 2413

FIGURE NO. 14

Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\24\2413\MXD\HGSCR\Figure 14_Boron Concentrations.mxd Author: stolzsd; Date/Time: 12/15/2017, 4:07:41 PM

Appendix A

Boring and Well Construction Logs

Appendix A1

MATHES Boring Logs and Well Details

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Hennepin Power Plant

JOB NO. 82-1293

BORING W-1

SHEET 1 OF 2

(21)

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Soil Classification System Unified Surface Elevation 460.0'		
	1A	AS			Brown Sandy CLAY w/Gravel, FILL, CL		
-5-	1	SS	18/16		Dark Gray FLYASH w/Bottom Ash, FILL, ML	10-7-9	
0-	2	SS	18/16			5-8-16	
-15-		SS	18/17	1		7-8-3	
0-	4	SS	18/14		Dark Gray-Brown Silty CLAY, CL	1-2-1	
25-	5	SS	18/16			WH/9-1-2	
	6	SS	18/17			WH-WH-2	
35-	7	SS	18/17			WH/12"-2	

Shear Strength, tsf
SV△ QP/₂□ QU/₂○
0 ½ 1 1½ 2 2½
PL NMC LL
0 50 100
Rock Quality Designation
0 50 100

DRILLING METHOD Hollow Auger
DATE DRILLED 12/8, 9/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at	–	Feet
0 Hours after completion	3.0	Feet
6 Days after completion	6.3	Feet
___ after completion	___	Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

RECORD OF SUBSURFACE EXPLORATION

(21)

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-1
SHEET 2 OF 2

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
	7	SS			Dark Gray-Brown Silty CLAY, CL		
40	8	SS	18/18		Dark Gray CLAY w/Silt, Sand, Shells, Organics, OH	WH-1-1	
45	9	SS	18/18			WH/12"-1	
50	10	SS	18/18	2	Gray Fine - Medium SAND W/Shells Trace Silt, SP-SM	WH-1-3	
55	11	SS	18/6			2-3-6	
60	12	SS	18/15		Dark Gray CLAY w/Silt Trace Sand, Shells, OH	WH-1-1	
					TOB		

Soil Classification System Unified

Surface Elevation 460.0'

Shear Strength, tsf
SV△ QP/2□ QU/2○
0 ½ 1 1½ 2 2½
PL NMC LL
0 50 100
Rock Quality Designation
0 50 100

Remarks:
1. Dry hole approximately 15.0 - 50.0'
2. Water level in Auger rose to river level immediately after retrieving sample 10

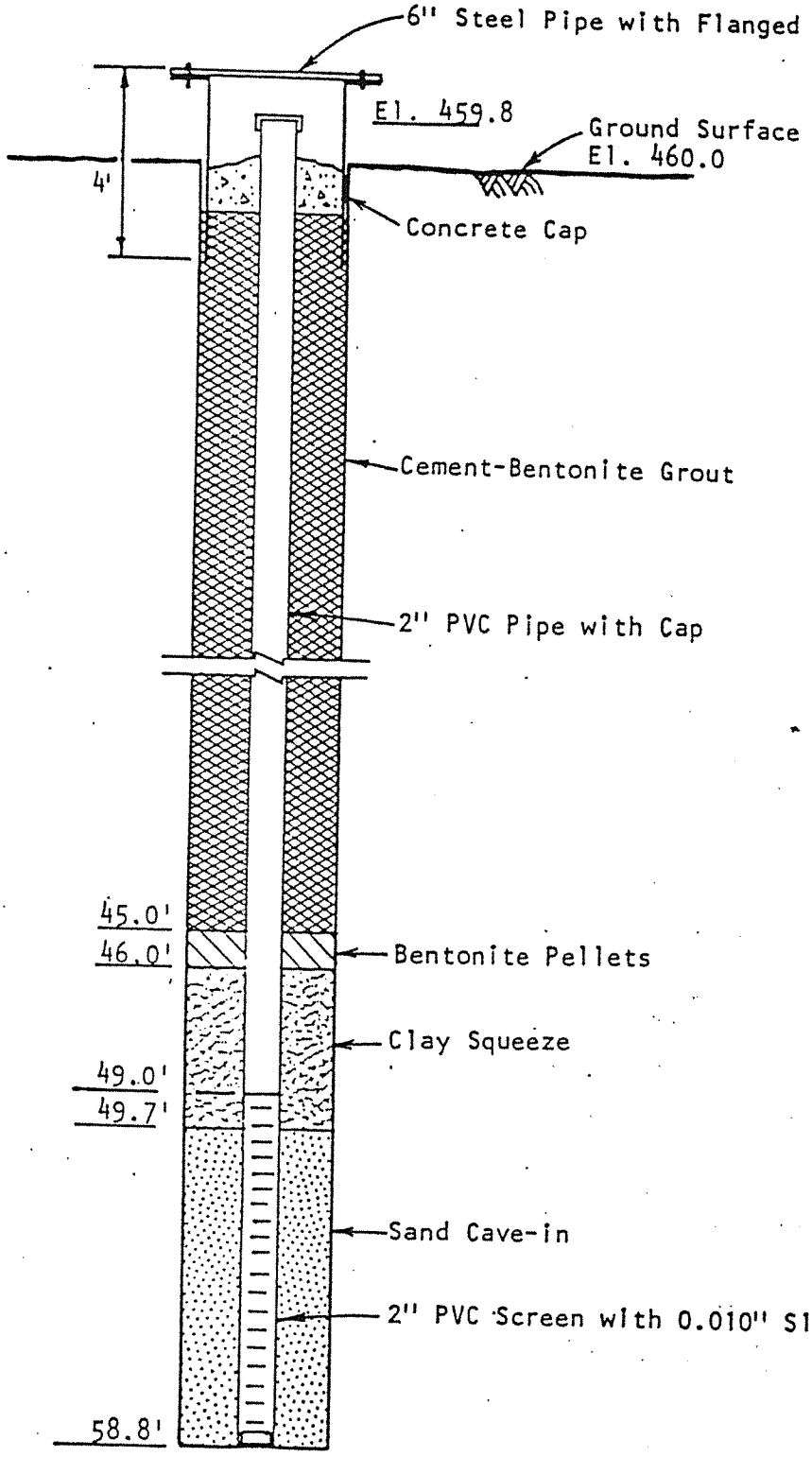
DRILLING METHOD Hollow Auger
DATE DRILLED 12/8, 9/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at	-	Feet
0 Hours after completion	3.0	Feet
6 Days after completion	6.3	Feet
___ after completion	___	Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

John Mathes & Associates, Inc.



6" Borehole to Termination Depth

Not to Scale

(21)

PIEZOMETER W-1

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-2
SHEET 1 OF 1

22

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Soil Classification System Unified Surface Elevation 461.4'		
	1	AS			Brown Sandy CLAY, CL		
5	2	SS	18/9		Gray - Brown Silty CLAY Trace Sand, CL	3-5-5	
10	3	SS	18/16		Brown Fine SAND w/Silt Trace Gravel, SM	5-7-5	
15	4	SS	18/16			19-20-28	
					Gray-Brown GRAVEL w/Sand Trace Clay, GP		
20	5	SS	18/18			17-27-38	
25	6	SS	18/13		-Coal @ 25.4'	23-18-12	
					Brown Fine SAND, SP		
30	7	SS	18/15			6-11-11	
					Brown GRAVEL w/Sand Trace Clay, GP-GC		
35	8	SS	18/6		TOB	0-4-6	

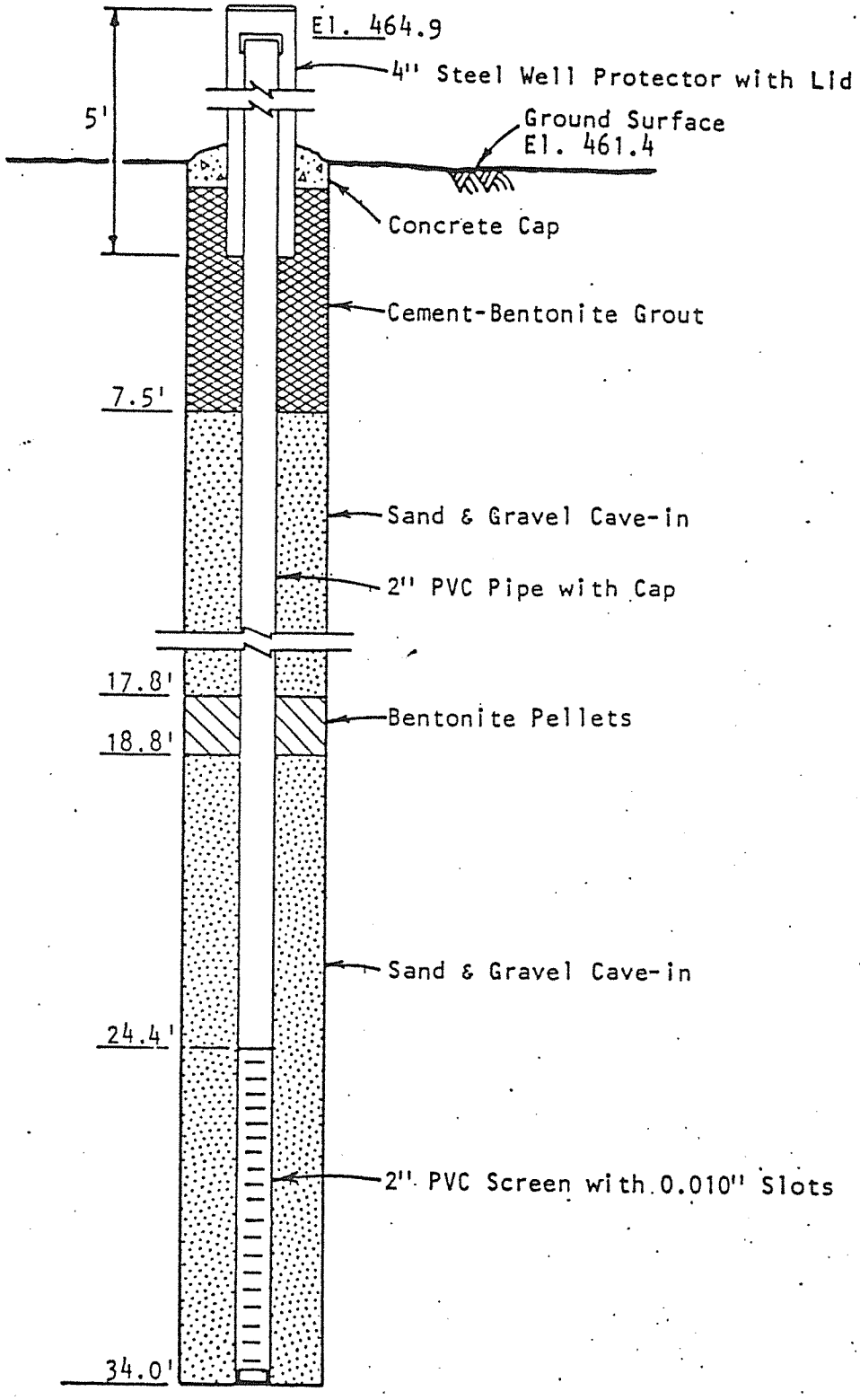
Shear Strength, tsf
SV△ QP/2□ QU/2○
0 ½ 1 1½ 2 2½
PL NMC LL
0 50 100
Rock Quality Designation
0 50 100

DRILLING METHOD Hollow Auger
DATE DRILLED 12/9/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at 8.0 Feet
___ Hours after completion ___ Feet
6 Days after completion 8.0 Feet
___ after completion ___ Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

John Mathes & Associates, Inc.



6" Borehole to Termination Depth

Not to Scale

22

PIEZOMETER W-2

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-3 (23)
SHEET 1 OF 2

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
	1	AS			Brown Sandy CLAY w/Gravel, Fill, CL		
5	2	SS	18/18		Dark Gray FLYASH w/Bottom Ash, FILL, ML	7-9-8	
					Dark Gray BOTTOM ASH, FILL, ML		
10	3	SS	18/14			7-17-16	
15	4	SS	18/12			7-7-5	
					Dark Gray Silty CLAY, CL		
20	5	SS	18/15			1-1-1	
25	6	SS	18/16			WH-2-1	
					Dark Gray CLAY w/Silt Trace Sand, Shells, OH		
30	7	SS	18/18			WH-2-2	
35	8	SS	18/10		Brown GRAVEL w/Sand Trace Clay, GP-GC	8-19-16	

Shear Strength, tsf
SV△ QP/½□ QU/½○
0 ½ 1 1½ 2 2½
PL + NMC • LL x
0 50 100
Rock Quality Designation
0 50 100

(Color Modifier MATERIAL Classification)
Soil Classification System Unified
Surface Elevation 460.2'

DRILLING METHOD Hollow Auger
DATE DRILLED 12/10/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at 18.4 Feet
0 Hours after completion 4.2 Feet
5 Days after completion 6.8 Feet
___ after completion ___ Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

John Mathes & Associates, Inc.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-3 (23)
SHEET 2 OF 2

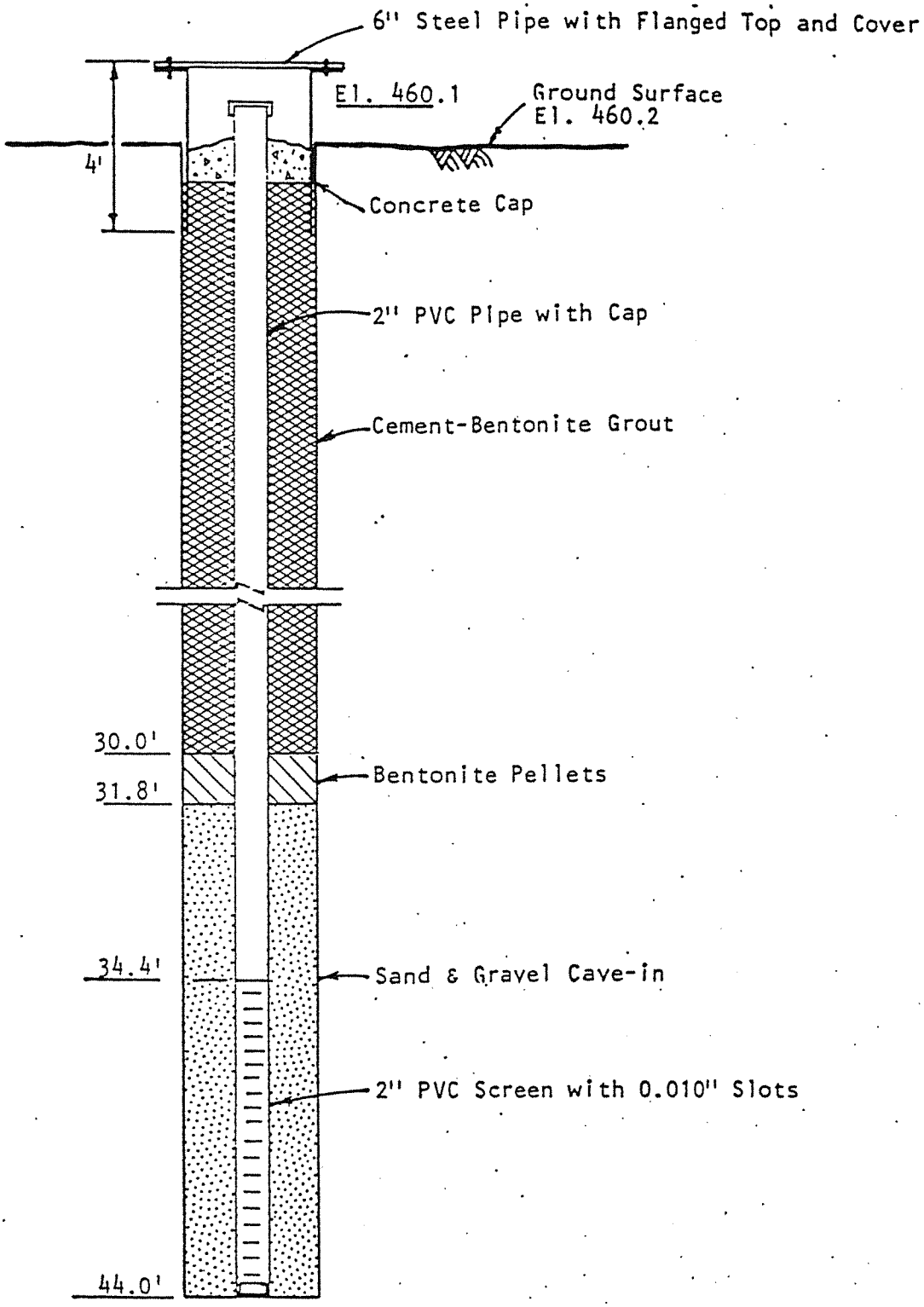
DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Soil Classification System Unified Surface Elevation 460.2'		
					Brown GRAVEL w/Sand Trace Clay, GP-GC		
					Brown Sandy CLAY w/Gravel, CL		
40	9	SS	18/18			4-2-37	
					Brown GRAVEL w/Sand Trace Clay, GP-GC		
45	10	SS	18/10		TOB	10-33-38	
50							

Shear Strength, tsf
SV△ QP/2□ QU/2○
0 ½ 1 1½ 2 2½
PL NMC LL
0 50 100
Rock Quality Designation
0 50 100

DRILLING METHOD Hollow Auger
DATE DRILLED 12/10/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at 18.9 Feet
0 Hours after completion 4.2 Feet
5 Days after completion 6.8 Feet
___ after completion ___ Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.



6" Borehole to Termination Depth

Not to Scale

23

PIEZOMETER W-3

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-4
SHEET 1 OF 2

24

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
	1	AS			Soil Classification System Unified Surface Elevation 460.6' Brown Sandy CLAY w/Gravel, CL		
					Dark Gray FLYASH w/Bottom Ash, ML		
-5-	2	SS	18/16			3-4-5	
-10-	3	SS	18/18			2-5-6	
-15-	4	SS	18/18			1-2-3	
					Dark Gray Silty CLAY, CL		
-20-	5	SS	18/9			1-1-2	
-25-	6	SS	18/18			WH-2-2	
-30-	7	SS	18/16			WH-2-3	
					Dark Gray CLAY w/Silt Trace Sand, OH		
-35-	8	SS	18/18			WH-1-2	

Shear Strength, tsf
SV△ QP/2□ QU/2○
0 ½ 1 1½ 2 2½
PL + NMC • LL x
0 50 100
Rock Quality Designation
0 50 100

DRILLING METHOD Hollow Auger
DATE DRILLED 12/10, 13/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS
66 Hours after completion Encountered at – Feet
2 Days after completion 14.0 Feet
— after completion 6.0 Feet
— after completion — Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

John Mathes & Associates, Inc.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-4 (24)
SHEET 2 OF 2

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					(Color Modifier MATERIAL Classification)		
					Soil Classification System Unified		
					Surface Elevation 460.6'		
					Dark Gray CLAY w/Silt Trace Sand, OH		
40		SS	18/18			WH-WH-2	
45	10	SS	18/18			WH-2-1	
50	11	SS	18/12			WH-3-8	
					Dark Gray Fine SAND w/Clay, SC		
55	12	SS	18/4	1		1-4-7	
					Dark Gray Gravelly Fine SAND Trace Silt, SP-SM		
60	13	SS	18/18			8-15-5	
					Gray GRAVEL w/Sand Trace Clay, GP-GC		
65	14	SS	18/16		TOB	14-17-22	
70					Remarks: 1. Water level approximately 6.0' appears same as river level.		

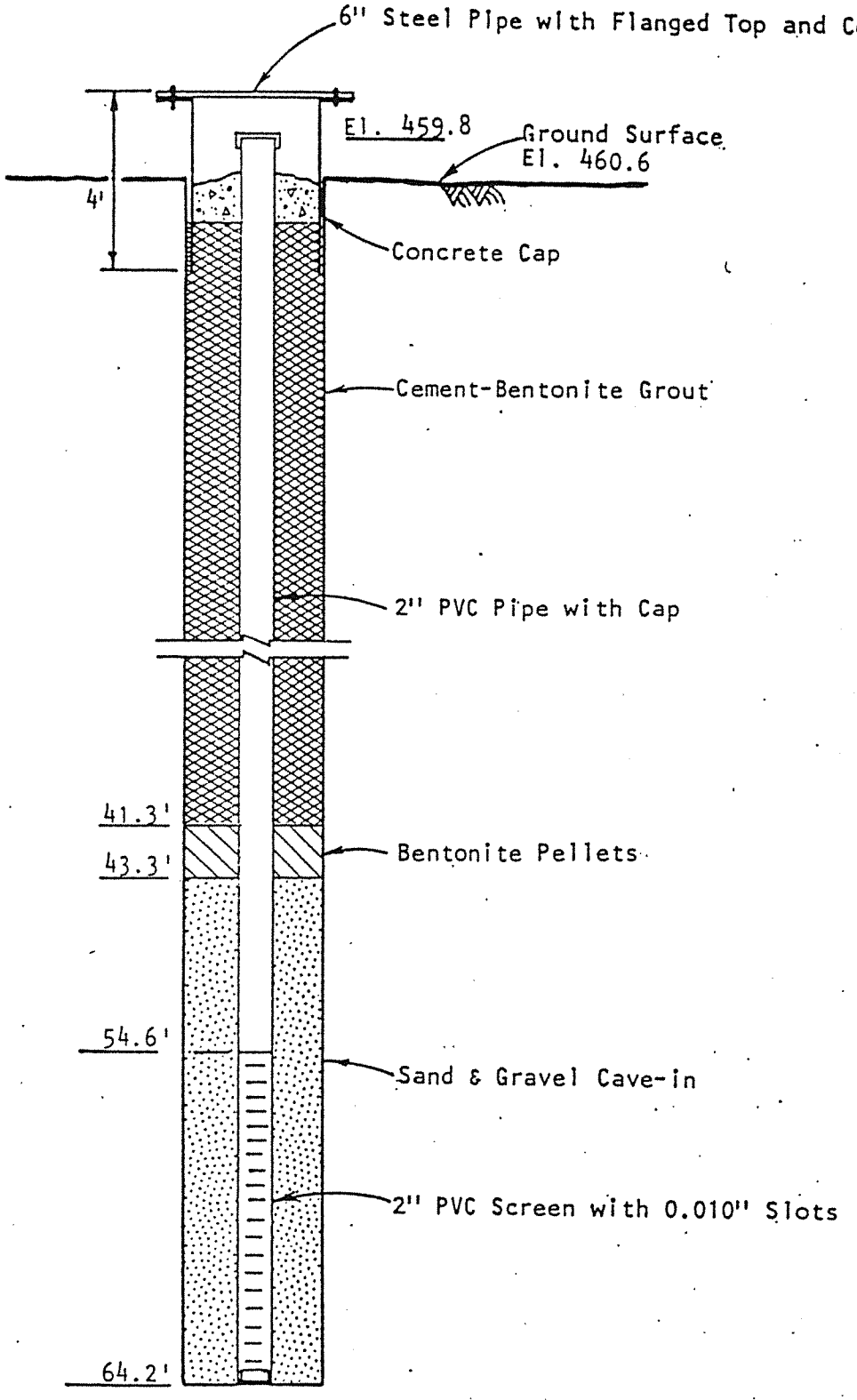
Shear Strength, tsf
SV△ QP/2□ QU/2○
0 ½ 1 1½ 2 2½
PL NMC LL
0 50 100
Rock Quality Designation
0 50 100

DRILLING METHOD Hollow Auger
DATE DRILLED 12/10, 13/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at – Feet
66 Hours after completion 14.0 Feet
2 Days after completion 6.7 Feet
___ after completion ___ Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

John Mathes & Associates, Inc.



6" Borehole to Termination Depth

Not to Scale

24

PIEZOMETER W-4

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-5
SHEET 1 OF 1

(25)

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Soil Classification System: Unified Surface Elevation: 459.8'		
					Dark Brown Sandy SILT Trace Clay, ML		
5	1	SS	18/7		Brown GRAVEL w/Sand Trace Silt, Clay, GP	4-10-14	
10	2	SS	18/13			6-12-17	
15	3	SS	18/13			7-12-16	
20	4	SS	18/18		Brown Fine SAND Trace Silt, SP	8-25-27	
25		SS	18/6		Brown Medium SAND w/Gravel, SP	4-7-7	
30	6	SS	18/9		Brown Gravelly SAND Trace Clay SP	6-12-10	
35	7	SS	18/6		TOB	7-8-13	

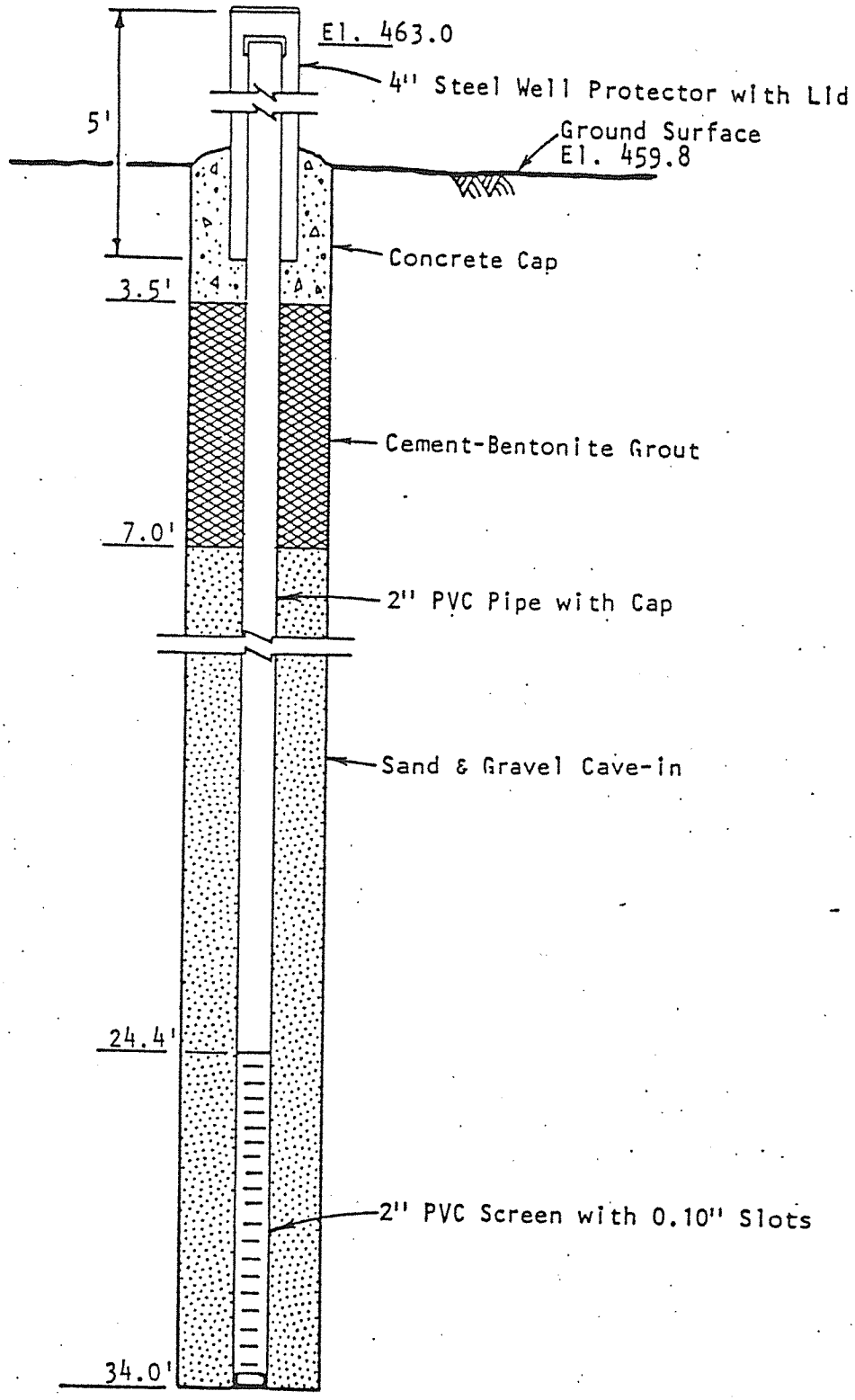
Shear Strength, tsf
SV△ QP/2□ QU/2○
0 ½ 1 1½ 2 2½
PL NMC LL
0 50 100
Rock Quality Designation
0 50 100

DRILLING METHOD Hollow Auger
DATE DRILLED 12/14/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at 6.0 Feet
24 Hours after completion 5.8 Feet
___ after completion ___ Feet
___ after completion ___ Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

John Mathes & Associates, Inc.



6" Borehole to Termination Depth

Not to Scale

25

PIEZOMETER W-5

Appendix A2

STMI Boring Logs and Well Details

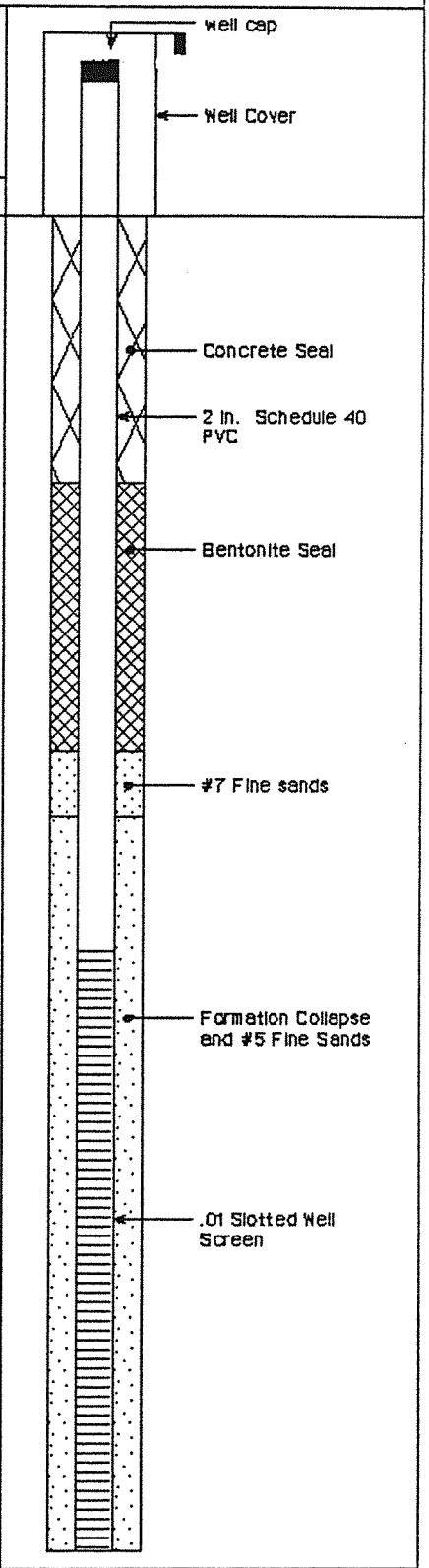
Monitoring Well No. 26

PROJECT TITLE: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear ft.

DATE: 08-22-96
HOLE DIA.: 7 in.
FINAL GW: 18 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 460.66 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Blind Drilling (Refer to MW 25 for lithologic description)			0–20	
Blind Drilling (Refer to MW 25 for lithologic description)				
Blind Drilling (Refer to MW 25 for lithologic description)				



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Notes:

Project No.
135-1.31

Monitoring Well No. 26

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear ft.

DATE: 08-22-95
HOLE DIA.: 7 in.
FINAL GW: 18 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 460.66 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Blind Drilling (Refer to MW 25 for lithologic description)			20–40		Sediment Trap

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Notes:

Project No.
135-1.31

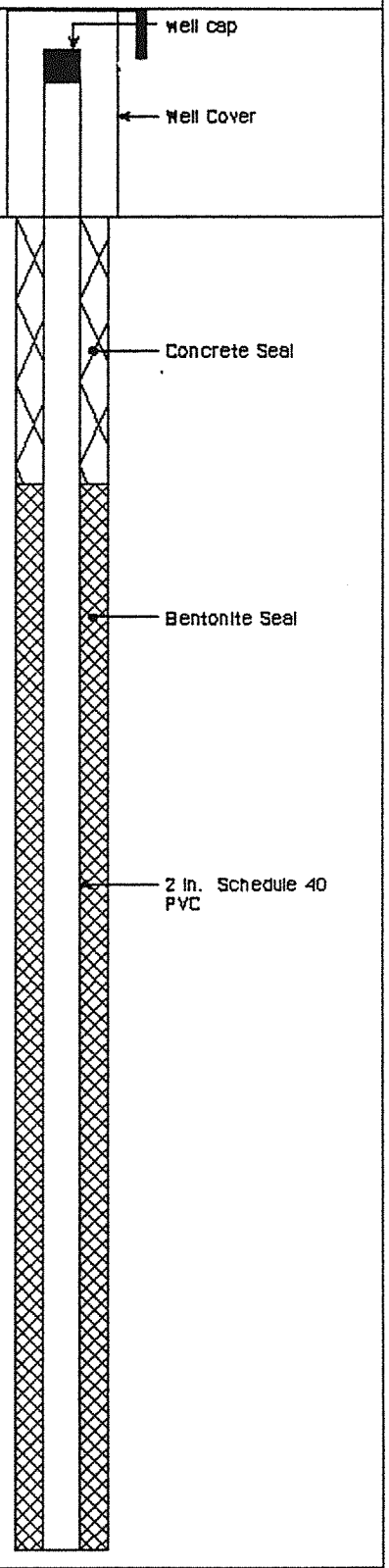
Monitoring Well No. 27

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 09-11-95
HOLE DIA.: 7 in.
FINAL GW: 3.88 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 447.94 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Dark gray, clayey silt, uniform, organic matter, soft, stickey			0–5	
Dark gray, clayey silt w/ some sand, roots, soft, uniform, wet			5–10	SS-1
Same as above, except color changes to lighter gray at 16 ft.			10–15	SS-2
Mottled gray, orange, uniform, clayey silt, soft, moist			15–20	SS-3



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Notes:

Project No. 135-1.31

Monitoring Well No. 27

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 09-11-95
HOLE DIA.: 7 in.
FINAL GW: 3.88 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 447.94 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Same as above			20–24	SS-3	2 in. Schedule 40 PVC
Uniform, brown grading to gray silty fine sand, wet, soft			24–26	SS-4	Bentonite Seal
uniform gray silty fine sand, wet, soft			26–30	SS-5	#7 Fine Sand
uniform brown fine-medium sand, wet, soft			30–33	SS-5	Formation Collapse and #5 Sand
Uniform brown fine-medium sand with pebbles (may be blown in)			33–34	SS-6	.01 Slotted Well Screen
Poorly sorted brown coarse sand and gravel, wet (glacial)			34–36	SS-6	
			36–40		

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Notes:

Project No. 135-1.31

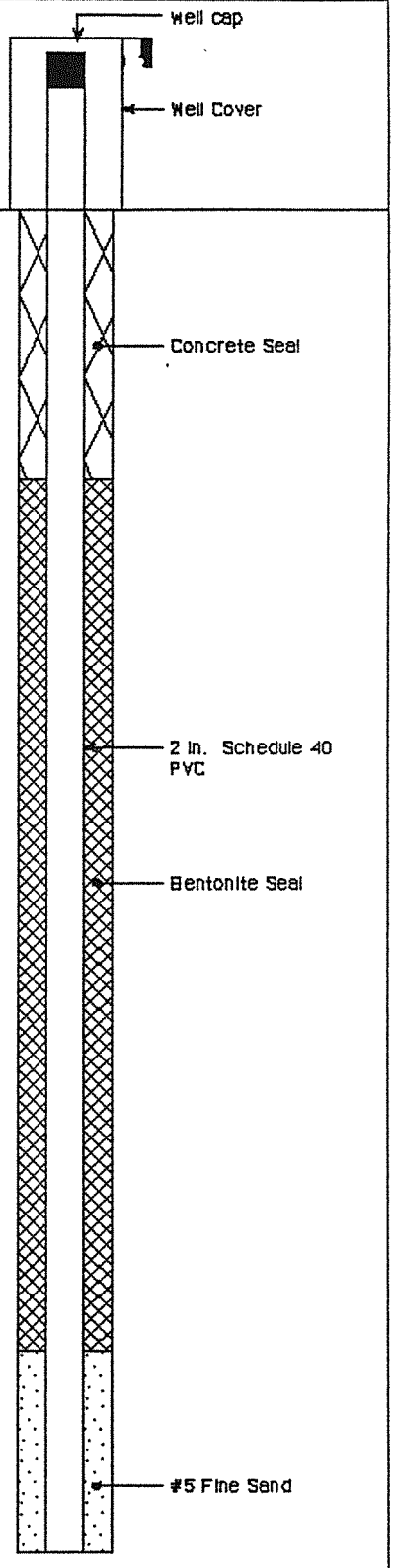
Monitoring Well No. 30

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 08-23-95
HOLE DIA.: 7 in.
FINAL GW: 6.36 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 451.24 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Brown, uniform, well sorted, fine to medium sand, wet			0–6	SS-1
Brown, uniform, well sorted fine to medium sand, siltier at 12 ft.			6–11	SS-2
Same as above			11–16	SS-3
			16–20	



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Notes:
Sample numbers refer to saved samples

Project No. 135-1.31

Monitoring Well No. 30

PROJECT TITLE: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 08-23-96
HOLE DIA.: 7 in.
FINAL GW: 6.36 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 451.24 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Sand as above (probably blow-in), grading to silty sand with coarse gravel			20–33	SS-4	2 in. Schedule 40 PVC
Silty sand with gravel, brown, poorly sorted, wet, like above			26–33	SS-6	.01 Slotted Well Screen; Formation Collapse and #5 Fine Sand

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Notes:
Sample numbers refer to saved samples

Project No.
135-1.31

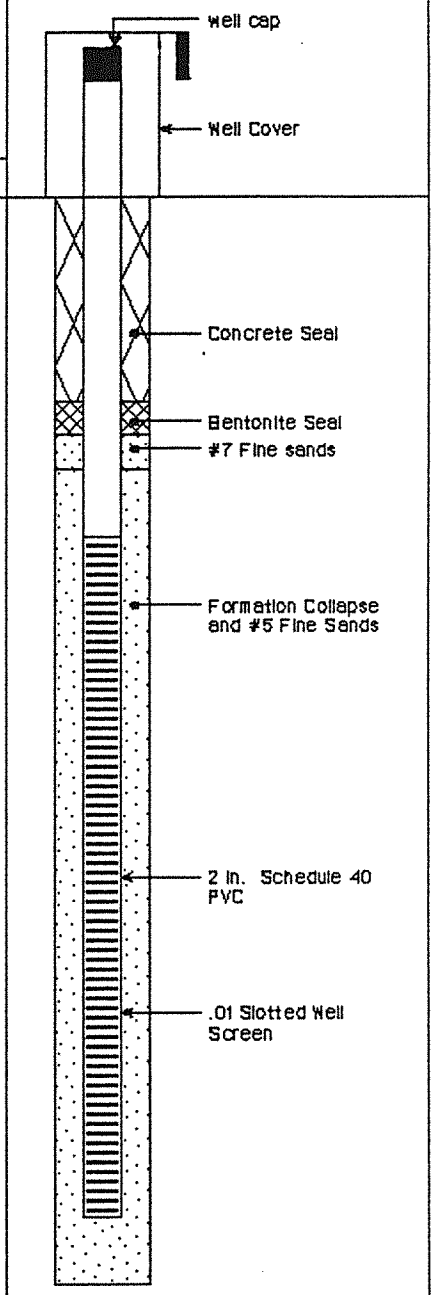
Monitoring Well No. 31

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 08-23-95
HOLE DIA.: 7 in.
FINAL GW: 6.30 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 451.24 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Blind Drilling (Refer to boring logs for MW 30 for lithologic description) ▼			0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	



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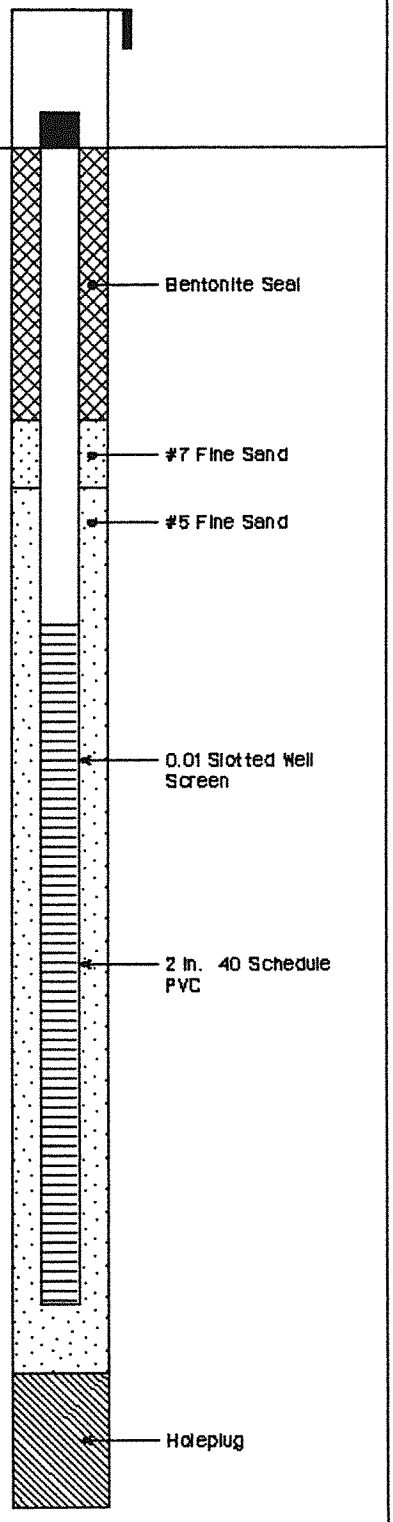
Notes:

Project No. 135-1.31

Monitoring Well No. 32

PROJECT Title: Hennepin West Ash Impoundment
DATE: 8-21-96
LOGGED BY: Mueller/Tu
DRILL RIG: Hollow Stem Auger
HOLE DIA.: 7 in.
SAMPLER: Split Spoon
DRILLER: Boart Longyear
FINAL GW: 5.06 ft.
HOLE ELEV.: 451.35 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Clay, little organic debris (twigs, wood chips, fine roots), dark brown, low to medium plasticity, moist (alluvium)			0–4	A-1A
Sand, well sorted, subangular to rounded, little silt, some clay, loose red to brown in color. Saturated at approximately 4 to 4.5ft.			4–9	A-1B
Sand and gravel, medium-grained, well-rounded, well sorted quartz and sand, fine to coarse-grained, subangular to subrounded quartz and calcareous gravel. Redish-brown in color (alluvium). Wet.			9–11	A-1C
			11–20	A-1D



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Notes:
Dicontinuously sampled every 5 feet. Sample numbers refer to saved samples

Project No.
135-1.31

Monitoring Well No. 32

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-21-96
HOLE DIA.: 7 in.
FINAL GW: 5.06 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 461.35 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Sandy clay, no plasticity, reddish brown in color, with rusty red laminations. Wet.			20–40	A-1E, A-1F, A-1G	Holeplug
Silty clay, trace coarse subangular sand, mixed lithologies, olive gray, no to low plasticity, hard, moist (till).					

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Notes:
Discontinuously sampled every 5 feet. Sample numbers refer to saved samples

Project No. 135-1.31

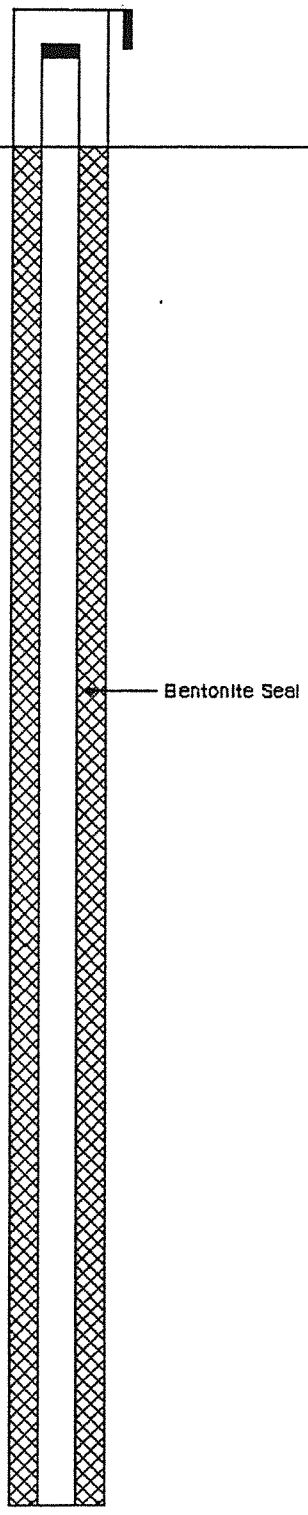
Monitoring Well No. 33

PROJECT TITLE: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-22-96
HOLE DIA.: 7 in.
FINAL GW: 4.38 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 448.69 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Silty clay, trace of very fine-grained sand, trace of plant debris, dark brown, medium plasticity (alluvium). Wet. Stagnant swampy odor.			0	B-1A
			1	
			2	
			3	
			4	
			5	B-1B
			6	
			7	
			8	
			9	
			10	B-1C
			11	
			12	
			13	
			14	
			15	B-1D
Silty clay, trace fine to medium-grained sand, medium to high plasticity, dark gray in color. Wet			16	
			17	
Same as Above			18	
			19	
			20	



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Brookfield, Wisconsin 53005-8208

Notes:

Project No.
135-1.31

Monitoring Well No. 33

PROJECT TITLE: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-22-96
HOLE DIA.: 7 in.
FINAL GW: 4.38 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 448.69 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Same As Above			20–40	B-1E, B-1F, B-1G, B-1H	#7 Fine Sand; #5 Fine Sand; 0.01 Slotted Well Screen; 2 in. 40 Schedule PVC
Clayey silt, high plasticity, olive in color. Wet					
Sand, fine grained, well-sorted, well-rounded, quartz, trace calcareous, gray. Saturated.					

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Brookfield, Wisconsin 53005-8208

Notes:

Project No.
135-1.31

Monitoring Well No. 33

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-22-96
HOLE DIA.: 7 in.
FINAL GW: 4.38 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 448.69 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE		WELL CONSTRUCTION DETAIL
			40			
			41			
			42			
			43			Holeplug
			44			
			45			
			46			
			47			
			48			
			49			
			50			
			51			
			52			
			53			
			54			
			55			
			56			
			57			
			58			
			59			
			60			

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Brookfield, Wisconsin 53005-8208

Notes:

Project No.
135-1.31

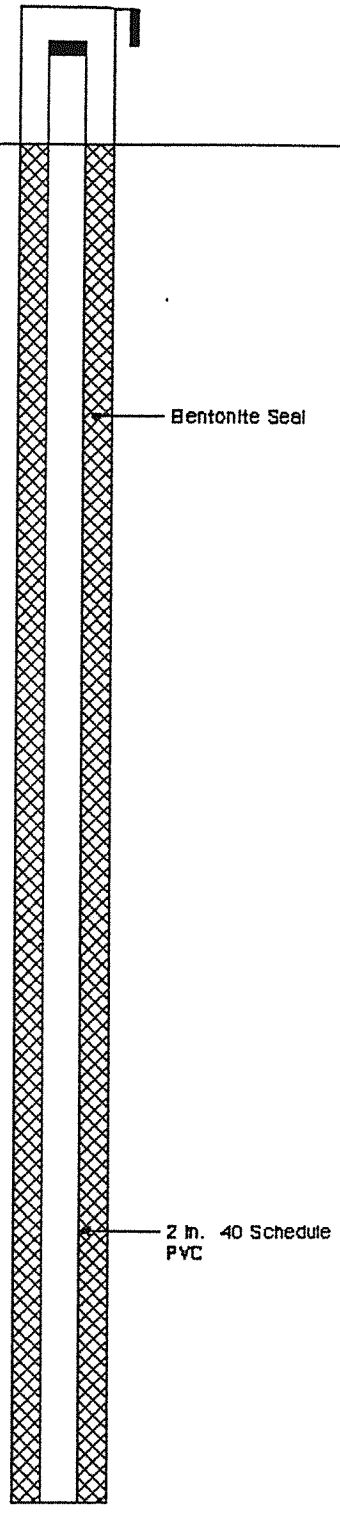
Monitoring Well No. 34

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-22-96
HOLE DIA.: 7 in.
FINAL GW: 7.54 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 448.19 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Silty clay, trace of plant debris, little fine-grained sand, very dark brown in color, medium to high plasticity (alluvium).			0	C-1A
			5	C-1B
			10	C-1C
			15	C-1D
			20	



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2511 N. 124th St. Suite 205
Brookfield, Wisconsin 53005-8208

Notes:

Project No. 135-1.31

Monitoring Well No. 34

PROJECT TITLE: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-22-96
HOLE DIA.: 7 in.
FINAL GW: 7.54 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 448.19 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Clayey silt, trace to little fine-grained sand and shell fragments, soft, olive-gray. Wet.			20–26	C-1E, C-1F	Bentonite Seal; 2 in. 40 Schedule PVC
Sand, fine-grained to medium-grained, well-sorted, quartz, trace of silt, loose. Yellowish brown color grades to olive gray below 31 ft.			27–38	C-1G	#7 Fine Sand; #5 Fine Sand; 0.01 Slotted Well Screen; Holeplug

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Notes:

Project No. 135-1.31

Monitoring Well No. L1

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 08-22-95
HOLE DIA.: 7 in.
FINAL GW: 12.75 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 465.11 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Fill, consisting of dark brown uniform silty sand with gravels, grading to poorly sorted gravelly sand (Dry)			0–10	SS-1	Well Cap; Cement Seal
Fill, consisting of dark grey silt with sand and gravel, mixed with fly ash, moist, very soft			10–16	SS-2	Bentonite Seal
Gray fly ash, silty, moist, well-sorted			16–20	SS-3	

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Notes:

Project No. 135-1.31

Monitoring Well No. L1

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 08-22-95
HOLE DIA.: 7 in.
FINAL GW: 12.75 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 465.11 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Black silty flyash with some sand, wet (2 samples stored for lab)			20–25	SS-4	Fine Sand Pack; #5 Fine Sand
Black silty clay with shell fragments. Wet, firmer than above (2 samples stored for lab)			25–30	SS-5	2 in. 40 Schedule PVC; 0.01 Slotted Well screen
Silt, with dark brown mottles, uniform texture, shell fragments.			30–35	SS-6	
Black uniform silt, soft, more plastic than above			35–40	SS-7	Holeplug

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Notes:

Project No. 135-1.31

Monitoring Well No. L1

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 08-22-95
HOLE DIA.: 7 in.
FINAL GW: 12.75 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 465.11 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE		WELL CONSTRUCTION DETAIL
Black silt with sand, uniform texture, numerous roots.			40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60	SS-8		

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Notes:

Project No.
135-1.31

Monitoring Well No. L2

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 08-23-95
HOLE DIA.: 7 in.
FINAL GW: Not Measured ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 466.43 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Black, coarse, dry bottom ash.			0–10	SS-1	Hole backfilled with bentonite chips and cuttings
Black, coarse, moist bottom ash					
Black, fine-silty sand, uniform			10–13	SS-2	
Brown, poorly sorted, silty coarse sand & gravel, dry			13–20	SS-3	

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Notes:
No well was set at this location

Project No.
135-1.31

Monitoring Well No. L2

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 08-23-95
HOLE DIA.: 7 in.
FINAL GW: Not Measured ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 466.43 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE		WELL CONSTRUCTION DETAIL
Brown, poorly sorted silty sand & gravel, wet			20	SS-4		Hole backfilled with bentonite chips and cuttings
			21			
			22			
			23			
			24			
			25			
			26			
			27			
			28			
			29			
			30			
			31			
			32			
			33			
			34			
			35			
			36			
			37			
			38			
			39			
			40			

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Notes:
No well was set at this location

Project No.
135-1.31

Monitoring Well No. L3

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 9-12-96
HOLE DIA.: 7 in.
FINAL GW: 15.26 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 459.26 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Black, silty flyash. Wet.			0–14	SS-1, SS-2	Well Casing; Cement Seal; Bentonite Seal; #7 Fine Sand; #5 Fine Sand; 2 in. 40 Schedule PVC; 0.01 Slotted Well screen
Fine, uniform sands, light brown. Wet.			14–20	SS-3	Holeplug

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Notes:
Continuously sampled bore-hole. Sample numbers refer to saved samples

Project No. 135-1.31

Monitoring Well No. L3

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 9-12-95
HOLE DIA.: 7 in.
FINAL GW: 15.26 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 459.26 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE		WELL CONSTRUCTION DETAIL
			20			
Fine, uniform sand, light brown. Wet.			21			
			22			Holeplug
			23			
			24			
			25	SS-4		
Fine to medium sand with gravels.			26			
			27			
			28			
			29			
			30			
			31			
			32			
			33			
			34			
			35			
			36			
			37			
			38			
			39			
			40			

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Notes:
Continuously sampled bore-hole. Sample numbers refer to saved samples

Project No.
135-1.31

Monitoring Well No. L4

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 08-21-95
HOLE DIA.: 7 in.
FINAL GW: 13.25 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 461.95 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Blind Drilling (Refer to boring log for MW 24 for lithologic description)			0–20	SS-1	well cap; Bentonite Seal; 2 in. Schedule 40 PVC; #7 Fine Sands; Formation Collapse and #5 Fine Sands; .01 Slotted Well Screen
Dark brown, dry fine silty sand, some gravel well sorted					

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Notes:

Project No. 135-1.31

Monitoring Well No. L4

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 08-21-95
HOLE DIA.: 7 in.
FINAL GW: 13.25 ft.

LOGGED BY: Hensel/Tu
SAMPLER: Split spoon
HOLE ELEV.: 461.95 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE		WELL CONSTRUCTION DETAIL
Blind Drilling (Refer to boring log for MW 24 for lithologic description)			20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40			Sediment Trap

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Brookfield, Wisconsin 53005-8208

Notes:

Project No.
135-1.31

Appendix A3

NRT Boring Logs and Well Details

Natural Resource Technology, Inc.
Standard Soil Boring Log

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION
Form Rev. 5-92

Facility/Project Name	**License/Permit/Monitoring Number**	**Boring Number**
DYNEGY – Hennepin Ash Impoundment		*HE-23S*

Boring Drilled By (Firm name and name of crew chief)	**Date Drilling Started**	**Date Drilling Completed**	**Drilling Method**
Boart Longyear *Randy Radke*	*04/03/00*	*04/03/00*	*4.25" HSA*

Facility Well No.	**Unique Well No.**	**Common Well Name**	**Final Static Water Level**	**Surface Elevation**	**Borehole Diameter**
			-- Feet MSL	*457.8 Feet MSL*	*8.25 inches*

Boring Location **State Plane**	**Feet N** **Feet E**	**Lat** **Long**	**Local Grid Location (if applicable)** ☐ *N* ☐ *S* ☐ *E* ☐ *W*

County		**Civil Town/City/ or Village**
Putnam		*Hennepin, IL*

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	ROD/ Comments
			1	0'-15' DRILL WITHOUT SAMPLING, COAL ASH, fine to coarse	FILL									
			2											
			3											
			4											
			5											
			6											
			7											
			8											
			9											
			10											
HE-23S (10-12)	24	4	11	10'-16.5' COAL ASH, dark gray to black, fine to medium sand consistency, soft, slightly moist	FILL					M				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature [signature] Firm **Natural Resource Technology, Inc.**

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			13											
HE-23S (13-15)	24	10	14	wet at 13.5'	FILL					W				
HE-23S (15-17)	24	2	15							W/M				
			16											
			17	16.5'–25' SILT, black (5Y 2.5/1), 20% clay, trace organics, soft, moist										
HE-23S (17.5-19.5)	24	4	18							M				
			19											
			20											
HE-23S (20-22)	24	5	21		ML					M				
			22	@ 21.5', olive gray (5Y 5/2) & yellowish brown (10YR 5/6), mottled, 15% clay, 10% fine grained sand, medium stiff, moist										
HE-23S (22.5-24.5)	24	8	23	23'–24' black (5Y 2.5/1)						M				
			24	24'–24.5 olive grey & yellowish brown, trace medium grained sand										
			25											
HE-23S (25-27)	24	5	26	25'–26.5' CLAYEY SILT, dark grayish brown (2.5Y 4/2), 5–15% fine grained sand, medium stiff, moist	ML					M				
			27	26.5'–34' SILTY CLAY, dark grayish brown (2.5Y 4/2), 15% fine grained sand, medium stiff, moist										
HE-23S (27.5-29.5)	24	8	28							M				
			29		CL									
			30	@ 29.5', 2" fine to medium sand seam, 10% silt										
HE-23S (30-32)	24	99	31							M				
				@ 31'8", 2" fine to medium sand seam, 10% silt										

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			33		CL					M				
HE-23S (32.5-34.5)	24	32	34	34'–34.5' SAND WITH GRAVEL, dark grayish brown (2.5Y 4/2), coarse grained, 15% silt, dense, moist	SP									
			35	EOB @ 34.5'										
			36											
			37											
			38											
			39											
			40											
			41											
			42											
			43											
			44											
			45											
			46											
			47											
			48											
			49											
			50											
			51											

Natural Resource Technology, Inc.
Standard Soil Boring Log

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION
Form Rev. 5-92

Facility/Project Name	**License/Permit/Monitoring Number**	**Boring Number**
DYNEGY – Hennepin Ash Impoundment		*HE-A1*

Boring Drilled By (Firm name and name of crew chief)	**Date Drilling Started**	**Date Drilling Completed**	**Drilling Method**
Boart Longyear *Randy Radke*	*04/05/00*	*04/05/00*	*4.25" HSA*

Facility Well No.	**Unique Well No.**	**Common Well Name**	**Final Static Water Level**	**Surface Elevation**	**Borehole Diameter**
			-- Feet MSL	*460.3 Feet MSL*	*8.25 Inches*

Boring Location **State Plane**	**Feet N** **Feet E**	**Lat** **Long**	**Local Grid Location (If applicable)** ☐ N ☐ E ☐ S ☐ W

County		**Civil Town/City/ or Village**
Putnam		*Hennepin, IL*

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1–10	0'–10' DRILL WITHOUT SAMPLING, COAL ASH	FILL									
HE-A1 (10–12)	24	12	10–11	10'–13.5' COAL ASH, fine grained, 10–15% coal cinders, stiff, dry						D				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature [signature] Firm **Natural Resource Technology, Inc.**

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			13		FILL									
HE-A1 (12.5-14.5)	18	16	14	13.5'–16' SILT, black (2.5Y 2.5/1), 10% clay, stiff, very moist						M				
			15	wet at 15'	ML									
HE-A1 (15-17)	16	12	16	16'–17' SANDY SILT, olive brown (2.5Y 4/4), fine, 5% clay, stiff, wet	ML					W				
			17	EOB @ 17'										
			18											
			19											
			20											
			21											
			22											
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30											
			31											

Natural Resource Technology, Inc.
Standard Soil Boring Log

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION
Form Rev. 5-92

Facility/Project Name	**License/Permit/Monitoring Number**	**Boring Number**
DYNEGY – Hennepin Ash Impoundment		*HE-A3*

Boring Drilled By (Firm name and name of crew chief)	**Date Drilling Started**	**Date Drilling Completed**	**Drilling Method**
Boart Longyear *Randy Radke*	*04/06/00*	*04/06/00*	*4.25" HSA*

Facility Well No.	**Unique Well No.**	**Common Well Name**	**Final Static Water Level**	**Surface Elevation**	**Borehole Diameter**
			-- Feet MSL	*461.7 Feet MSL*	*8.25 inches*

Boring Location **State Plane**	**Feet N** **Feet E**	**Lat** **Long**	**Local Grid Location (If applicable)** ☐ N ☐ S ☐ E ☐ W

County	**Civil Town/City/ or Village**
Putnam	*Hennepin, IL*

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			1	0'–8' DRILL WITHOUT SAMPLING	FILL									
			2											
			3											
			4											
			5											
			6											
			7											
			8											
HE-A3 (8-10)	12	26	9	8'–18' COAL ASH, silt to fine grained sand consistency, coal cinders, very stiff, moist to dry						M/D				
			10											
HE-A3 (10-10)	8	12	11							W/D				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature [signature] Firm **Natural Resource Technology, Inc.**

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			13											
HE-A3 (12.5-14.5)	24	22	14							W/D				
			15		FILL									
HE-A3 (15-17)	24	10	16	@ 16', very dark gray (5Y 3/1)						W/D				
			17											
			18											
HE-A3 (17.5-19.5)	8	6		18'–19' SILT WITH SAND, black (5Y 2.5/1), fine, 5% organics, trace clay, loose, moist	ML					M				
			19	19'–19.5' SILTY SAND, dark olive green (5Y 3/2), 30% silt, 5% organics, trace clay, loose, moist	SM									
			20	EOB @ 19.5'										
			21											
			22											
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30											
			31											

Natural Resource Technology, Inc.
Standard Soil Boring Log

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION
Form Rev. 5-92

Facility/Project Name	**License/Permit/Monitoring Number**	**Boring Number**
DYNEGY – Hennepin Ash Impoundment		*HE-L5*

Boring Drilled By (Firm name and name of crew chief)	**Date Drilling Started**	**Date Drilling Completed**	**Drilling Method**
Boart Longyear *Randy Radke*	*04/06/00*	*04/06/00*	*4.25" HSA*

Facility Well No.	**Unique Well No.**	**Common Well Name**	**Final Static Water Level**	**Surface Elevation**	**Borehole Diameter**
			-- Feet MSL	*461.3 Feet MSL*	*8.25 inches*

Boring Location
State Plane **Feet N** **Feet E**
Lat **Long**
Local Grid Location (If applicable) ☐ N ☐ E ☐ S ☐ W

County		**Civil Town/City/ or Village**
Putnam		*Hennepin, IL*

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1	0'–8' DRILL WITHOUT SAMPLING. (COAL ASH)										
			2											
			3											
			4											
			5											
			6											
			7											
			8											
HE-L5 (8-10)	15	66/0.3	9	8'–12' COAL ASH, gray, silt to fine sand consistency, very dense, wet to dry at 9'						W/D				
			10											
HE-L5 (10-12)	--	50/0.2	11							D				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature *C. Robb* Firm **Natural Resource Technology, Inc.**

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
HE-L5 (12-14)	24	24	13	12'–17' COAL ASH/SILT, dark gray, (5Y 4/1) with brown pockets, very stiff, dry	ML ASH					D				
			14	5% rounded brown pebbles										
HE-L5 (14-16)	24	15	15							M				
			16											
HE-L5 (16-18)	24	4	17							M				
				17'–19' CLAYEY SILT, black (2.5Y 2.5/1) 40% clay, moist, soft	ML									
HE-L5 (18-20)	24	4	18							M				
			19	19'–26' SILTY CLAY, olive brown (2.5Y 4/3), 40% silt, 5–10% fine grained sand, soft, moist										
			20	20'–25' DRILL WITHOUT SAMPLING, wet at approxitmately 19'–20'	CL					W				
			21											
			22											
			23											
			24											
			25											
HE-L5 (25-27)	17	27	26	26'–32' SAND WITH GRAVEL, light olive brown (2.5Y 5/4), fine to medium sand, 15–20% fine sub-angular gravel, medium dense, wet						W				
			27											
HE-L5 (27.5-29.5)	7	20	28	increasingly coarser with depth	SP					W				
			29											
			30											
HE-L5 (30-32)	6	14	31							W				
				EOB @ 32'										

Natural Resource Technology, Inc.
Standard Soil Boring Log

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION
Form Rev. 5-92

Facility/Project Name	**License/Permit/Monitoring Number**	**Boring Number**
DYNEGY - Hennepin Ash Impoundment		*HE-35*

Boring Drilled By (Firm name and name of crew chief)	**Date Drilling Started**	**Date Drilling Completed**	**Drilling Method**
Boart Longyear *Bob Erickson*	*9/28/99*	*9/28/99*	*HSA 4 1/4"*

Facility Well No.	**Unique Well No.**	**Common Well Name**	**Final Static Water Level**	**Surface Elevation**	**Borehole Diameter**
			Feet MSL	*-- Feet MSL*	*8.25 inches*

Boring Location **State Plane**	**Feet N** **Feet E**	**Lat** **Long**	**Local Grid Location (if applicable)** ☐ N ☐ E ☐ S ☐ W

County		**Civil Town/City/ or Village**
Putnam		*Hennepin, IL*

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1	0-7' Fill, brown sand and gravel.	FILL									
			7	7-12' Fill, black silt, uniform, dry, coal ash.	FILL									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm **Natural Resource Technology, Inc.**

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			13	12–15' Fill, black silt, uniform, moist, coal ash.	FILL									
			14											
			15											
		13–9	16											
			17	6" recovery, fill, fine sandy silt, black, mica flakes, dry, coal ash.	FILL									
			18											
			19											
			20											
				20–21' Fill, black–gray fine sandy silt with occasional mica flakes, dry, coal ash.	FILL									
			21											
		2–2 2–3			SP									
			22	21–22' Brown medium sand, uniform, moist.										
				EOB @ 22'										
			23											
			24	No well set. Boring backfilled with bentonite chips.										
			25											
			26											
			27											
			28											
			29											
			30											
			31											

Natural Resource Technology, Inc.
Standard Soil Boring Log

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION
Form Rev. 5-92

Facility/Project Name	**License/Permit/Monitoring Number**	**Boring Number**
DYNEGY – Hennepin Ash Impoundment		*WELL-35*

Boring Drilled By (Firm name and name of crew chief)	**Date Drilling Started**	**Date Drilling Completed**	**Drilling Method**
Boart Longyear *Bob Erickson*	*9/28/99*	*9/28/99*	*HSA 4 1/4"*

Facility Well No.	**Unique Well No.**	**Common Well Name**	**Final Static Water Level**	**Surface Elevation**	**Borehole Diameter**
			-- Feet MSL	*Feet MSL*	*8.25 inches*

Boring Location **State Plane**	**Feet N** **Feet E**	**Lat** **Long**	**Local Grid Location (If applicable)** ☐ N ☐ E ☐ S ☐ W

County		**Civil Town/City/ or Village**
Putnam		*Hennepin, IL*

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			1–11	0–5' Fill, white–grey,angular sandy gravel, dry.	FILL									
				5–7' Black silty sand, roots, small grey pebbles, dry.	SM									
				7–18' Brown medium sand, uniform texture.	SP									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm **Natural Resource Technology, Inc.**

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			13		SP									
			14											
			15											
			16											
			17											
			18											
			19	EOB @ 19'										
			20											
			21											
			22											
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30											
			31											

Natural Resource Technology, Inc.
Standard Soil Boring Log

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Superfund ☐ Other:

SOIL BORING LOG INFORMATION
Form Rev. 5-92

Facility/Project Name	**License/Permit/Monitoring Number**	**Boring Number**
DYNEGY – Hennepin Ash Impoundment		*HE-36*

Boring Drilled By (Firm name and name of crew chief)	**Date Drilling Started**	**Date Drilling Completed**	**Drilling Method**
Boart Longyear *Bob Erickson*	*9/28/99*	*9/28/99*	*HSA 4 1/4"*

Facility Well No.	**Unique Well No.**	**Common Well Name**	**Final Static Water Level**	**Surface Elevation**	**Borehole Diameter**
		36	*-- Feet MSL*	*Feet MSL*	*8.25 inches*

Boring Location		**Local Grid Location (If applicable)**
State Plane	**Feet N** / **Feet E**	**Lat** / **Long**	☐ N ☐ E ☐ S ☐ W

County	**Civil Town/City/ or Village**
Putnam	*Hennepin*

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1–11	0–4' Black silt, roots, topsoil.	ML									
				4–10' Red-brown unifrom fine sand, dry.	SP									
					GW									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm **Natural Resource Technology, Inc.**

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			13	10–30' Brown–grey gravel with sand. Dolmite clasts up to 3".	GW									
			14											
			15											
			16											
			17											
			18											
			19											
			20											
			21											
			22											
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30	EOB @ 30'										
			31											

SOIL BORING LOG INFORMATION

NATURAL RESOURCE TECHNOLOGY

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Hennepin Power Station		49

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Chad Dutton Bulldog Drilling	7/2/2015	7/6/2015	hollow stem auger

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
49	Feet (NAVD88)	465.76 Feet (NAVD88)	8.3 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒

State Plane 1,689,022.19 N, 2,528,297.09 E E/W

1/4 of 1/4 of Section , T N, R

Lat 41° 18' 4.255"

Long -89° 19' 23.987"

Local Grid Location ☐ N ☐ S Feet ☐ E ☐ W Feet

Facility ID	County	State	Civil Town/City/ or Village
	Putnam	Illinois	Hennepin

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 SS	24 13	3 4 7 10	1	0 - 5.3' **FILL, SILT WITH GRAVEL:** (ML)g, very dark grayish brown (10YR 3/2), trace sand and roots, rounded to subangular fine gravel, noncohesive, nonplastic, dry.									
2 SS	24 10.5	4 6 5 3	3	2.5' increase in gravel content and gravel size to fine to coarse, coarse sand (5-15%), dry.	(FILL) (ML)g								
3 SS	24 19	2 3 9 10	5	5' moist. 5.3 - 20.2' **FILL, ASH (Coal):** very dark gray (10YR 3/1), mostly silt sized particles, few interbedded sand sized layers, trace coarse ash, noncohesive, nonplastic, moist to wet.									
4 SS	24 22	5 27 30 50 for 5"	8	7.5' black (10YR 2/1). 8.2' mostly medium sand-sized particles with some coarse sand to fine gravel-sized ash.	(FILL)								
5 SS	24 24	5 11 20 50 for 5"	10	10' mostly silt sized particles, trace fine gravel to coarse sand sized ash, trace fine sand sized ash.									
6	24	4 22	13										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm Natural Resource Technology
234 W. Florida St., Fifth Floor, Milwaukee, WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

NATURAL RESOURCE TECHNOLOGY

Boring Number 49

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SS	24	26 24	14	5.3 - 20.2' **FILL, ASH (Coal):** very dark gray (10YR 3/1), mostly silt sized particles, few interbedded sand sized layers, trace coarse ash, noncohesive, nonplastic, moist to wet. *(continued)*									
7 SS	24 22	4 9 38 16	15 16	15' wet. 16.4' seam of sand-sized particles (2" thick).	(FILL)								
8 SS	10 7.5	22 50 for 4"	17 18 19	17.5' mostly sand sized particles, trace gravel, trace silt.									
9 SS	24 14	2 2 2 2	20 21 22	20.2 - 22.5' **LEAN CLAY:** CL, black (10YR 2/1), cohesive, medium plasticity, wet.	CL								
10 ST	24 0		23 24	22.5 - 24.5' Shelby Tube Sample. No Recovery.									ST10: 24" push at 150lbs of pressure. No Recovery.
11 SS	24 2	4 4 4 4	25 26 27	24.5 - 27.8' **LEAN CLAY:** CL, Low Recovery, trace gravel, cohesive, low plasticity, wet.	CL								
12 SS	24 21.5	1 1 4 7	28 29	27.5' very dark gray (10YR 3/1). 27.8 - 30' **SILTY SAND:** SM, mostly fine sand, coarse to fine gravel (5-15%), wet.	SM								
13 SS	24 14	6 15 18 14	30 31	30 - 45' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, yellowish brown (10YR 5/4), fine to medium sand, fine to coarse rounded to subangular gravel, silt decreasing to trace silt with depth (5-15%), trace clay, wet.									
14 SS	24 15	16 16 14 12	32 33	33.2' piece of gravel (2" diameter).	(SW)g								
15 SS	24 5	8 3 2	34	34' fine to coarse sand.									

NATURAL RESOURCE TECHNOLOGY

Boring Number 49

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
		5	35	30 - 45' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, yellowish brown (10YR 5/4), fine to medium sand, fine to coarse rounded to subangular gravel, silt decreasing to trace silt with depth (5-15%), trace clay, wet. *(continued)*										
16 SS	24 9	3 3 4 11	36	36' increased gravel content with depth. 36.3' - 36.4' layer of increased clay content [15-30%].										
17 SS	24 18	11 10 8 22	37 38	38.3' trace very dark brown silt nodules (10YR 2/2).										
18 SS	24 14.5	9 16 15 16	39 40	40' trace very dark brown (10YR 2/2) and light brown (7.5YR 6/3) mottling.	(SW)g									
19 SS	24 17.5	12 21 21 17	41 42	42' no light brown (7.5YR 6/3) mottling.										
20 SS	12 9.5	10 14	43 44											
			45	45' End of Boring.										

NATURAL RESOURCE TECHNOLOGY

MONITORING WELL CONSTRUCTION

Facility/Project Name: Hennepin Power Station	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: 49
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☒ Lat. 41° 18' 4.255" Long. -89° 19' 23.987" or	
Facility ID	St. Plane 1,689,022.19 ft. N, 2,528,297.09 ft. E. E/Ⓦ	Date Well Installed: 07/06/2015
Type of Well: mw	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W	Well Installed By: (Person's Name and Firm): Chad Dutton
Distance from Waste/Source: ____ ft. / State: Illinois	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known	Gov. Lot Number: ____ / Bulldog Drilling

A. Protective pipe, top elevation ____ ft. (NAVD88)

B. Well casing, top elevation 468.19 ft. (NAVD88)

C. Land surface elevation 465.76 ft. (NAVD88)

D. Surface seal, bottom 464.8 ft. (NAVD88) or 1.0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☒ SW ☒ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ Hollow Stem Auger ☒ Other ☐ ____

15. Drilling fluid used: Water ☒ 0 2 Air ☐ Drilling Mud ☐ 0 3 None ☐

16. Drilling additives used? ☐ Yes ☒ No

Describe ____

17. Source of water (attach analysis, if required):
Onsite Potable Well

E. Bentonite seal, top 435.8 ft. (NAVD88) or 30.0 ft.

F. Fine sand, top ____ ft. (NAVD88) or ____ ft.

G. Filter pack, top 430.8 ft. (NAVD88) or 35.0 ft.

H. Screen joint, top 430.8 ft. (NAVD88) or 35.0 ft.

I. Well bottom 420.8 ft. (NAVD88) or 45.0 ft.

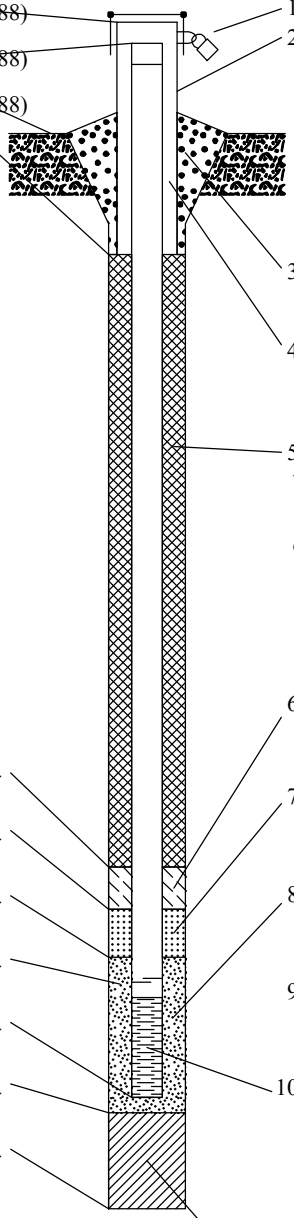
J. Filter pack, bottom 420.8 ft. (NAVD88) or 45.0 ft.

K. Borehole, bottom 420.8 ft. (NAVD88) or 45.0 ft.

L. Borehole, diameter 8.3 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 2.07 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 4.0 in.
b. Length: 5.0 ft.
c. Material: Steel ☒ Other ☐ ____
d. Additional protection? ☒ Yes ☐ No
If yes, describe: Three steel bollards
3. Surface seal: Bentonite ☐ Concrete ☒ Other ☐ ____
4. Material between well casing and protective pipe: Bentonite ☒ Sand Other ☒
5. Annular space seal: a. Granular/Chipped Bentonite ☒
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐
c. ____ Lbs/gal mud weight . . . Bentonite slurry ☐
d. 30 % Bentonite . . . Bentonite-cement grout ☒
e. ____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ Tremie pumped ☒ Gravity ☐
6. Bentonite seal: a. Bentonite granules ☐
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite chips ☐
c. Prepacked bentonite riser Other ☒
7. Fine sand material: Manufacturer, product name & mesh size
a. ____
b. Volume added ____ ft^3
8. Filter pack material: Manufacturer, product name & mesh size
a. Sand prepacked screen.
b. Volume added ____ ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ Flush threaded PVC schedule 80 ☐ Other ☐ ____
10. Screen material: Schedule 40 PVC
a. Screen Type: Factory cut ☐ Continuous slot ☐ Sand prepacked screen Other ☒
b. Manufacturer ____
c. Slot size: 0.010 in.
d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☒ Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge. Date Modified: 11/4/2015

Signature [signature] Firm Natural Resource Technology
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

Appendix A4

AECOM Boring Logs and Well Details

File: P:\PROJECTS\GEOTECH\DYNEGY - BALDWIN 2014\CCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 1 BORING LOCATION PLAN (HENNEPIN OLD WEST ASH POND NO. 1 AND NO. 3).DWG Last edited: JUL. 15, 15 @ 11:19 a.m. by: david_deguire

HEN-B007
HEN-B006
HEN-C005
HEN-B005
HEN-B004
HEN-C004
HEN-P003
HEN-C006
HEN-B008
HEN-B009
HEN-C007
HEN-C014
HEN-B019
HEN-B018
HEN-C018
HEN-P001
HEN-P002
HEN-C002
HEN-B002
HEN-C012
HEN-C013
HEN-C001
HEN-B001
HEN-C003
HEN-B003
HEN-B017
HEN-C019
HEN-B016
HEN-C017
HEN-B012
HEN-C010
HEN-B010
HEN-C008
HEN-B014
HEN-C015
HEN-B013
HEN-C011
HEN-C009
HEN-B011
HEN-B015
HEN-C016

HENNEPIN OLD WEST ASH POND
(POND NO. 1 AND POND NO. 3)

XXX-X### — EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER); ID NUMBER; STATION ABBREVIATION

LEGEND

- PROPOSED BORING LOCATION
- PROPOSED CPT LOCATION
- PROPOSED PIEZOMETER LOCATION
- PROPOSED CROSS SECTION LOCATION
- CCR UNIT BERM ALIGNMENT

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

8

DRAFT

0 200

APPROXIMATE SCALE FEET

N

DYNEGY, INC	PROJECT NO. 60428794
AECOM	
DRN. BY: djd July 2015 DSGN. BY: eg CHKD. BY: eg	Hennepin Old West Ash Pond (Pond No. 1 and Pond No. 3) Field Investigation Plan
	FIG. NO. D-03

PRIVILEGED & CONFIDENTIAL - ATTORNEY CLIENT PRIVILEGED

EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)

XXX–X###

ID NUMBER

STATION ABBREVIATION

LEGEND

- PROPOSED BORING LOCATION
- PROPOSED CPT LOCATION
- PROPOSED PIEZOMETER LOCATION
- PROPOSED CROSS SECTION LOCATION
- CCR UNIT BERM ALIGNMENT

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

9

DRAFT

0 200

APPROXIMATE SCALE FEET

N

DYNEGY, INC	PROJECT NO. 60428794
AECOM	
DRN. BY: djd July 2015 DSGN. BY: eg CHKD. BY: eg	Hennepin Old West Polishing Pond Field Investigation Plan
	FIG. NO. D-04

File: P:\PROJECTS\GEOTECH\DYNEGY – BALDWIN 2014\CCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 1 BORING LOCATION PLAN (HENNEPIN OLD WEST ASH POND NO. 1 AND NO. 3).DWG Last edited: JUL. 15, 15 @ 11:19 a.m. by: david_deguire

PRIVILEGED & CONFIDENTIAL - ATTORNEY CLIENT PRIVILEGED

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B001

Date(s) Drilled	10/08/2015 to 10/08/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	56.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	7 6 6	67		Medium dense, dry, brown, clayey GRAVEL (GC) [Fill].					2.0			
					2.5								
	SS-2	4 4 4	100		Loose, dry, brown, clayey SAND (SC) [Fill].					0.5			
5					5.0								
	SS-3	3 4 5			Soft, moist, brown, sandy lean CLAY (CL).					0.5			
	ST-4		100							2.0			*Pushed shelby tube from 7.5 to 9.5 feet*
10	SS-5	WOH 3 3	89							0.5			*10.0 feet of casing set*
15					15.0								
	SS-6	WOH	44		Very soft, moist to wet, gray, SILT (ML).								
20	ST-7		90							0.25			*Pushed shelby tube from 20.0 to 22.0 feet*
25					25.0								
	SS-8	WOH	89		Very soft, moist to wet, dark gray mottled with brown, clayey SILT (ML-CL), trace white shells.					0.25			
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:19 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B001

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH 3 4	22							0.25			
35	SS-10	3 3 4	100		35.0 Medium dense, wet, black to dark gray, lean CLAY (CL).					0.25			
40	SS-11	WOH WOH 4	100							0.25			
45	SS-12	6 3 3	78		45.0 Medium dense, wet, dark gray, sandy SILT (ML) with wood fragments.					0.25			*45.1 feet: Sand seam from 45.1 to 45.2 feet*
50	SS-13	6 6 8	56		50.0 Very dense, wet, gray, silty SAND (SM), trace fine to coarse gravel.								
55	SS-14	43 37 47	67		55.0 Very dense, wet, brown, clayey fine to coarse GRAVEL (GC).								
					56.5 End of Boring at 56.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:19 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B002

Sheet 1 of 2

Date(s) Drilled	10/07/2015 to 10/08/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	60.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	10.0 ft on 10/8/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	14 15 17	100		Medium dense, dry, brown, clayey fine to coarse GRAVEL (GC)	0.0								
	SS	SS-2	28 27 12	100											
5	SS	SS-3	9 21 24	100		Hard, dry, black to dark gray, clayey SILT (ML-CL), trace fine to coarse gravel.	5.5 6.5								
	SS	SS-4	10 5 5	78		Stiff, dry brown, sandy lean CLAY (CL) with fine to coarse gravel.						0.5 1.5			
10	SS	SS-5	6 4 3	0											*10.0 feet of casing set* *Drove wood in Sample 5, no recovery*
15	SS	SS-6	5 5 3	22		Loose to medium dense, moist to wet, brown, silty SAND (SM), trace fine to coarse gravel.	15.0								
20	SS	SS-7	4 4 4	67		Loose, moist to wet, brown, clayey SAND (SC).	20.0 20.8					0.5 <0.25			
						Ash, medium dense, wet, gray, SILT (ML) [Fill].									
25	ST	ST-8		100								0.25 0.5			*Pushed shelby tube from 25.0 to 27.0 feet*
30							30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:25 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B002

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	1 3 3	94		Soft to medium, wet, dark gray mottled with brown, lean CLAY (CL), trace shell fragments.					0.25 0.5			
35	ST-10		80							0.25 0.5			*Pushed shelby tube from 35.0 to 37.0 feet*
40	SS-11	WOH 2 7	100		40.0 Very soft to medium, wet, black, lean CLAY (CL), trace wood fragments.					0.5 0.75			
45	SS-12	2 5 7	94		45.0 Medium dense, moist, black, SILT (ML) with wood fragments, trace shells. 46.0 Medium dense, wet, dark gray, CLAYEY SAND (SC).					0.5			
50	SS-13	4 11 11	100		50.0 Medium dense, gray, well graded medium to fine SAND (SW).								
55	SS-14	18 17 23	100		55.0 Dense, wet, brown, well graded SAND (SW), little fine to coarse gravel.								
60	SS-15	54/6"			60.0 Very dense, wet, well graded GRAVEL (GW). 61.5 End of Boring at 60.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:25 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B003

Sheet 1 of 2

Date(s) Drilled	10/06/2015 to 10/06/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	57.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	0.0 ft on 10/6/2015		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	WOH	33		Ash, very stiff, moist to wet, gray, sandy SILT (ML) [Fill].					<0.25			
	SS-2	WOR	100							<0.25			
5	SS-3	WOR	100							<0.25			
	SS-4	WOR	100							<0.25			
10	ST-5		100							<0.25			*Pushed shelby tube from 10.0 to 12.0 feet*
15					15.0								
	SS-6	WOH WOH 4	89		Very soft, moist to wet, dark gray to black, clayey SILT (CL-ML).					<0.25			
20	SS-7	WOH	94							<0.25			*Mottled with dark brown and trace shells in Sample 7*
25	ST-8		100							0.5			*Pushed shelby tube from 25.0 to 27.0 feet*
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:30 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B003

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH 3 4	100							0.5			*Wood fragments in Sample 9*
35	SS-10	WOH WOH 3	100							0.5			
40	SS-11	10 8 7	56		40.0 Medium dense, wet, gray, silty fine SAND (SM).								
45	SS-12	20 26 16	44		45.0 Dense to very dense, wet, grayish brown to brown, silty fine to coarse GRAVEL (GM).								
50	SS-13	30 47 50											
55					57.5 End of Boring at 57.5 ft								*Boring backfilled with Portland Cement and bentonite*
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:30 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B004

Sheet 1 of 2

Date(s) Drilled	10/02/2015 to 10/02/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	46.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	20.0 ft on 10/5/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS	SS-1	9 14 18	100		Brown, silty GRAVEL (GM) [Fill].	0.5								
						Dense, brown, clayey fine to medium coarse GRAVEL (GC).									
	SS	SS-2	32 18 30	100											
5	SS	SS-3	13 40 42	33											
							7.5								
	SS	SS-4	5 7 8	100		Stiff, dry, gray, SILT (ML), trace fine to coarse gravel.						1.5 3.0			
10	ST	ST-5		50								<0.5			*Pushed shelby tube from 10.0 to 12.0 feet*
							15.0								
15	SS	SS-6	2 3 1	67		Medium dense to soft, moist, brown, lean CLAY (CL) with sand.						<0.5			
20	ST	ST-7		67								0.5			*Pushed shelby tube from 20.0 to 22.0 feet*
							25.0								
25	SS	SS-8	WOH WOH WOH	100		Clayey silt, gray, very soft, moist, clayey SILT (CL-ML).						0.5			
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:36 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B004

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	ST-9		79							0.25			*Pushed shelby tube from 30.0 to 32.0 feet*
					35.0								
35	SS-10	2 2 4	89		Soft, wet, brownish gray, sandy SILT (ML).					0.5			*38.0 feet: Drillers Note - hard drilling*
					40.0								
40	SS-11	7 10 23	83		Medium dense, wet, brown, clayey GRAVEL (GC).								
45	SS-12	30 30 29	78		46.5								
					End of Boring at 46.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:36 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B005

Sheet 1 of 1

Date(s) Drilled	09/24/2015 to 09/24/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	28.5 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
Boring Location	East due to sunken barge (ft NAD83)	Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0 Barge.								
					1.5 Water.								
					4.0								
5	SS-1	WOH 1 2 1	33		Dark gray to black silty SAND (SM), some organics and clay.								
					7.5								
	ST-2		83		Dark gray silty organic CLAY (OH), some sand.					0.5			
10	SS-3	WOH WOH WOH	56										
	ST-4		92							0.5			
					14.5								
15	SS-5	3 3 2	33		Dark green, gravelly CLAY (CL), trace sand and silt.								
					19.0								
20	SS-6	7 6 12	11		Green to dark green fine to coarse SAND and gravel (SP-GP), trace silt.								
25	SS-7	6 5 9	17										
					28.5 End of Boring at 28.5 ft								*28.0 feet: Drillers Note - obstruction or boulder*
30													

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B006

Date(s) Drilled	10/13/2015 to 10/13/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	25 26 22	78		Dense, dry, brown, clayey fine to coarse GRAVEL (GC).	0.0								
	SS	SS-2	15 17 26	100								0.5 1.5			
5	SS	SS-3	15 23 15	78			7.5								
	SS	SS-4	5 7 8	89		Medium dense, dry, brown, clayey SAND (SC), little fine to coarse gravel.						0.5 1.5			
10	SS	SS-5	7 6 7	89								0.25			
15	SS	SS-6	8 9 11	78								0.25			
20	SS	SS-7	13 12 20	89		Medium dense, moist to wet, brown, well graded fine to coarse GRAVEL (GW), trace fines and sand.	20.0								
25	SS	SS-8	39 43 43	44		Very dense, moist to wet, brown, fine to coarse GRAVE (GM) with sand.	25.0								
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:44 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B006

Sheet 2 of 2

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	29 32 30	67										
35	SS-10	9 9 9	33		35.0 Medium dense, moist to wet, yellowish brown, silty fine to coarse GRAVEL (GM), little fine to coarse sand.								
40	SS-11	10 8 6	22		41.5 End of Boring at 41.5 ft								*Boring backfilled with 95 pounds of Portland Cement and 25 pounds of bentonite*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:45 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B007

Sheet 1 of 1

Date(s) Drilled	09/23/2015 to 09/23/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	21.5 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0 Barge.								
					1.5 Water.								
					3.5								
	SS-1	WOR 1 3	11		Dark gray to brown, fine SAND and organic CLAY (OH-SP).								
5	SS-2	7 7 4	56		5.5 Dark gray organic CLAY (OH), trace sand.								
					7.5								
	SS-3	20 24 33	33		Brown to black, fine to coarse SAND and GRAVEL (SP-GP), trace silt.								*7.5 feet: Drillers Note - harder drilling*
10	SS-4	16 19 8	56		11.0 Brown, clayey GRAVEL (GC), trace silt and sand.								
	SS-5	12 12 13	33		14.5								
15	SS-6	8 15 17	44		Brown, fine to coarse SAND and GRAVEL (SP-GP), some clay.								
20	SS-7	10 9 6	17		21.5 End of Boring at 21.5 ft								*Boring backfilled with bentonite cement fluid*
25													
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:50 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B008

Sheet 1 of 1

Date(s) Drilled	10/13/2015 to 10/13/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	21.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	17.0 ft on 10/13/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS-1		1 2 2	100		Ash, gray sandy SILT (ML) [Fill].						0.50			
	SS-2		2 3 3	94								0.50			
5	SS-3		11 7 5	100								0.50			*5.5 feet: Wet layer from 5.5 to 6.0 feet*
							7.5								
	ST-4			100		Very stiff, dry, brown, lean CLAY (CL), few fine to coarse gravel.						4.0			*Pushed shelby tube from 7.5 to 9.5 feet*
10	SS-5		9 9 23	67											
							15.0								
15	SS-6		13 15 19	78		Medium dense, moist to dry, brown, well graded fine to coarse GRAVEL (GW) with sand, trace fines.									*17.0 feet: Drillers note - water*
							20.0								
20	SS-7		14 41 42	67		Very dense, brown, well graded fine to coarse GRAVEL (GW-GM) with silt.									
							21.5								
						End of Boring at 21.5 ft									*Boring backfilled with 49 pounds of Portland Cement and 15 pounds of bentonite*
25															
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:53 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B009

Sheet 1 of 2

Date(s) Drilled	10/13/2015 to 10/13/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	51.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	5 7 10	78		Gravelly lean CLAY (CL) with sand.	0.0					2.0			
	SS	SS-2	17 22 29	100								1.5			
5	SS	SS-3	26 50/5"	61		Dry, black to dark gray, fine to coarse gravelly SILT (ML), trace coal.	5.0					0.25			
	SS	SS-4	17 10 17	89		Stiff to very stiff, dry, black and dark brown, sandy lean CLAY (CL), trace fine to coarse gravel.	7.5					1.5 2.0			
10	SS	SS-5	4 5 6	78		Stiff, dry to moist, reddish brown, lean CLAY (CL) with sand, trace fine to coarse gravel.	10.0					.75 1.75			*12.5 feet: Drillers Note - hard drilling*
15	SS	SS-6	27 31 29	78		Very dense, dry to moist, brown, well graded SAND (SW-SM) with silt, and fine to coarse gravel.	15.0								
20	SS	SS-7	23 27 25	94		Very dense, moist to wet, brown, well graded fine to coarse GRAVEL (GW-GM) with silt, little fine to coarse sand.	20.0								
25	SS	SS-8	22 22 22	100		Dense, moist to wet, brown, well graded fine to coarse SAND (SW).	25.0								
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:56 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B009

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	20 28 28	100										
35	SS-10	4 5 7	100		35.0 Brown lean CLAY (CL). 35.5 Brown silty SAND (SM). 36.0 Brown sandy SILT (ML).					0.25 0.75			
40	SS-11	9 9 12	100		40.0 Medium dense, moist to wet, brown, well graded SAND (SW).								
45	SS-12	9 10 11	94		45.0 Brown SILT (ML). 45.5 Wet, brown, well graded SAND (SW-SM) with silt.					0.5			
50	SS-13	12 30 20	67		50.0 Dense to very dense, wet, brown, clayey fine to coarse GRAVEL (GC). 51.5 End of Boring at 51.5 ft								*Boring backfilled with 94 pounds of Portland cement and 25 pounds of bentonite*
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:56 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B010

Sheet 1 of 2

Date(s) Drilled	10/07/2015 to 10/07/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	19 30 23	100		Dense, dry, brown, clayey fine to coarse GRAVEL (GC).		0.0								
								2.5								
	SS	SS-2	10 24 20	100		Hard, dry, brown, cohesive sandy lean CLAY (CL), trace fine to coarse gravel.		3.5					1.5 2.0			
						Dense, dry, brown, clayey fine to coarse GRAVEL (GC).		5.0								
5	SS	SS-3	12 17 22	100		Very stiff to hard, dry, black to dark gray SILT (ML).							0.2 0.5			
								7.5								
	SS	SS-4	15 19 17	100		Hard, dry, black to dark gray, sandy SILT (ML), trace black coal fragments.							0.5			
10	ST	ST-5		94									4.0			*Pushed shelby tube from 10.0 to 11.5 feet*
15	SS	SS-6	4 3 4	61		Medium, moist, dark brown, sandy lean CLAY (CL).		15.0					.75			
								20.0								
20	SS	SS-7	10 11 15	56		Medium dense, moist to wet, brown, well graded SAND (SW), trace to little fine to coarse gravel.										
25	SS	SS-8	20 13 13	56												
30								30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:01 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B010

Sheet 2 of 2

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	25 28 30	67		Very dense, wet, brown, well graded fine to coarse GRAVEL (GW-GM) with silt and sand.								
35	SS-10	15 18 25	89		35.0 Dense, wet, brown, well graded fine to coarse SAND (SW), trace fine to coarse gravel.								
40	SS-11	10 9 10	67		41.5 End of Boring at 41.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:02 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B011

Sheet 1 of 1

Date(s) Drilled	10/06/2015 to 10/06/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	21.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	7.0 ft on 10/7/2015		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	4 6 11	100		Stiff, dry, dark brown, sandy lean CLAY (CL), trace fine to coarse gravel.					0.75			
	SS-2	5 5 8	100							1.0			*4.0 feet: Drillers Note - rock*
5	SS-3	9 6 6	100		5.5 Medium dense, wet, brown, poorly graded SAND (SP), trace gravel.								*6.0 feet: Drillers Note - wet at 6.0 feet WD with HSA*
	SS-4	11 12 12	78										
10	SS-5	14 15 20	78		10.0 Medium dense, wet, brown, well graded SAND (SW) with fine to coarse gravel.								
15	SS-6	13 26 27	78		15.0 Dense, wet, brown, silty fine to coarse GRAVEL (GM) with fine to coarse sand.								
20	SS-7	20 33 32	6		21.5 End of Boring at 21.5 ft								*20.0 feet: Drillers Note - pushed rock in Sample 7* *Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
25													
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:07 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B012

Sheet 1 of 2

Date(s) Drilled	10/07/2015 to 10/07/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	46.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	7 9 15	44		Medium dense, dry, brown, clayey fine to coarse GRAVEL (GC).								
	SS-2	12 17 17	100							1.0 2.5			
5	SS-3	4 13 21	89							0.5 2.0			
	SS-4	9 9 27	89		8.0 Dry, brown to dark gray, sandy lean CLAY to clayey silt (CL-ML).					1.0			
10	SS-5	5 8 7	78		10.0 Stiff, moist, brown and black, sandy lean CLAY (CL).					1.0 2.0			
15	SS-6	11 19 28			15.0 Hard, moist, dark gray to black, sandy SILT (ML) with Ash [Fill].								
20	ST-7		87.5							1.0			*Pushed shelby tube from 20.0 to 22.0 feet*
25	SS-8	2 3 5	78		25.0 Medium, moist, black lean CLAY (CL).					0.75 1.0			
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:10 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B012

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	ST-9		95		31.0 Soft, moist to wet, yellowish brown mottled with gray and brown, lean CLAY (CL).					0.5			*Pushed shelby tube from 30.0 to 32.0 feet*
35	SS-10	WOH 4 5	94							0.75			
40	SS-11	10 17 11	67		40.0 Medium dense, moist to wet, brown, clayey fine to coarse GRAVEL (GC).								
45	SS-12	18 18 17	44		46.5 End of Boring at 46.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:10 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B014

Sheet 1 of 2

Date(s) Drilled	10/12/2015 to 10/12/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	61.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS	SS-1	19 20 18	78		Dense, brown, clayey fine to coarse GRAVEL (GC) [Fill].									
	SS	SS-2	15 30 17	67											
5	SS	SS-3	4 7 5	89			5.5					0.4			
						Stiff, moist, brown, SILT (ML).	7.5								
	SS	SS-4	13 14 18	100		Very stiff, dry to moist, dark gray, sandy SILT (ML) with Ash, trace fine to coarse gravel [Fill].						0.25 0.75			
10	SS	SS-5	8 11 13	78			11.0					0.5			
						Very stiff, moist, dark gray SILT (ML).									
15	SS	SS-6	5 6 6	100			16.0					0.25 1.5			
						Stiff, moist, black, lean CLAY (CL).	20.0								
20	SS	SS-7	WOH 2 4	100		Soft, wet, dark gray to greenish gray, silty CLAY (CL-ML).						0.25			
25	ST	ST-8		65								0.25			*Pushed shelby tube from 25.0 to 27.0 feet*
30							30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:15 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B014

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH WOH 4	100		Very soft, moist to wet, dark gray, lean to silty CLAY (CL-ML).					0.25 0.5			
35	ST-10		100							0.5			*Pushed shelby tube from 35.0 to 37.0 feet*
40	SS-11	WOH 5 6	100		40.0 Soft, moist, dark gray to black SILT (ML), trace wood fragments.					0.5			
45	SS-12	2 7 10	89		45.0 Medium dense to dense, wet, gray, silty SAND (SM).								
50	SS-13	13 17 16	78										*Trace fine to coarse gravel in Sample 13*
55	SS-14	46 52 37	78		55.0 Very dense, wet, light gray to light brown, silty fine to coarse GRAVEL (GM) with fine to coarse sand.								
60	SS-15	27 40 38	67		61.5 End of Boring at 61.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:16 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B015

Date(s) Drilled	10/05/2015 to 10/06/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	46.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	3.0 ft on 10/5/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS	1	3 3 5	67		Black topsoil, lean CLAY (CL).	0.5					0.25			
						Loose, moist, brown, clayey SAND (SC).	2.5								
	SS	2	6 8 12	100		Stiff, moist, black, lean CLAY (CL).						2.0 3.0			
5							5.0								
	SS	3	3 6 5	100		Stiff, moist, dark gray, clayey SILT (CL-ML).						0.5 0.75			
	ST	4		80								0.5			*Pushed shelby tube from 7.5 to 9.5 feet*
10	SS	5	WOH 2 1	100								0.25			
15	SS	6	1 2 3	78								0.25			
20	SS	7	WOH	89								0.25			
25	ST	8		95								0.25			*Pushed shelby tube from 25.0 to 27.0 feet*
30							30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:21 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B015

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH 2 5	100		Soft, wet, dark gray SILT (ML), trace wood and shells, occasional sand seam.					0.25			
35	SS-10	2 3 7	100		35.2 Medium dense, wet, well graded SAND (SW).								
40	SS-11	21 27 20	56		39.0 Dense to very dense, moist to wet, brown to grayish brown, silty fine to coarse GRAVEL (GM), little sand.								*39.0 feet: Drillers Note - change in drilling*
45	SS-12	24 53 50	89		46.5 End of Boring at 46.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:21 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B016

Sheet 1 of 3

Date(s) Drilled	10/09/2015 to 10/12/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	76.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	21 21 13	100		Dense to very dense, dry, brown, clayey fine to coarse GRAVEL (GC).								
	SS-2	18 33 18	100										
5	SS-3	10 9 19	100										
	SS-4	28 23 36	100							2.5 3.0			
10					10.0								
	SS-5	15 9 3	67		Stiff to very stiff, moist, black to dark gray, sandy SILT (ML) with Ash, trace hard ash pieces [Fill].					0.25			
15					15.0								
	SS-6	4 5 3	100		Medium to stiff, moist, black, lean CLAY (CL), some wood fragments.					0.25 0.5			
20					20.0								
	ST-7		100		Soft, black to dark gray silty CLAY (ML-CL).					0.25			*Pushed shelby tube from 20.0 to 22.0 feet*
25					25.0								
	SS-8	WOH WOH 2	100		Soft, wet, grayish brown mottled with brown to dark gray, lean CLAY (CL).					0.25			
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:27 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B016

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH WOH 4	83							0.25 0.5			
35	ST-10		100							0.25			*Pushed shelby tube from 35.0 to 37.0 feet*
40	SS-11	WOH 2 4	67		40.0 Very soft, wet, dark gray, SILT (ML), trace shells.					0.25			
45	SS-12	WOH WOH WOH	22							0.25			
50	SS-13	3 7 8	67		51.0 Medium dense, wet, gray, silty SAND (SM), trace fine gravel.								
55	SS-14	8 8 10	56										
60	SS-15	WOR WOH WOH	100		60.0 Very soft, wet, clayey SILT (CL-ML), trace shells.					0.25			
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:27 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B016

Sheet 3 of 3

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	SS-16	WOR WOH WOH	100										
					67.0 — Dense, wet, gray, well graded fine to coarse GRAVEL (GW-GM) with sand.								*67.0 feet: Drillers Note - change in drilling*
70	SS-17	19 16 15	44										
75	SS-18	22 28 39	44		76.5 — End of Boring at 76.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
80													
85													
90													
95													
100													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:27 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B017

Sheet 1 of 3

Date(s) Drilled	10/05/2015 to 10/05/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	66.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	3.0 ft on 10/5/2015		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	2 4 3	67		Topsoil, lean CLAY (CL). 0.5 Soft, moist, brown, lean CLAY (CL) with sand.					<0.5			
					2.5								
	SS-2	6 9 12	100		Stiff to soft, moist to wet, black, clayey SILT (ML-CL).					1.25			
5	ST-3		87										*Pushed shelby tube from 5.0 to 7.0 feet*
	SS-4	2 2 3	100							0.25			*Trace sand seams in Samples 4, 5, 7, and 8*
10	SS-5	WOH WOH 2	78							0.25			
15	ST-6		75							0.25			*Pushed shelby tube from 15.0 to 17.0 feet*
20	SS-7	WOH	100							0.25			
25	SS-8	WOR WOH WOH	100							0.25			
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:34 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B017

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	ST-9		95							0.75			*Pushed shelby tube from 30.0 to 32.0 feet*
35	SS-10	WOH	100							0.5			*Trace sand seams and shells in Samples 10 and 11*
40	SS-11	1 6 6	100		40.5 Medium dense, wet, dark gray, silty fine to coarse SAND (SM), trace shells and gravel.					0.25 0.5			
45	SS-12	3 7 7	78										
50	SS-13	WOR WOH WOH	100		50.0 Very soft, wet, dark gray, clayey SILT (CL-ML), trace shells.					0.25			
55	SS-14	WOR WOH WOH	100							0.25			
60	SS-15	15 16 15	67		58.0 Dense, wet, gray, well graded fine to coarse GRAVEL (GW).								*58.0 feet: Drillers Note - change in drilling*
65					65.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:35 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B017

Sheet 3 of 3

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	SS-16	17 16 20			Dense, wet, grayish brown to light to medium gray, well graded fine to coarse GRAVEL (GW-GC) with clay. 66.5								
					End of Boring at 66.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
70													
75													
80													
85													
90													
95													
100													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:35 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B018

Date(s) Drilled	10/08/2015 to 10/09/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	71.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	15.0 ft on 10/9/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	25 25 26	100		Very dense, dry, brown, clayey fine to coarse GRAVEL (GC)						4.0			
	SS	SS-2	42 34 18	100			3.5					4.0			
						Brown to black clayey SAND to lean CLAY (SC-CL).	5.0								
5	SS	SS-3	12 35 22	100		Very dense, dry, brown, clayey fine to coarse GRAVEL (GC), trace black ash at bottom.	6.5					4.0			
	SS	SS-4	4 4 10	100		Stiff, moist, dark gray, sandy SILT (ML) with Ash [Fill].						0.25			
10	ST	ST-5		85								1.5			*Pushed shelby tube from 10.0 to 12.0 feet*
15	SS	SS-6	WOH 2 3	100		Very soft to soft, moist, black to dark gray, silty CLAY (CL-ML).	15.0					0.25			
20	SS	SS-7	WOH WOH 3	100								0.25			*Trace shells in Sample 7*
25	ST	ST-8		70								0.25			*Pushed shelby tube from 25.0 to 27.0 feet*
30							30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:42 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B018

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH WOH 4	100		Very soft, moist to wet, dark gray and trace black, lean CLAY (CL).					0.25			
35	SS-10	WOH	100		35.0 Very soft, wet, dark gray, clayey SILT (CL-ML), trace shells.					0.25			
40	ST-11		100							0.5			*Pushed shelby tube from 40.0 to 42.0 feet*
45	SS-12	WOH WOH WOH	100							0.25			
50	SS-13	WOH 3 4	33		50.0 Loose to medium dense, wet, dark gray, sandy SILT (SM).								
55	SS-14	4 6 12	67										
60	SS-15	WOH WOH WOH	100		60.0 Very soft, wet, dark gray, silty CLAY (CL-ML), trace shells.					0.25			
65					65.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:43 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B018

Sheet 3 of 3

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	SS-16	53 37 44	67		Very dense, wet, gray, silty fine to coarse GRAVEL (GM).								
70	SS-17	23 21 19	67		71.5 End of Boring at 71.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
75													
80													
85													
90													
95													
100													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:43 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B019

Sheet 1 of 2

Date(s) Drilled	09/24/2015 to 09/24/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	55.5 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					Barge.	0.0								
					Water.	1.5								
						4.0								
5	SS-1	1	33		Dark brown fine to coarse SAND and GRAVEL (SP-GP).	4.3								
					Soft to stiff, dark gray organic silty CLAY (OH).									
	ST-2		80								0.25			*Pushed shelby tube from 7.5 to 9.5 feet*
10	SS-3	WOR WOH 1	56								0.5			
	ST-4		85								1.5			*Pushed shelby tube from 12.5 to 14.5 feet*
						14.5								
15	SS-5	1 2 2	83		Stiff to medium, dark gray silty CLAY (CL), trace organics and shells.						1.0			
20	ST-6		100								0.75			*Pushed shelby tube from 20.0 to 22.0 feet*
25	ST-7		100								1.0			*Pushed shelby tube from 25.0 to 27.0 feet*
30														

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:50 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B019

Sheet 2 of 2

Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-8	1 2 2	100							1.25			
35	SS-9	1 1 2	100		36.0					1.0			
					Loose, dark gray clayey fine SAND (SC), trace silt.								
40	SS-10	6 7 6	78		40.0 Medium dense fine SAND (SP), trace silt.								
45	SS-11	5 3 3	78		45.0 Medium dense, dark gray silty CLAY (CL), trace shells and organics.					0.75			
50	SS-12	1 1 2	67							0.75			
55	SS-13	7 14 16	11		54.0 Medium dense, dark gray fine to coarse SAND and GRAVEL (SP-GP). 55.5 End of Boring at 55.5 ft								*Boring backfilled with bentonite and cement fluid*
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:50 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B020

Date(s) Drilled	10/01/2015 to 10/02/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 50 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS-1	19 17 13	56		Gravel (GP). 0.3 Lean CLAY (CL), trace fine to coarse gravel. 2.5								
	SS-2	6 8 7	67		Medium dense, moist, brown, clayey fine to coarse GRAVEL (GC). 5.0					0.0 1.0			
5	SS-3	6 8 7	83		Stiff, moist, sandy lean CLAY (CL), trace fine to coarse gravel.					1.5			
	SS-4	1 3 4	78							1.0			
10	ST-5		52										*Pushed shelby tube from 9.5 to 11.5 feet*
15	SS-6	5 3 7	6		Loose, brown well graded GRAVEL (GW). 15.0								*17.0 feet: Drillers Note - cobbles from 17.0 to 20.0 feet*
20	SS-7	30 48 50/5"	72		Dry, brown with some rust and black, well graded SAND (SW) with gravel [Fill]. 20.0								
25	SS-8	22 33 29	67		Very dense, dry, brown clayey GRAVEL (GC), little sand. 25.0								
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:56 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B020

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	27 19 22	78											
35	SS-10	19 27 20	78											
40	SS-11	15 16 41	56		End of Boring at 41.5 ft	41.5								*Less fines in Sample 11* *Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
45														
50														
55														
60														
65														

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:56 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B021

Sheet 1 of 2

Date(s) Drilled	10/01/2015 to 10/02/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	45.1 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	80/6"	17		Topsoil, lean CLAY (CL).								
					2.5								
	SS-2	6 5 4	44		Stiff, brown, sandy lean CLAY (CL), trace fine to coarse gravel.					<0.5			
5	ST-3									2.0			*Pushed shelby tube from 5.0 to 6.0 feet*
	SS-4	10 61	83		8.3								
					Very dense, dry, brown, silty GRAVEL (GM).								
10					10.0								
	SS-5	14 14 12	67		Medium dense, moist, brown, clayey GRAVEL (GC).								
15					15.0								
	SS-6	20 15 19	44		Stiff, moist, dark brown to gray and black, medium plastic cohesive lean CLAY (CL).					<0.5			
20					20.0								
	SS-7	9 12 9	100		Very stiff, moist, gray to black, sandy SILT (ML) with Ash [Fill].					1.0			
	ST-8		72										*Pushed shelby tube from 22.0 to 24.0 feet*
25	SS-9	6 20 32	100							<0.5			
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:01 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B021

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-10	11 20 24	94								0.5			*Less sand in Sample 10*
35	SS-11	4 8 10	100		Stiff, moist, black, lean CLAY (CL) with Ash, trace to little sand [Fill].	35.0					2.5			
40	SS-12	5 6 5	100		Medium dense, moist to wet, brown, silty SAND (SM).	40.0								
45	SS-13	50/2"	0		End of Boring at 45.1 ft	45.1								*45.0 feet: Drillers Note - hit rock Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
50														
55														
60														
65														

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:01 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B022

Sheet 1 of 1

Date(s) Drilled	09/23/2015 to 09/23/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Hollow-Stem Auger	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	21.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Drill Cuttings and Bentonite Chips	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	1 1 1	100		Very soft, moist, brown to dark gray, sandy SILT (ML).					0.0 0.5			*0.0 feet: Trace roots from 0.0 ot 0.5 feet*
	ST-2		71										*Pushed shelby tube from 2.5 to 4.5 feet*
5					5.0								
	SS-3	2 2 2	100		Soft, moist, dark gray, SILT (ML).					0.5			
					6.3								
	ST-4		100		Stiff, dry, dark gray, silty SAND (SM) with Ash [Fill].								*Pushed shelby tube from 7.5 to 9.5 feet*
10	SS-5	5 5 6	67							0.0 0.5			
15					15.0								
	SS-6	21 25 20	100		Dense, dry, dark brown to black, silty SAND (SM) with Ash [Fill].					0.0 0.75			
20					20.0								
	SS-7	3 4 5	100		Stiff, moist, brown, sandy lean CLAY (CL).					1.0 1.25			
					21.5								
					End of Boring at 21.5 ft								*Boring backfilled with 75 pounds of bentonite chips and soil cuttings*
25													
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:07 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B023

Sheet 1 of 3

Date(s) Drilled	09/22/2015 to 09/23/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	76.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	7 11 15	100		Dense, moist, brown, fine to medium sandy silty GRAVEL (GM) [Fill]								
					2.0								
	SS-2	8 15 18	100		Stiff to hard, moist, sandy silty CALY (CL) with medium to coarse gravel [Fill]. Grades with medium brown sand in occasional lenses. Grades with zones of high plastic clay.					4.5			
5	SS-3	10 27 18	100							3.5 4.25			
	SS-4	7 17 20	100							4.5			
					9.5								
10	SS-5	13 12 10	83		Medium dense, moist, brown clayey silty fine to medium SAND (SM) [Fill].					4.5			
					11.0								
					Hard, moist, brown, silty sandy CLAY (CL) with fine to medium gravel [Fill].								
					13.0								
					Medium dense, moist, brown fine to medium GRAVEL with sand and clay lenses [Fill].								
15	SS-6	22 32 52	83										
					18.0								
					Moist, dark gray to black, silt to fine gravel sized fly / bottom ASH [Fill].								
20	SS-7	51 39 26	94										
					23.0								
					Moist to wet, dark gray, silt sized fly ash with some sand to small gravel sized FLY ASH particles [Fill].								
25	SS-8	4 6 5	83							0.0 0.25			
	ST-9		63										
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:10 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B023

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-10	15 11 11	100							0.25 0.5			
					33.0								
					Medium dense to dense, moist, dark gray to black, silty sand to small gravel sized bottom ASH [Fill].								
35	SS-11	20 36 53	100							0.5 3.5			
					40.0								
40	SS-12	14 11 12	100		Medium dense, moist to wet, dark gray to black, silty SAND (SM), trace gravel and ash [Fill].					0.5 1.3			
					44.0								
45	SS-13	7 4 14	33		Very stiff, wet, brown, sandy lean CLAY (CL) with fine to coarse gravel.					0.5			
					50.0								
50	SS-14	34 52	83		Very dense, wet, brown, clayey fine to coarse angular GRAVEL (GC) with sand.								
55	SS-15	18 11 8	78										
60	SS-16	11 7 8	17										
65					65.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:10 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B023

Sheet 3 of 3

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	SS-17	6 4 5	67		Loose, wet, brown, silty fine to coarse GRAVEL (GM).								
70					70.0								
	SS-18	19 19 13	67		Dense, wet, brown, silty fine to coarse GRAVEL (GM) with fine sand.								*70.6 feet: Sand seam from 70.6 to 71.0 feet*
75					75.0								
	SS-19	18 17 9	33		Medium dense, wet, silty fine to coarse GRAVEL (GM).								
					76.5								
					End of Boring at 76.5 ft								*Boring backfilled with 94 pounds of Portland Type I Cement*
80													
85													
90													
95													
100													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:10 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B024

Date(s) Drilled	09/22/2015 to 09/22/2015	Logged By	Andrew Wilding	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	62.7 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0								0.0								
	SS	1	14 15 15	100		Dense, moist, brown fine to medium silty GRAVEL [Fill].										
	SS	2	19 23 18	100												
								4.5								
5	SS	3	5 7 15	100		Stiff, moist, brown silty CLAY with some medium gravel and sand [Fill].		5.8					3.5			
						Medium dense, moist, brown, silty medium SAND, trace organics [Fill].		7.0								
	SS	4	4 15 23	78		Medium stiff, moist, brown, silty SAND, with some small to medium gravel [Fill].							2.25 3.0			
								9.5								
10	SS	5	10 12 16	78		Medium stiff, moist, dark gray, clayey SILT with medium to coarse sand, some gravel (presumably fly ash) and seams of brown silty clay [Fill].							4.0 4.5			
								13.0								
						Dense, moist, dark gray to black fine to coarse sand sized bottom ASH with some fine gravel [Fill].										
15	SS	6	13 20 29	94												
						Grades with fine gravel.										
20	SS	7	75/0.3'	38												
								22.0								
						Very soft, moist to wet, dark gray silt to fine sand sized FLY ASH [Fill].										
25	SS	4	3 2 3	100												
	ST	9		57												*Pushed shebly tube from 27.0 to 29.0 feet* *Shelby tube refusal at 29.2*
30																

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:18 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B024

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-10	1 3 2	100		Grades with thin, hard cemented layers.								
35	SS-11	5 9 12	100							0.5			
					39.0 Medium dense, wet, sandy silty fine to coarse GRAVEL (GM).								
40	SS-12	55/6"	50										
45	SS-13	22 27 21	78										
50	SS-14	15 18 15	50		Grades with ~1" silty clay layers and zones of silty clay matrix (silty clay, brownish gray, soft to medium stiff, moist).								
55	SS-15	55/0.2'	0										
					58.0 Medium dense, moist, silty SAND (SM) with trace to fine medium gravel.								
60	SS-16	20 22 13	78										
					62.0 Wet, sandy fine to medium, rounded GRAVEL (GP). 62.7								
	SS-17	80/0.1'	17		End of Boring at 62.7 ft								*Boring backfilled with Portland Type I cement*
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:18 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B025

Sheet 1 of 2

Date(s) Drilled	10/01/2015 to 10/01/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	56.5 ft
Drill Rig Type	Mobile 50 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS-1	23 19 22	56		Medium dense, dry, brown, silty SAND (SM) with gravel [Road Fill].		0.0								
							2.5								
	SS-2	5 7 9	72		Stiff, dry, brown, lean CLAY (CL).							3.0			
5	SS-3	14 26 19	78		Dense, dry, silty GRAVEL (GM) with sand [Fill].		5.0								
							7.5								
	SS-4	2 2 2	89		Soft, gray with some black SILT (ML) to very fine silty SAND (SM).							<0.5			
10	SS-5	2 3 4	33									0.5			*Pushed shelby tube from 10.5 to 14.0 feet*
	ST-6		100									1.0			
15	SS-7	2 3 2	56									<0.5			
							20.0								
20	SS-8	9 5 3	56		Stiff, moist to wet, gray with some black layering, sandy SILT (ML).							<0.5			
25	ST-9		100												*Pushed shelby tube from 25.0 to 27.0 feet*
	SS-10	4 4 5	56									1.0			
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:23 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B025

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-11	3 4 5	67							<0.5			
35	SS-12	5 7 7	72							1.0			
40	SS-13	6 12 11	61							1.1			
45	SS-14	6 7 8	83							1.0			
50	SS-15	7 8 10	89							0.5 1.5			
55	SS-16	10 12 13	94		55.0 Very stiff, moist to wet, black, gray and some dark brown, sandy SILT (ML). 56.5 End of Boring at 56.5 ft					3.5 4.0			*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:23 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B026

Sheet 1 of 1

Date(s) Drilled	09/23/2015 to 09/23/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	12.0 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0						Barge.	0.0								
						Water.	1.5								
							4.0								
5	SS-1		4 5 7	56		Dark brown fine to coarse SAND and GRAVEL (SP-GP).	4.5								
						Dark gray to brown gravelley CLAY (GC), trace sand.									
	SS-2		8 4 9												
10							11.5								
						End of Boring at 12 ft									*11.5 feet: Drillers Note - hard drilling from 11.5 to 12.0 feet* *12.0 feet: Possible boulder or obstruction* *Boring backfilled with bentonite grout*
15															
20															
25															
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:29 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B026A

Sheet 1 of 1

Date(s) Drilled	09/23/2015 to 09/23/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	26.5 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					Blind drill - see HEN-B026. 0.0								*Blind drilled to 10.0 feet*
10	SS-1	7 6 7	11		10.0 Brown gravelly CLAY (GC), trace sand.								
	SS-2	25 42 13	0										
	SS-3	6 7 5	33										*Large rock in Sample 3*
15													
	SS-4	5 5 9	11										
20	SS-5	7 8 6	11		20.0 Brown GRAVEL (GP) with sand and clay.								
25	SS-6	8 9 6	33		25.0 Brown fine to coarse SAND (SP) and GRAVEL (GP), trace silt and clay. 26.5 End of Boring at 26.5 ft								*Boring backfilled with bentonite grout*
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:31 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B027

Date(s) Drilled	09/22/2015 to 09/22/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	31.5 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					Barge. 0.0								
					1.5 Water.								
5					7.0								
	SS-1	2 3 3 WOH	78		Dark brown SAND (SP) and GRAVEL (GP). 7.5 Dark gray, silty CLAY (CL), trace sand.					1.5			
10	ST-2		72		12.0					2.5			*Pushed shelby tube from 10.0 to 12.0 feet*
	SS-3	3 4 7	61		Dark gray to brown, silty CLAY (CL) with some gravel and sand.					1.5 2.0			
15	SS-4	4 5 7	22							1.75			
20	SS-5	3 5 4	33		20.0 Brown gravelly CLAY (GP) with some sand.								
25	SS-6	7 8 12	22		25.0 Brown to gray clayey SILT (ML) with some sand and gravel.								
					28.0 Fine to coarse SAND (SP) and GRAVEL (GP).								*28.0 feet: Cave in*
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:34 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B027

Sheet 2 of 2

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION: Elevation (feet)	MATERIAL DESCRIPTION: Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-7	8 9 8	56											
						31.5								
					End of Boring at 31.5 ft									*Boring backfilled with bentonite grout*
35														
40														
45														
50														
55														
60														
65														

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:34 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B029

Date(s) Drilled	10/01/2015 to 10/01/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	24 28 34	100		Very dense, dry, brown, silty GRAVEL (GM) [Road Fill].								
					2.5								
	SS-2	10 6 11	100		Stiff to very stiff, dry, lean CLAY (CL).					4.5			
5	ST-3		100							4.5			*Pushed shelby tube from 5.0 to 7.0 feet*
	SS-4	12 14 17	100							4.0			
10	ST-5		100							2.5			*Pushed shelby tube from 10.0 to 12.0 feet*
					15.0								
15	SS-6	4 6 8	83		Stiff, dark brown with trace rust, lean CLAY (CL), trace fine to coarse gravel.					1.5			
					20.2								
20	SS-7	6 12 20	78		Dense, dry, brown, clayey GRAVEL (GC).					1.5			
25	SS-8	17 17 43	56										
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:40 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B029

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	29 50/5"	22										*Less fines in Sample 9*
35	SS-10	20 25 28	61										
40	SS-11	16 14 15	6										
					41.5 End of Boring at 41.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:40 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B030

Sheet 1 of 1

Date(s) Drilled	09/29/2015 to 09/30/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Hollow-Stem Auger	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	11.0 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	9.0 ft on 9/29/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS-1		22 17 37	83		Brownish gray sand, gravel, and clay [Fill].									
							2.5								
	SS-2		15 17 15	67		Brown fine to coarse sand and gravel with some clay [Fill].									
5	SS-3		18 20 30	83											
							7.5								
	SS-4		4 5 6	100		Dark gray with trace gravel, sand, and clay, with ASH [Fill].									
							10.0								*9.0 feet: Wet*
10	ST-5			33		Black ASH with gravel [Fill].									*Pushed shelby tube from 10.0 to 11.0 feet*
							11.0								*10.0 feet: Switch to mud rotary*
						End of Boring at 11 ft									*Boring backfilled with Portland Type I cement*
15															
20															
25															
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:45 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B032

Sheet 1 of 2

Date(s) Drilled	09/30/2015 to 09/30/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	32 29 20	67		Very dense, dry, brown, fine to coarse well graded GRAVEL (GW) with silt and sand [Fill].	1.0					4.5			
	SS	SS-2	6 18 17	100		Hard, dry, black, lean CLAY (CL), trace fine to medium gravel.						3.5			
5	ST	ST-3		79								4.5			*Pushed shelby tube from 5.0 to 7.0 feet*
	SS	SS-4	8 12 16	100								3.5			
10	SS	SS-5	8 16 20	44								0.5			*10.0 feet: Coarse gravel*
15	SS	SS-6	19 39 43	72		Very dense, moist, brown and black, clayey fine to coarse GRAVEL (GC).	15.0								
20	SS	SS-7	18 36 50/3"	61											
25	SS	SS-8	98 35 50/4"	78											*24.5: Drillers Note - boulder from 24.5 to 25.2 feet*
30							30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:48 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B032

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	18 11 30	100		Hard, moist, brown, fine to coarse gravelly lean CLAY (CL).					3.0 4.5			
35	SS-10	41 28 40	67		35.0 Very dense, moist, brown and black, clayey fine to coarse GRAVEL (GC).								
40	SS-11	12 18 50/4"	72		41.5 End of Boring at 41.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:48 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B034

Sheet 1 of 2

Date(s) Drilled	09/30/2015 to 10/01/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	25 19 21	100		Very dense, dry, brown, silty SAND (SM) [Fill]. 0.5 Hard, dry, black, gravelly lean CLAY (CL) [Fill].					1.5 2.5			
	SS-2	7 8 11	100							3.5 4.5			
5					5.0								
	SS-3	17 28 32	100		Dense, dry, brown, silty SAND (SM). 5.5 Very dense, brown to gray, silty fine to coarse GRAVEL (GM) with sand.								
	SS-4	11 18 32	100										
10					10.0								
	SS-5	27 35 18	56		Very dense, moist, brown, clayey GRAVEL (GC).								
15	SS-6	21 24 25	44										
20					20.0								
	SS-7	10 11 9	44		Medium dense, dry, silty fine to coarse GRAVEL (GM).								
25	SS-8	11 13 16	6										
30					30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:53 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B034

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	14 14 12	22		Medium dense, moist to wet, brown, well graded GRAVEL (GW).								
35	SS-10	9 11 10	67										
40	SS-11	10 8 9	17		41.5 End of Boring at 41.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:53 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B037

Sheet 1 of 2

Date(s) Drilled	09/23/2015 to 09/24/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	12 15 21	100		Dense, dry, brown, silty SAND (SM) with fine to coarse gravel [Road Fill].	0.0								
							2.0								
	SS	SS-2	12 17 20	100		Dense, dry, poorly graded SAND (SP), trace fine to medium gravel [Fill].									
5	SS	SS-3	12 19 26	100		Dense, dry, brown, silty SAND (SM) with fine to coarse gravel [Fill].	5.0								
	SS	SS-4	10 8 12	94		Very stiff, dark gray to black, lean CLAY (CL), trace fine to coarse gravel [Fill].	8.0								
10	SS	SS-5	12 33 31	100		Dry to moist, dark brown, clayey fine to coarse GRAVEL (GC) with sand.	10.0								*11.3 feet: Rusty in color* *13.0 feet: 100% water loss*
15	SS	SS-6	10 43 40	67		Very dense, moist, light brown, fine to coarse clayey GRAVEL (GC) with sand.	15.0								
20	SS	SS-7	10 14 22	94											
25	SS	SS-8	19 21 16	56											
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:59 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B037

Sheet 2 of 2

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	21 14 19	83		30.5 Hard, moist, dark greenish gray, fine to coarse, rounded to angular gravelly lean CLAY (CL).					1.25			
35	SS-10	7 12 18	83		35.0 Very stiff, moist, brown, clayey fine to coarse GRAVEL (GC).								
40	SS-11	13 20 21	67		41.5 End of Boring at 41.5 ft								*Boring backfilled with Portland Type I Cement*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:59 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B038

Sheet 1 of 1

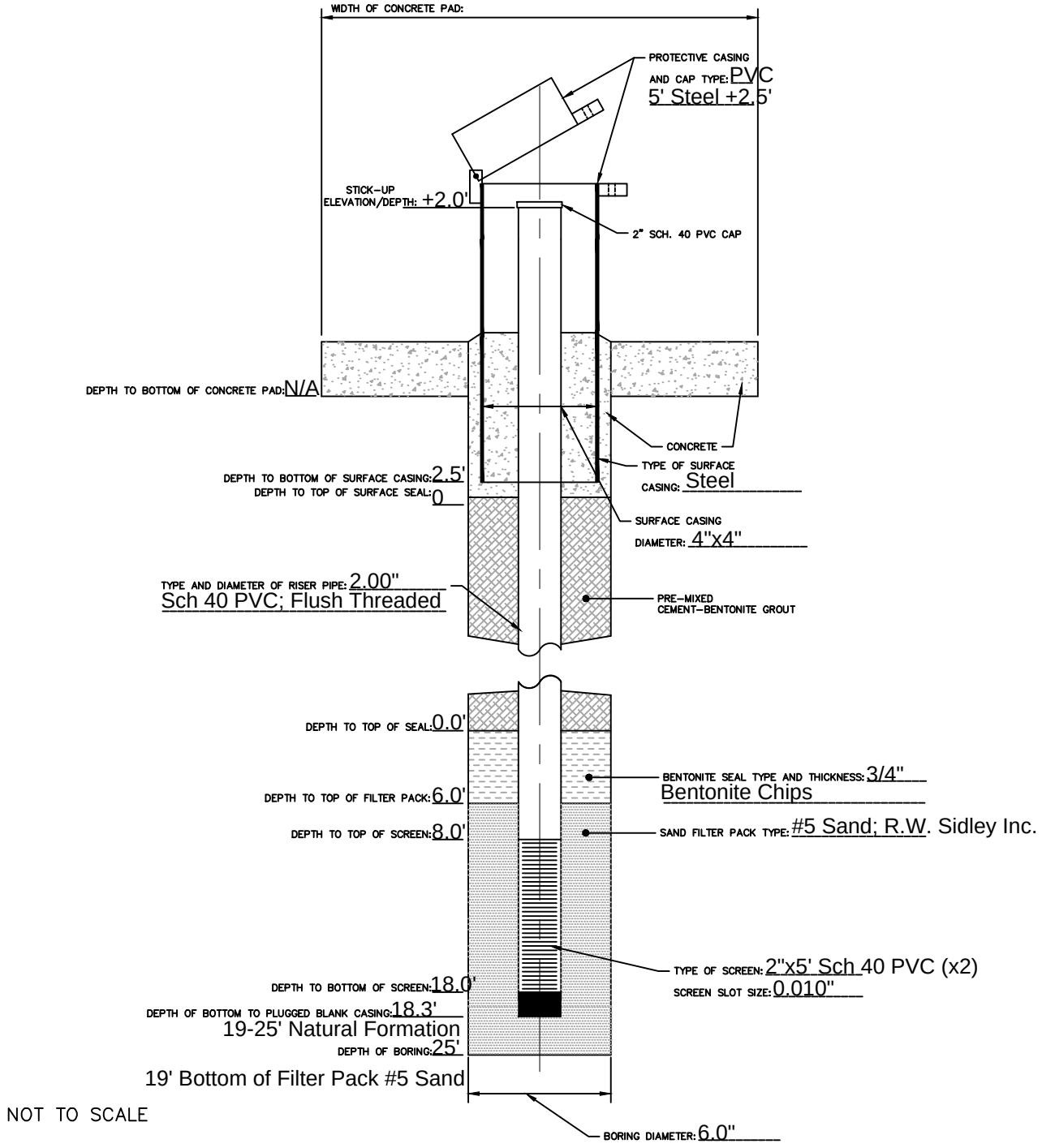
Date(s) Drilled	09/23/2015 to 09/23/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Hollow-Stem Auger	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	21.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Drill Cuttings and Bentonite Chips	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS-1		12 18 22	89		Dense, dry, dark brown, well graded GRAVEL with CLAY (GW-GC) [Road fill]									
							3.0								
	SS-2		16 30 50/5.5"	97		Very dense, dry, gray, well graded fine to coarse GRAVEL (GW) [Fill].									
5	SS-3		37 50/5"	50											
	SS-4		5 6 31	94			8.1								
						Stiff, moist, black and brown, lean CLAY (CL), trace sand and fine gravel [Fill].	8.6								
						Very dense, dry, brown, well graded GRAVEL (GW) [Fill].									
10	SS-5		6 10 12	100			10.5								
						Very stiff, dry, greenish gray, lean CLAY (CL) [Fill].						6.0			
15							15.0								
	SS-6		15 15 24	100		Dense, moist, brown, clayey GRAVEL (GC) with sand [Fill].									
20	SS-7		7 17 13	94			21.5								
						End of Boring at 21.5 ft									*Boring backfilled with 75 pounds of bentonite chips and soil cuttings*
25															
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:44:04 AM

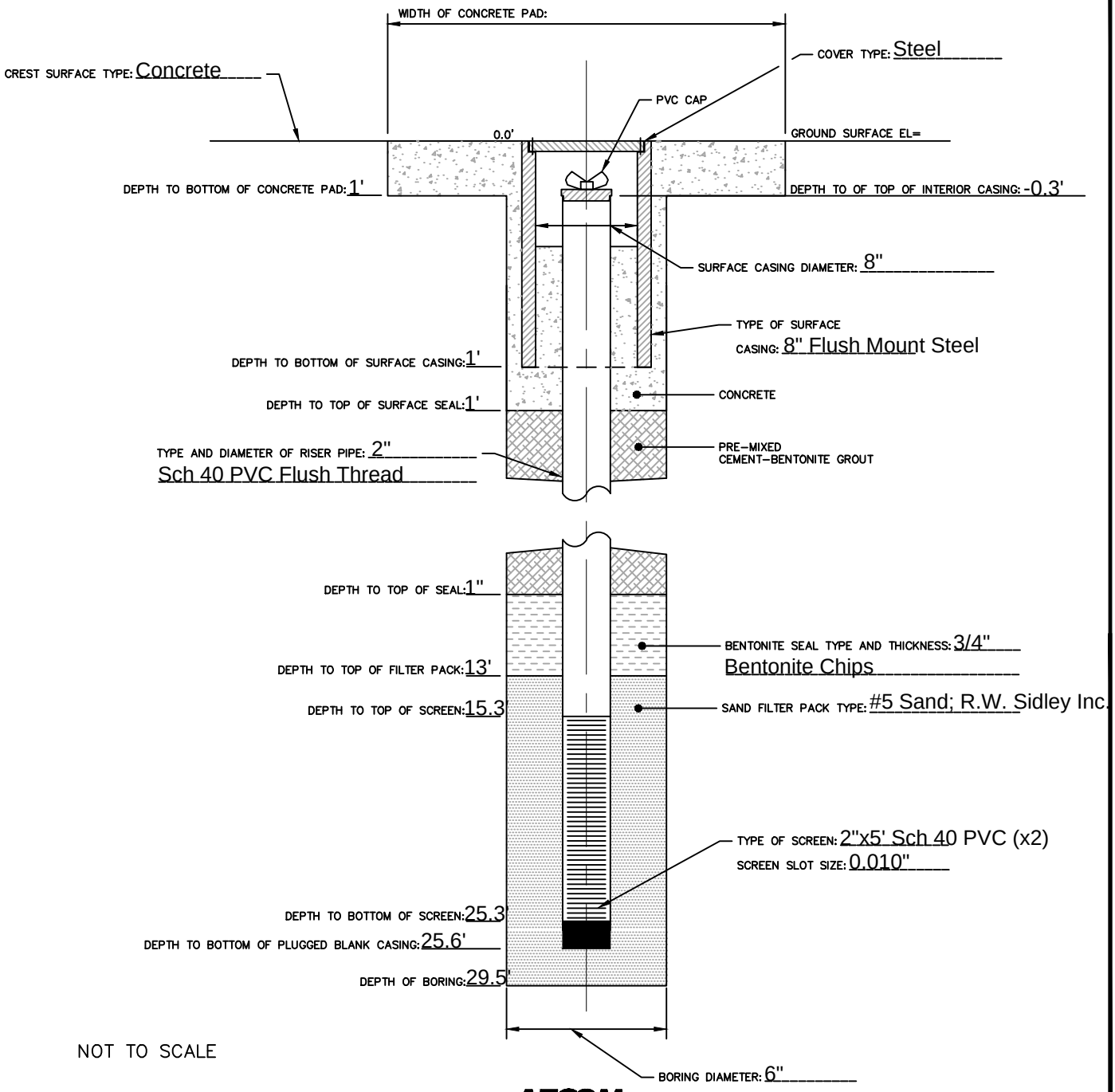
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location	P001	Date Installed	10/15/15	Time	9:10 A.M.
Installed By	Scott Komen	Observed By	R. Weseljak	Total Depth	25'
Method of Installation	6" Solid Flight Auger	Drilling Contractor	Strata	Surface Elevation	
Screened Interval	8-18'	Completion Zone	Silts and Clays		
Remarks		Groundwater Level(s)	13.33' T.O.C.		



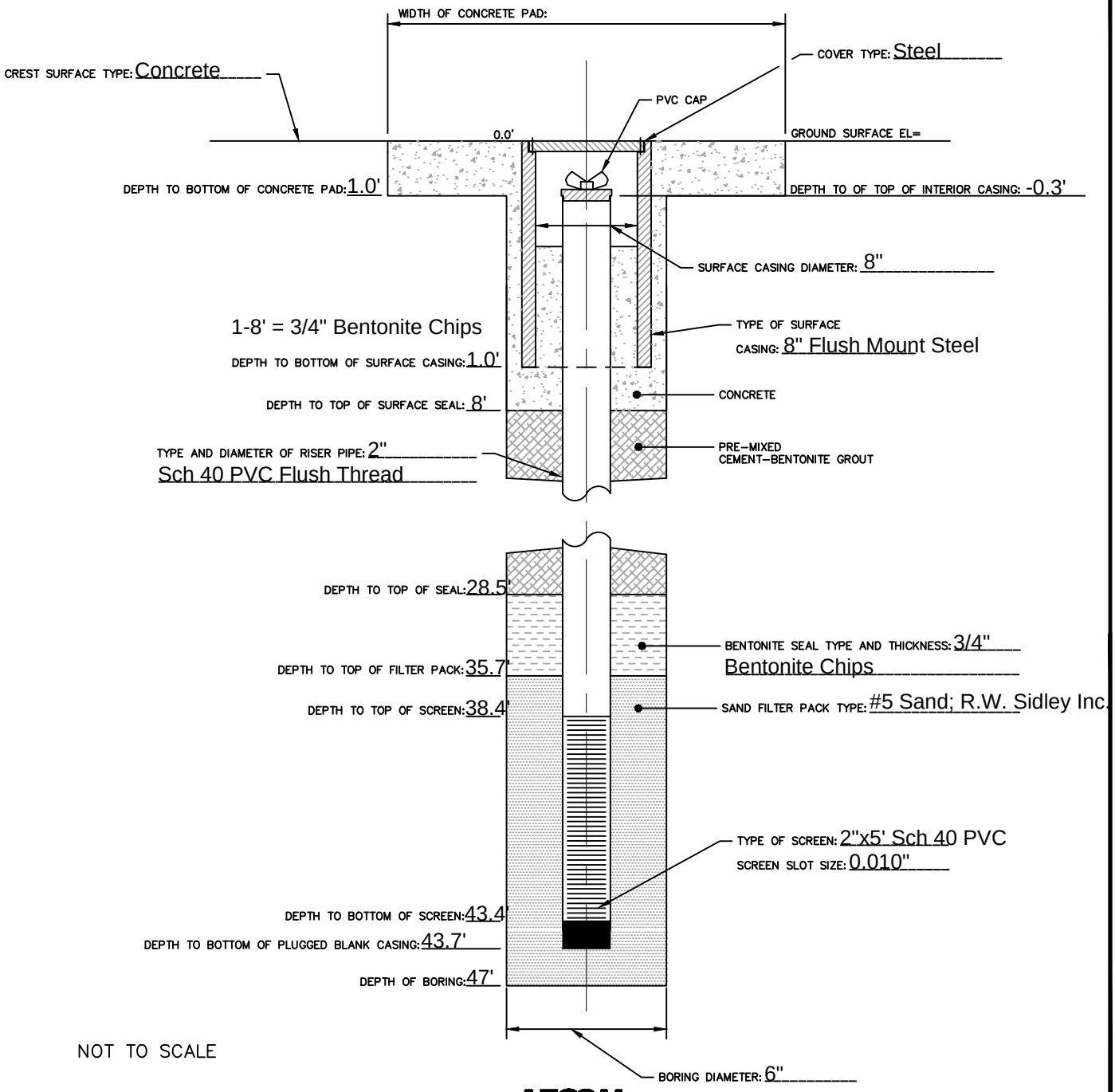
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location: P002	Date Installed: 10/15/15	Time: 11:10 A.M.
Installed By: Scott Komen	Observed By: R. Weseljak	Total Depth: 29.5'
Method of Installation: 6" Solid Flight Auger	Drilling Contractor: Strata	Surface Elevation:
Screened Interval: 15.3-25.3'	Completion Zone: Sands	
Remarks:	Groundwater Level(s): 15.90' T.O.C.	



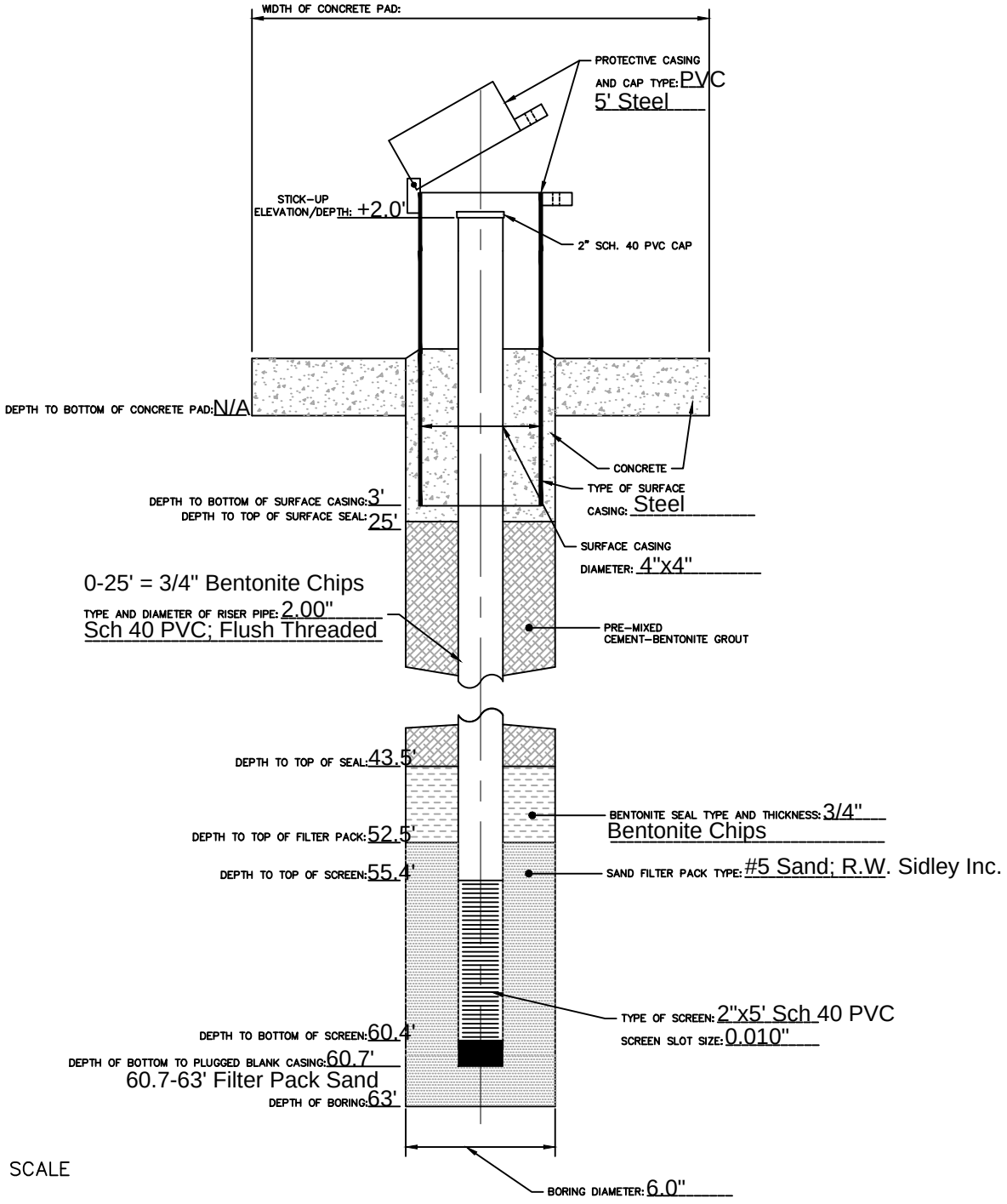
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location: P003	Date Installed: 10/14/15	Time: 9:45 A.M.
Installed By: Scott Komen	Observed By: R. Weseljak	Total Depth: 47'
Method of Installation: 6" Mud Rotary/ 6" Casing	Drilling Contractor: Strata	Surface Elevation:
Screened Interval: 38.4'-43.4'	Completion Zone: Gravels	
Remarks:	Groundwater Level(s): 17.15' T.O.C.	



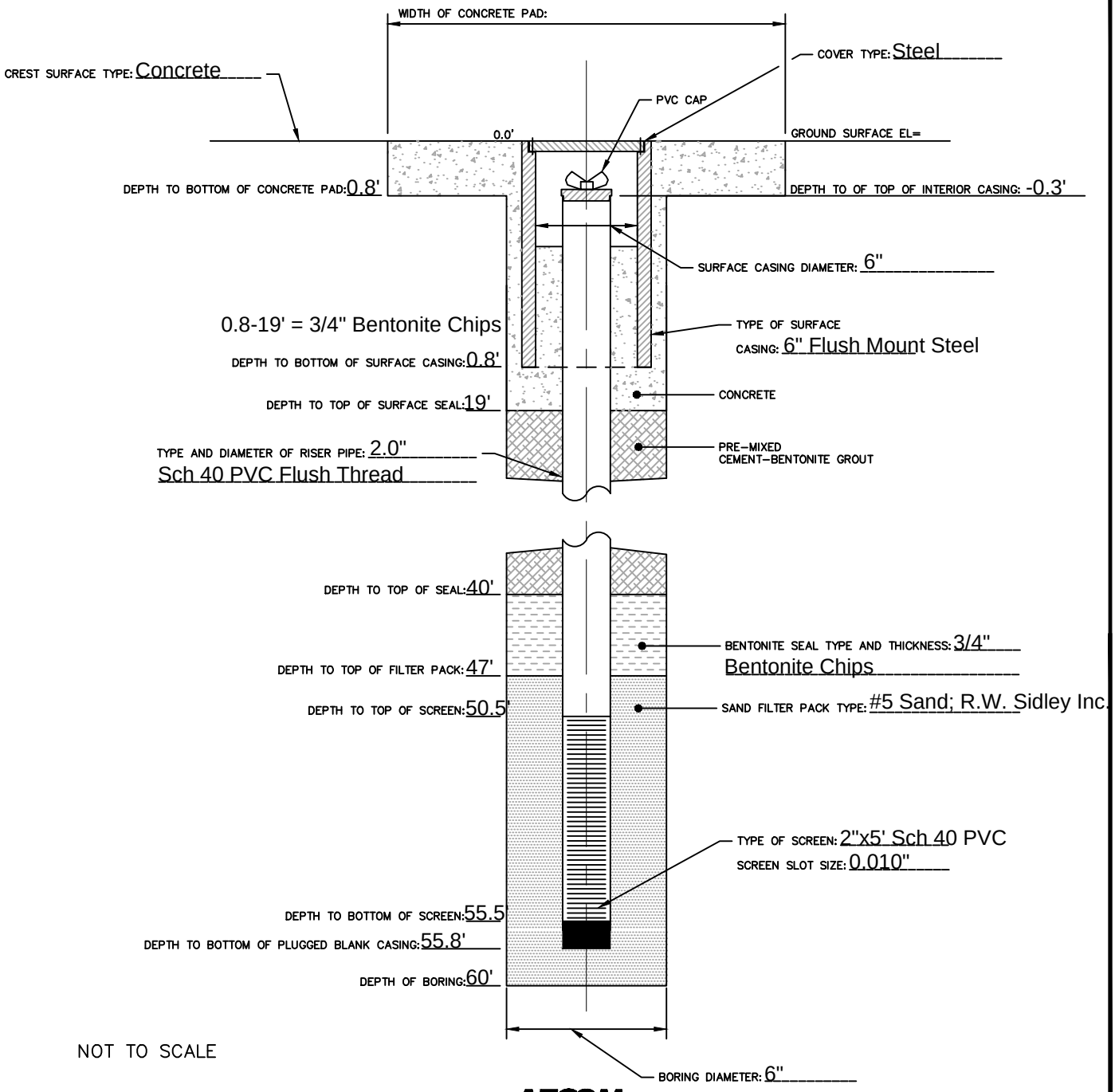
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location	P004	Date Installed	10/16/15-10/19/15	Time	8:00 A.M.
Installed By	Scott Komen	Observed By	R. Weseljak	Total Depth	63'
Method of Installation	6" Mud Rotary with 6' Casing	Drilling Contractor	Strata	Surface Elevation	
Screened Interval	55.4-60.4'	Completion Zone	Gravels		
Remarks		Groundwater Level(s)	48.65' T.O.C.		



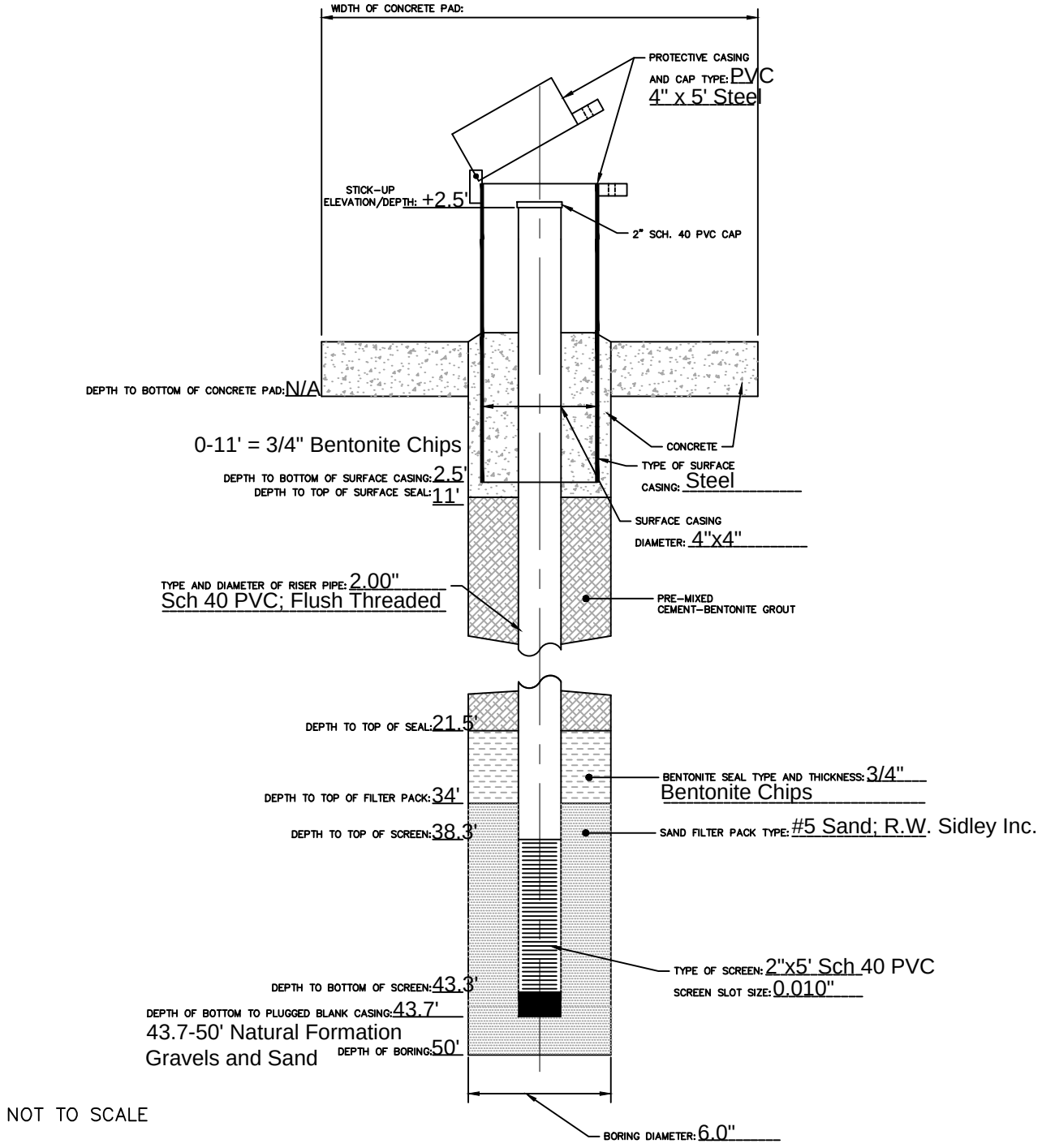
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location: P005	Date Installed: 10/20/15	Time: 4:30 P.M.
Installed By: Scott Komen	Observed By: R. Weseljak	Total Depth: 60'
Method of Installation: 6" Tricone Mud Rotary	Drilling Contractor: Strata	Surface Elevation:
Screened Interval: 50.5-55.5'	Completion Zone: Gravels and Sands	
Remarks:	Groundwater Level(s): 45.80' T.O.C.	



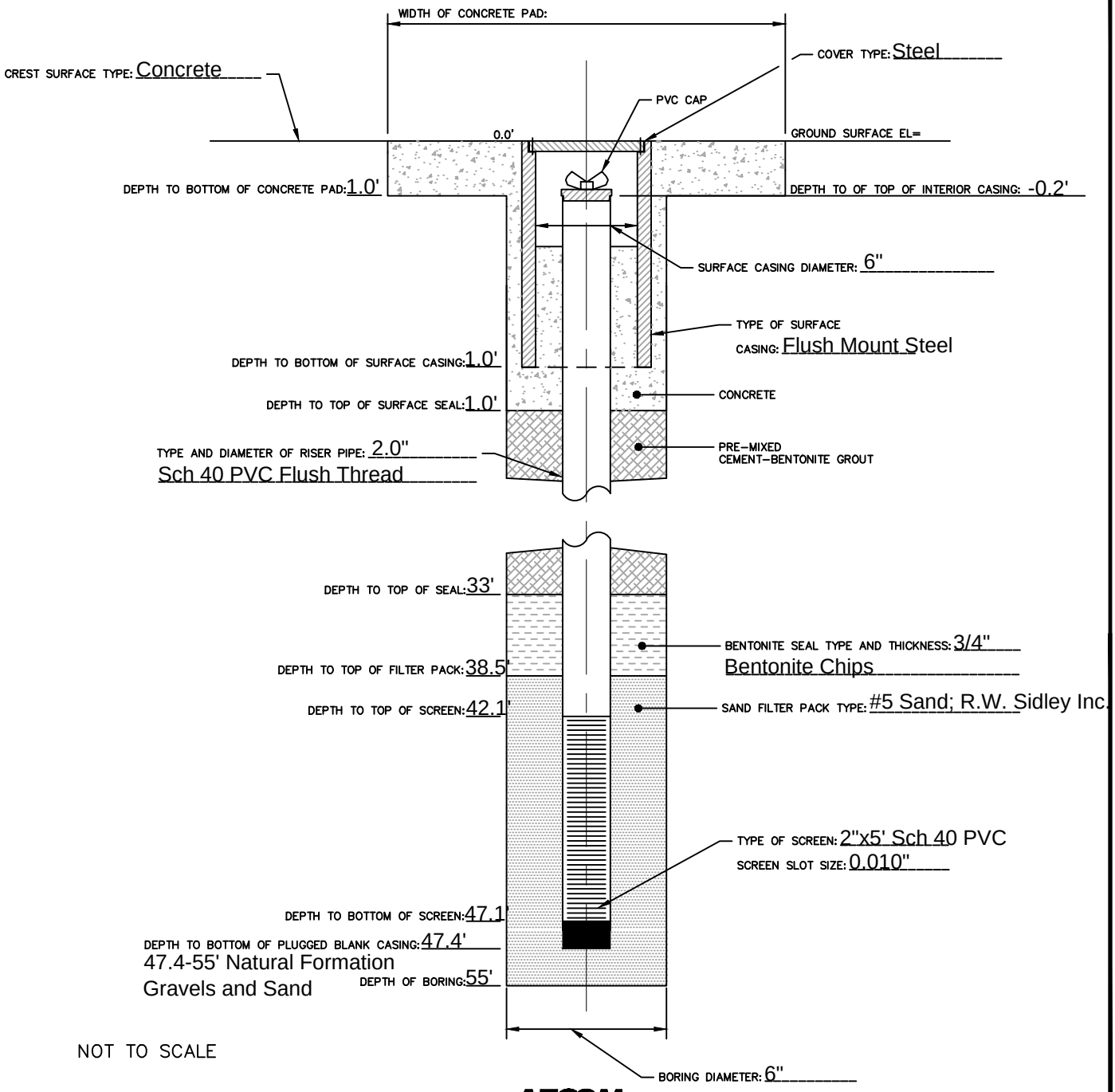
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location	P006	Date Installed	10/20/15	Time	11:20 A.M.
Installed By	Scott Komen	Observed By	R. Weseljak	Total Depth	50'
Method of Installation	6" Tricone Mud Rotary	Drilling Contractor	Strata	Surface Elevation	
Screened Interval	38.3-43.3'	Completion Zone	Gravel		
Remarks		Groundwater Level(s)	45.74' T.O.C.		



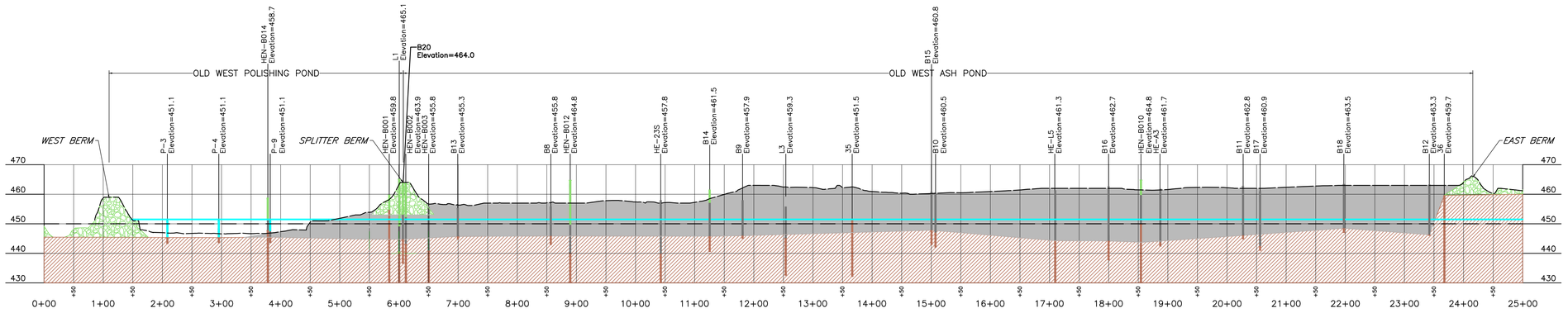
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location: P007	Date Installed: 10/21/15	Time: 5:00 P.M.
Installed By: Scott Komen	Observed By: R. Weseljak	Total Depth: 55'
Method of Installation: 6" Tricone Mud Rotary	Drilling Contractor: Strata	Surface Elevation:
Screened Interval: 42.1-47.1'	Completion Zone: Gravels	
Remarks:	Groundwater Level(s): 44.65' T.O.C.	



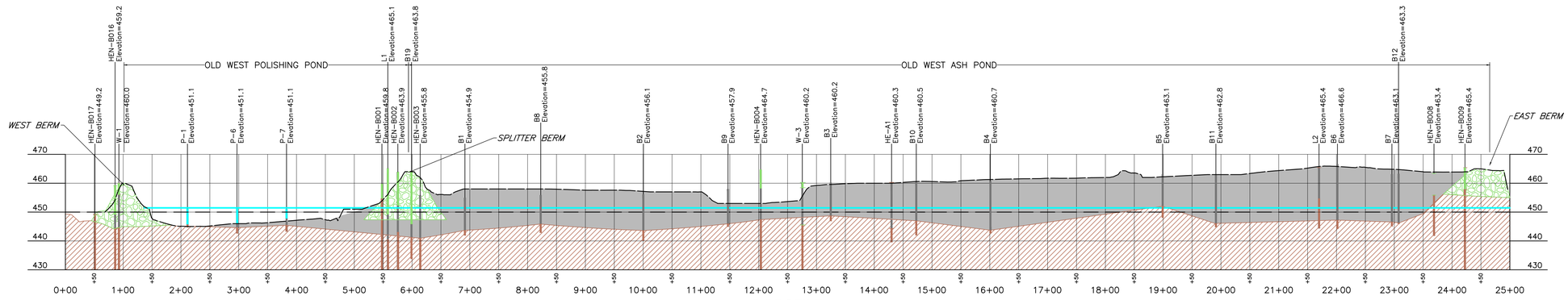
Appendix A5

CEC Boring Logs and Well Details



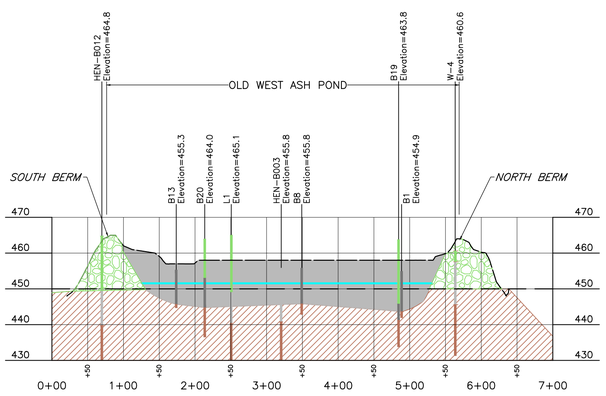
A PROFILE

SCALE H:1"=100'; V:1"=20'



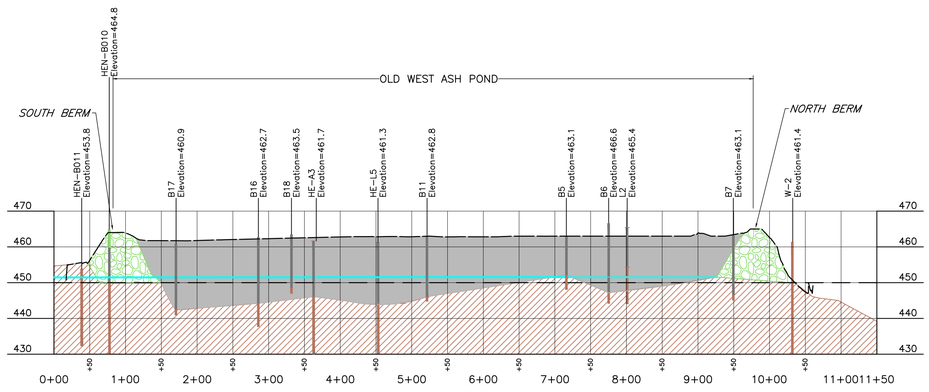
B PROFILE

SCALE H:1"=100'; V:1"=20'



C PROFILE

SCALE H:1"=100'; V:1"=20'



D PROFILE

SCALE H:1"=100'; V:1"=20'

REFERENCE

1. DATA FROM GROUNDWATER SURFACE PROVIDED BY NRT, DATED SEPTEMBER 2015.

LEGEND

- AVERAGE NORTH/NORTHWEST OF UNIT HIGH GROUNDWATER ELEVATIONS FROM 1996–2015 (451.5 FT. MSL)
- TOP OF EXISTING GRADE (2015 WEAVER CONSULTING GROUP SURVEY)
- INTERPRETED NATURAL GROUND SURFACE (450) OUTSIDE OF ASH POND
- P-4 / 451.1 — SOIL BORING / GROUND SURFACE ELEVATION
- MISCELLANEOUS BERM SOIL FILL
- CCR/ASH
- NATIVE SOIL

GEOLOGIC CONDITIONS

1. THE TEST BORING INFORMATION PRESENTED HEREIN DEPICTS SUBSURFACE CONDITIONS AT THE TEST BORING LOCATIONS AND AT THE TIME OF DRILLING. SOIL CONDITIONS AT OTHER LOCATIONS MAY DIFFER.
2. GEOLOGIC CORRELATIONS BETWEEN TEST BORINGS ARE GENERALLY BASED ON STRAIGHT–LINE INTERPOLATION. ACTUAL CONDITIONS BETWEEN TEST BORINGS MAY DIFFER.

REVISION RECORD

NO	DATE	DESCRIPTION
1	5/23/17	REVISED SOIL BORING LOCATIONS AND ELEVATIONS; REVISED CROSS SECTIONS

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www.cecinc.com

DYNEGY INC.
OLD WEST ASH POND SYSTEM
SATURATED ASH EVALUATION
HENNEPIN STATION
HENNEPIN, ILLINOIS

EXISTING CONDITIONS - SECTIONS
OLD WEST ASH POND SYSTEM
HENNEPIN STATION

DATE:	03/27/2017
DRAWN BY:	CAC
DVG SCALE:	AS SHOWN
CHECKED BY:	DRAFT
PROJECT NO:	164-478
APPROVED BY:	DRAFT

DRAWING NO.: C200

SHEET 2 OF 2

P:\2016\164-478\--CAD\Dwg\C101-West Ash Pond Borings\164478-C001-C100-Cross Sections.dwg[C200] LS:4/3/2017 - cswg - LP: 4/13/2017 9:38 AM

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BORING NUMBER B1/LPZ-1

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/15/17 **COMPLETED** 3/15/17
GROUND ELEVATION 454.928 ft **BACKFILL** Monitoring Well MW-1
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
WHILE DRILLING 1.0 ft / Elev 453.9 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING 3.0 ft / Elev 451.9 ft
NOTES
24hrs AFTERDRILLING 3.0 ft / Elev 451.9 ft

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
	ASH: Gray SILT - FLY ASH, moist to wet, very loose, **(ASH)**	0				
			SS 1	0	1-0-1-0 (1)	NP
			SS 2A	50	0-0-2 (2)	NP
450		5	SS 2B	50	4-0-0 (0)	NP
	% Gravel ~ 0.1% % Sand ~ 9.1% % Silt ~ 85.3% % Clay ~ 5.4%		SS 3	50	0-0-0-0 (0)	NP
	ASH: Gray and brown SANDY SILT - BOTTOM ASH, moist to wet, very loose, **(ASH)**		SS 4A	50	0-0-0 (0)	NP
	ASH: Gray SILT - FLY ASH, moist to wet, very loose, **(ASH)**					
445		10	SS 4B	50	0-0-0 (0)	NP
	Black SILTY CLAY, moist, medium stiff, **(CL)**		SS 5	100	2-3-3-3 (6)	1.0 P
	End of boring at 13.0 feet.					

SPT N VALUE: 20 40 60 80
PL MC LL: 20 40 60 80
UCS (tsf): 1 2 3 4

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BORING NUMBER B2

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/15/17 **COMPLETED** 3/15/17
GROUND ELEVATION 456.123 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
WHILE DRILLING 1.0 ft / Elev 455.1 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING ---
NOTES
24hrs AFTERDRILLING 6.0 ft / Elev 450.1 ft

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
455	ASH: Gray SILT - FLY ASH, some sand, wet, very loose, **(ASH)**	0	SS 1	0	0-0-1-0 (1)	NP
			SS 2A	67	0-0-0 (0)	NP
		5	SS 2B	67	0-0-0 (0)	NP
450	ASH: Dark gray SILTY SAND - BOTTOM ASH, moist to wet, very loose, **(ASH)**		SS 3	75	1-2-1-0 (3)	NP
			SS 4A	77	0-0-0 (0)	NP
		10	SS 4B	77	0-0-0 (0)	NP
445			SS 5	100	1-2-2-2 (4)	NP
	Black SILTY LOAM, moist, medium stiff, **(CL)** % Gravel ~ 0% % Sand ~ 20.2% % Silt ~ 60.2% % Clay ~ 19.6%		SS 6A	67	0-0-2 (2)	0.5 P
	Grades to gray.	15	SS 6B	67	2-3-3 (6)	0.5 P
	End of boring at 16.0 feet.					

SPT N VALUE: 20 40 60 80
PL MC LL: 20 40 60 80
UCS (tsf): 1 2 3 4
23 34 44

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B3/LPZ-3

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/16/17 **COMPLETED** 3/16/17
GROUND ELEVATION 460.19 ft **BACKFILL** Monitoring Well MW-3
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
▽ **WHILE DRILLING** 3.0 ft / Elev 457.2 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING ---
NOTES
▼ **24hrs AFTERDRILLING** 10.7 ft / Elev 449.5 ft

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
460	ASH: Dark gray SANDY SILT - BOTTOM ASH, trace gravel, moist to wet, loose to dense, **(ASH)**	0				
			SS 1	100	2-3-3-3 (6)	NP
			SS 2A	100	3-7-11 (18)	NP
455		5	SS 2B	100	9-10-11 (21)	NP
			SS 3	100	3-3-4-7 (7)	NP
			SS 4A	93	2-8-20 (28)	NP
450		10	SS 4B	93	14-13-10 (23)	NP
	▼ ASH: Dark gray SILT - FLY ASH, wet, loose, **(ASH)**					
	Black SILTY CLAY, moist, stiff, **(CL)**		SS 5	85	0-1-4-4 (5)	NP 1.5 P 2.5 P
	End of boring at 13.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ UCS (tsf) ☐
1 2 3 4

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BORING NUMBER B4

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/15/17 **COMPLETED** 3/15/17
GROUND ELEVATION 460.703 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
WHILE DRILLING 1.0 ft / Elev 459.7 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING ---
NOTES
24hrs AFTERDRILLING 8.0 ft / Elev 452.7 ft

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
460	FILL: Dark gray to black SANDY CLAY, trace roots, moist, soft to medium stiff, **(CL-OL-FILL)**	0				
	ASH: Dark gray SANDY SILT - BOTTOM ASH, trace gravel, moist to wet, very dense to medium dense, **(ASH)**		SS 1	50	1-1-1-4 (2)	0.5 P
			SS 2	99	3-22-60/0.42	NP
455		5	SS 3	100	7-5-9-22 (14)	NP
			SS 4A	100	9-18-20 (38)	NP
		10	SS 4B	100	26-60/0.42	NP
450			SS 5	100	8-6-11-7 (17)	NP
		15	SS 6	100	4-7-31-60 (38)	NP
445	Black SILTY CLAY, moist, medium stiff, **(CL)** % Gravel ~ 1.2% % Sand ~ 4.0% % Silt ~ 53.7% % Clay ~ 41.1%		SS 7	100		NP 0.75 P
	End of boring at 18.0 feet.					

SPT N VALUE
20 40 60 80
PL MC LL
20 40 60 80
UCS (tsf)
1 2 3 4
60/0.42
60/0.42
33 45 73

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B5/LPZ-5

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/16/17 **COMPLETED** 3/16/17
GROUND ELEVATION 463.062 ft **BACKFILL** Monitoring Well MW-5
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
▽ **WHILE DRILLING** 3.0 ft / Elev 460.1 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING ---
NOTES
24hrs AFTERDRILLING Dry

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
	ASH: Dark gray and brown SANDY SILT - BOTTOM ASH, sandy silt, moist, very loose, **(ASH)**	0	SS 1	80	2-1-1-2 (2)	NP
460	▽ ASH: Gray SILT - FLY ASH, silt, wet, very loose to loose, **(ASH)** % Gravel ~ 0.1% % Sand ~ 9.9% % Silt ~ 81.4% % Clay ~ 8.6%		SS 2A	93	0-2-3 (5)	NP
	ASH: Dark gray SANDY SILT - BOTTOM ASH, sandy silt, **(ASH)**	5	SS 2B	93	6-3-2 (5)	NP
	ASH: Gray SILT - FLY ASH, wet, very loose, **(ASH)**		SS 3	100	0-1-2-3 (3)	NP
455		10	ST 4	0		NP
	Dark brown SITLY SAND, wet, **(SM)**		SS 5	75	2-2-8-5 (10)	NP
450	Dark brown GRAVELLY SANDY LOAM, moist, **(SP)** % Gravel ~ 16.3% % Sand ~ 54.9% % Silt ~ 20.8% % Clay ~ 8.0%		SS 6	70	4-4-3-3 (7)	NP
	End of boring at 15.0 feet.	15				

SPT N VALUE: 20 40 60 80
PL MC LL: 20 40 60 80
UCS (tsf): 1 2 3 4
1421

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B6

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/16/17 **COMPLETED** 3/16/17
GROUND ELEVATION 466.583 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
WHILE DRILLING 3.0 ft / Elev 463.6 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING 20.2 ft / Elev 446.4 ft
NOTES
24hrs AFTERDRILLING Dry

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
	FILL: Black SILTY SAND, moist, loose, **(SM-FILL)**	0				
465			SS 1	90	3-4-4-5 (8)	NP
	ASH: Gray SILT - FLY ASH, wet, loose, **(ASH)**		SS 2A	67	3-4-5 (9)	NP
	ASH: Dark gray SILTY SAND - BOTTOM ASH, moist to wet, very loose to loose, **(ASH)**	5	SS 2B	67	5-5-4 (9)	NP
460			SS 3	70	2-1-2-1 (3)	NP
			SS 4A	80	1-1-2 (3)	NP
	ASH: Gray SILT - FLY ASH, wet, very loose, **(ASH)** % Gravel ~ 2.1% % Sand ~ 15.4% % Silt ~ 79.2% % Clay ~ 3.2%	10	SS 4B	80	1-2-2 (4)	NP
455	ASH: Dark brown to dark gray SILTY SAND - BOTTOM ASH, trace coal, moist to wet, medium dense to very loose, **(ASH)**		SS 5	80	1-1-3-2 (4)	NP
			SS 6A	100	2-4-6 (10)	NP
		15	SS 6B	100	10-15-13 (28)	NP
450			SS 7	90	1-1-1-1 (2)	NP
			SS 8A	80	1-3-2 (5)	NP
	Dark gray coarse SAND, wet, very loose, **(SP-FILL)**	20				
	Brown SAND, wet, very loose, **(SP-FILL)**		SS 8B	80	1-1-3 (4)	NP 3.0 P 2.0 P
445	Black SILTY CLAY, moist, very stiff to medium stiff, **(CL)**		SS 9	95	2-2-2-2 (4)	0.5 P 0.75 P
	End of boring at 23.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ UCS (tsf) ☐
1 2 3 4

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BORING NUMBER B7

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/16/17 **COMPLETED** 3/16/17
GROUND ELEVATION 463.102 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
▽ **WHILE DRILLING** 11.0 ft / Elev 452.1 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING Dry
NOTES
24hrs AFTERDRILLING Dry

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
	ASH: Black with brown SILTY SAND - BOTTOM ASH, moist, medium dense, **(ASH)**	0	SS 1	65	8-13-15-4 (28)	NP
460			SS 2A	67	2-3-2 (5)	NP
	ASH: Gray SILT - FLY ASH, moist to wet, loose, **(ASH)**	5	SS 2B	100	2-2-5 (7)	NP
	ASH: Black to dark gray FINE SANDY SILT - BOTTOM ASH, moist, very loose to loose, **(ASH)**		SS 3	75	0-1-1-1 (2)	NP
455			SS 4A	83	0-0-0 (0)	NP
		10	SS 4B	83	2-3-3 (6)	NP
	▽ ASH: Gray SILT - FLY ASH, wet, very loose to loose, **(ASH)**		SS 5	100	1-1-2-2 (3)	NP
450			SS 6A	100	1-1-1 (2)	NP
		15	SS 6B	100	2-3-4 (7)	NP
	Brown SAND AND GRAVEL, wet, very dense, **(SP-GP)**		SS 7	80	24-26-16-21 (42)	NP
	End of boring at 18.0 feet.					

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
☐ UCS (tsf) ☐ 1 2 3 4

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B8

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/14/17 **COMPLETED** 3/14/17
GROUND ELEVATION 455.837 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
WHILE DRILLING 1.0 ft / Elev 454.8 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING 8.0 ft / Elev 447.8 ft
NOTES
24hrs AFTERDRILLING 5.7 ft / Elev 450.1 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
455		ASH: Gray SILT - FLY ASH, moist to wet, very loose, **(ASH)**	0	SS 1	25	1-0-0-0 (0)	NP
				SS 2A	100	0-0-0 (0)	NP
			5	SS 2B	100	0-2-0 (2)	NP
450		ASH: Gray with black SILTY SAND - BOTTOM ASH, moist to wet, very loose, **(ASH)**		SS 3	40	0-0-0-0 (0)	NP
		ASH: Gray SILT - FLY ASH, wet, **(ASH)**		SS 4A	100	0-0-0 (0)	NP
			10	SS 4B	67	1-3-4 (7)	0.75 P
445		Dark gray LEAN CLAY, trace sand and fine gravel, wet to moist, medium stiff, **(CL)**		SS 5	50	2-3-4-3 (7)	0.5 P
		End of boring at 13.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ UCS (tsf) ☐
1 2 3 4

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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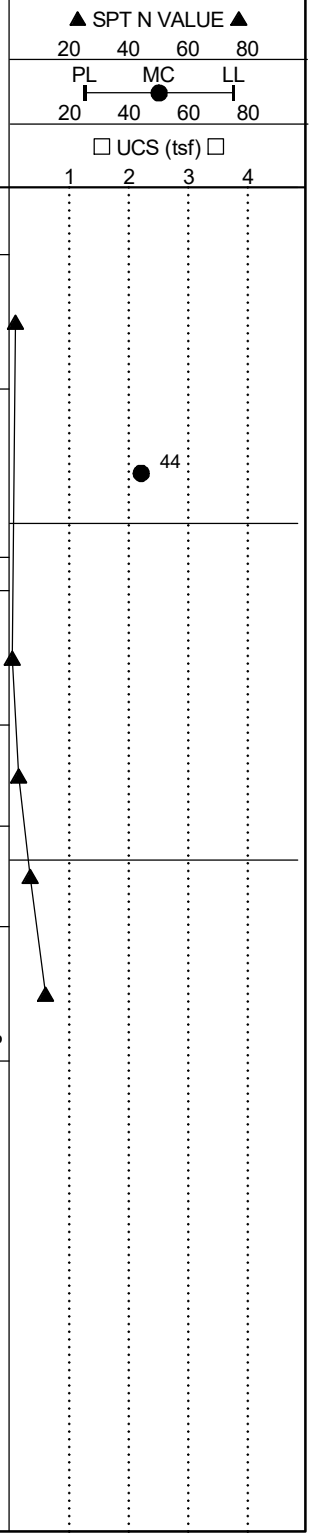
BORING NUMBER B9

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/15/17 **COMPLETED** 3/15/17
GROUND ELEVATION 457.949 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
▽ **WHILE DRILLING** 2.0 ft / Elev 455.9 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING ---
NOTES
24hrs AFTERDRILLING Dry

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
	ASH: Gray SILT - FLY ASH, with layers of fine sand interbedded, moist to wet, very loose, **(ASH)**	0				
455	▽		SS 1	65	1-1-1-2 (2)	NP
	γ_D= 72.41 pcf	5	ST 2	53		NP
			SS 3	100	0-0-1-1 (1)	NP
450	ASH: Dark gray SANDY SILT - BOTTOM ASH, moist to wet, loose to medium dense, **(ASH)**		SS 4A	50	0-0-3 (3)	NP
		10	SS 4B	50	6-3-4 (7)	NP
			SS 5	75	3-4-8-11 (12)	NP 3.0 P 4.5+ P
445	Black SILTY CLAY, moist, very stiff to hard, **(CL)**					
	End of boring at 13.0 feet.					



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BORING NUMBER B10

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/15/17 **COMPLETED** 3/15/17
GROUND ELEVATION 460.481 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
WHILE DRILLING 3.0 ft / Elev 457.5 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING ---
NOTES
24hrs AFTERDRILLING 11.8 ft / Elev 448.7 ft

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
460	ASH: Dark gray to black SILTY SAND - BOTTOM ASH, trace gravel, slag, moist to wet, medium dense to very dense, **(ASH)**	0				
			SS 1	100	4-6-8-12 (14)	NP
			SS 2A	87	10-12-11 (23)	NP
455		5	SS 2B	87	10-12-15 (27)	NP
			SS 3	93	6-7-10-60 (17)	NP
			SS 4A	100	21-14-22 (36)	NP
450		10	SS 4B	100	33-30-45 (75)	NP
	ASH: Gray SILT - FLY ASH, trace sand, moist, very dense, **(ASH)**		SS 5	100	9-21-60/0.25	NP
	Black SILTY CLAY, trace organics, moist, stiff, **(CL)**		SS 6A	83	2-2-4 (6)	NP
		15	SS 6B	83	6-7-6 (13)	1.5 P
445	γ_D= 92.80 pcf		ST 7	53		2.0 P
	End of boring at 18.5 feet.					0.25 P

SPT N VALUE
20 40 60 80
PL MC LL
20 40 60 80
UCS (tsf)
1 2 3 4

60/0.25
29

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B11

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/16/17 **COMPLETED** 3/16/17
GROUND ELEVATION 462.798 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
▽ **WHILE DRILLING** 1.0 ft / Elev 461.8 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING ---
NOTES
24hrs AFTERDRILLING Dry

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
	ASH: Dark gray and dark brown SANDY SILT - BOTTOM ASH, with interbedded black sand lenses, trace gravel, moist to wet, very loose, **(ASH)**	0	SS 1	90	2-2-1-1 (3)	NP
460			SS 2A	87	0-0-0 (0)	NP
		5	SS 2B	87	0-1-1 (2)	NP
			SS 3	75	0-0-0-1 (0)	NP
455			SS 4A	50	1-1-3 (4)	NP
	ASH: Brown SILT - FLY ASH, moist to wet, very loose, **(ASH)**	10	SS 4B	50	1-1-2 (3)	NP
	ASH: Gray SILT - FLY ASH, moist to wet, very loose, **(ASH)**		SS 5	80	1-1-1-2 (2)	NP
450			SS 6A	67	0-0-1 (1)	NP
		15	SS 6B	67	0-1-0 (1)	NP
	Brown SAND, trace gravel, wet, medium dense, **(SP)**		SS 7	70	1-1-6-13 (7)	NP
445	End of boring at 18.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ UCS (tsf) ☐
1 2 3 4

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B12

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/16/17 **COMPLETED** 3/16/17
GROUND ELEVATION 463.279 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
WHILE DRILLING 2.5 ft / Elev 460.8 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING Dry
NOTES
24hrs AFTERDRILLING Dry

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
	ASH: Gray SANDY SILT - BOTTOM ASH, trace coal, moist to wet, very loose, **(ASH)**	0				
			SS 1	75	1-1-2-3 (3)	NP
460			SS 2A	80	1-1-2 (3)	NP
	ASH: Dark gray to black SILTY SAND - BOTTOM ASH, with coal, moist, medium dense to very dense, **(ASH)**	5	SS 2B	80	9-18-16 (34)	NP
			SS 3	90	4-7-4-8 (11)	NP
455			SS 4A	67	1-1-3 (4)	NP
		10	SS 4B	67	6-9-9 (18)	NP
			SS 5	100	2-4-5-10 (9)	NP
450			SS 6	78	3-4-15-60 (19)	NP
	ASH: Gray SILT - FLY ASH, moist, very dense, **(ASH)**	15				
			SS 7	90	14-32-60/0.33	NP
	Brown SAND AND GRAVEL, moist, very dense, **(SP)**					
	End of boring at 17.3 feet.					

SPT N VALUE
20 40 60 80
PL MC LL
20 40 60 80
UCS (tsf)
1 2 3 4
60/0.33

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B13/LPZ-13

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/15/17 **COMPLETED** 3/15/17
GROUND ELEVATION 455.302 ft **BACKFILL** Monitoring Well MW-13
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
▽ **WHILE DRILLING** 1.0 ft / Elev 454.3 ft
CEC REP CAC **CHECKED BY** MDJ
▼ **AT END OF DRILLING** 3.0 ft / Elev 452.3 ft
NOTES
AFTERDRILLING ---

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
455		ASH: Gray ASPHALT, wet, very loose, **(ASH)**	0				
				SS 1	0	0-1-1-1 (2)	NP
				SS 2A	0	0-0-0 (0)	NP
450			5	SS 2B	0	1-0-0 (0)	NP
				SS 3	100	0-0-0-0 (0)	NP
				SS 4A	0	0-0-0 (0)	NP
445			10	SS 4B	0	0-0-0 (0)	NP
		Black SILTY CLAY, moist, medium stiff, **(CL)**		SS 5	50	1-2-2-3 (4)	NP 0.5 P
		End of boring at 13.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ UCS (tsf) ☐
1 2 3 4

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B14

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/14/17 **COMPLETED** 3/14/17
GROUND ELEVATION 461.529 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
▽ **WHILE DRILLING** 11.0 ft / Elev 450.5 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING Dry
NOTES
24hrs AFTERDRILLING Dry

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
	FILL: Black CLAYEY SILT, with sand, trace roots, moist, loose, **(OL-FILL)**	0				
460			SS 1	100	2-2-2-2 (4)	NP
			SS 2A	93	2-2-3 (5)	NP
	ASH: Gray SILT - FLY ASH, moist to wet, very loose to loose, **(ASH)**	5	SS 2B	93	3-5-4 (9)	NP
455			SS 3	75	1-1-1-1 (2)	NP
			SS 4A	90	1-1-1 (2)	NP
	ASH: Black and gray SILTY SAND - BOTTOM ASH, moist, **(ASH)**	10	SS 4B	90	1-4-3 (7)	NP
	▽ ASH: Gray SILT - FLY ASH, wet, very loose, **(ASH)**					
450			SS 5	100	0-0-1-0 (1)	NP
			SS 6A	100	2-2-1 (3)	NP
		15	SS 6B	100	1-1-2 (3)	NP 1.25 P
445	Black SILTY LOAM, moist, medium stiff, **(CL)** % Gravel ~ 0.1% % Sand ~ 33.4% % Silt ~ 43.7% % Clay ~ 22.9%		SS 7	45	0-1-1-1 (2)	1.0 P
	Black SANDY LOAM, moist, medium stiff, **(CL)** % Gravel ~ 0.1% % Sand ~ 52.3% % Silt ~ 33.5% % Clay ~ 14.2%		SS 8A	100	1-1-2 (3)	0.5 P
		20	SS 8B	100	3-4-3 (7)	0.5 P
	End of boring at 21.0 feet.					

SPT N VALUE: 20 40 60 80
PL MC LL: 20 40 60 80
UCS (tsf): 1 2 3 4
SS 7: 22 5 43
SS 8A: 15 20 26

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B15/LPZ-15

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/14/17 **COMPLETED** 3/14/17
GROUND ELEVATION 460.82 ft **BACKFILL** Monitoring Well MW-15
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
▽ **WHILE DRILLING** 6.0 ft / Elev 454.8 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING ---
NOTES
AFTERDRILLING ---

Elevation (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
460	ASH: Gray SILT - FLY ASH, trace fine gravel, moist, medium dense, **(ASH)**	0	SS 1	100	10-15-12-11 (27)	NP
			SS 2A	100	3-6-9 (15)	NP
		5	SS 2B	100	12-11-9 (20)	NP
455	ASH: Brown SILTY SAND - BOTTOM ASH, trace gravel, moist, medium dense, **(ASH)**		SS 3	100	3-3-6-14 (9)	NP
	ASH: Dark gray SANDY LOAM - BOTTOM ASH, trace gravel, slag, moist to wet, medium dense to very dense, **(ASH)**		SS 4A	100	3-12-27 (39)	NP
	% Gravel ~ 10.1% % Sand ~ 39.7% % Silt ~ 48.4% % Clay ~ 1.8%	10	SS 4B	100	26-60/0.42	NP
450			SS 5	100	6-14-18-29 (32)	NP
	Black LEAN CLAY, moist, stiff, **(CL)**		SS 6A	93	3-4-7 (11)	2.75
		15	SS 6B	93	8-6-5 (11)	1.5
445	Brown SANDY CLAY, wet, very soft, **(CL)**		SS 7	75	1-2-3-4 (5)	<0.25 P 0.25 P 1.75 P
	Brown LEAN CLAY, moist, soft to stiff, **(CL)**					
	End of boring at 18.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ UCS (tsf) ☐
1 2 3 4

60/0.42

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B16

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/14/17 **COMPLETED** 3/14/17
GROUND ELEVATION 462.696 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD CME Continuous Sampler
WHILE DRILLING 23.0 ft / Elev 439.7 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING 17.0 ft / Elev 445.7 ft
NOTES
24hrs AFTERDRILLING 16.0 ft / Elev 446.7 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ UCS (tsf) ☐ 1 2 3 4
		ASH: Gray SILTY SAND - BOTTOM ASH, some gravel, moist, medium dense, **(ASH)**	0					
460		ASH: Dark gray and brown SILTY SAND - BOTTOM ASH, some gravel, moist, dense, **(ASH)**		SS 1	54		NP	
			5					
		ASH: Gray GRAVELLY SILTY LOAM -, trace fine gravel, moist, dense to very dense, **(ASH)**		SS 2	73		NP	
455				SS 3	70		NP	
			10					
		% Gravel ~ 17.8% % Sand ~ 28.2% % Silt ~ 52.1% % Clay ~ 1.9% Wet at 11-ft to 12-ft.		SS 4	66		NP	
450			15					
				SS 5	76		NP	
445		ASH: Dark gray SANDY SILT - BOTTOM ASH, with slag, moist, very dense, **(ASH)**					NP	
		Black and brown LEAN CLAY, moist, medium stiff, **(CL)**					0.5 P 1.0 P	
			20					

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BORING NUMBER B16

CLIENT Dynegy Inc. - Hennepin Station **PROJECT NAME** Old West Ash Pond System: Data Gap Analysis

PROJECT NUMBER 164-478 **PROJECT LOCATION** Hennepin Station, Hennepin, Illinois

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ UCS (tsf) ☐ 1 2 3 4
		Gray SANDY CLAY, wet, medium stiff, **(CL)**	20				0.25 P	
440		▽		SS 6	50		1.5 P	
		Brown SAND, trace gravel, wet, **(SP)**	25				NP	
		End of boring at 25.0 feet.						

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BORING NUMBER B17/LPZ-17

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/14/17 **COMPLETED** 3/14/17
GROUND ELEVATION 460.931 ft **BACKFILL** Monitoring Well MW-17
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD CME Continuous Sampler
WHILE DRILLING 8.0 ft / Elev 452.9 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING ---
NOTES
48hrs AFTERDRILLING 13.0 ft / Elev 447.9 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	SPT N VALUE / PL MC LL / UCS (tsf)
460		ASH: Dark gray SILTY SAND - BOTTOM ASH, trace gravel, moist, medium dense to dense, **(ASH)**	0	SS 1	54		NP	
			5					
455		ASH: Gray SILT - FLY ASH, wet, **(ASH)**		SS 2	72		NP	
		ASH: Dark gray SILTY SAND - BOTTOM ASH, trace gravel, moist to wet, **(ASH)**	10					
450		ASH: Gray SILT - FLY ASH, wet, **(ASH)**		SS 3	84		NP	
			15					
445		Brown SAND, wet, **(SP)** % Gravel ~ 3.2% % Sand ~ 79.2% % Silt ~ 14.7%		SS 4	58		NP	
			20					

SPT N VALUE: 20 40 60 80
PL MC LL: 20 40 60 80
UCS (tsf): 1 2 3 4

GEOTECH - MDJ 164-478 WEST POND BORINGS.GPJ GEOTECHDATA.GDT 4/6/17

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BORING NUMBER B17/LPZ-17

CLIENT Dynegy Inc. - Hennepin Station **PROJECT NAME** Old West Ash Pond System: Data Gap Analysis

PROJECT NUMBER 164-478 **PROJECT LOCATION** Hennepin Station, Hennepin, Illinois

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ UCS (tsf) ☐ 1 2 3 4
		% Clay ~ 2.9%						
		End of boring at 20.0 feet.						

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BORING NUMBER B18

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/14/17 **COMPLETED** 3/14/17
GROUND ELEVATION 463.465 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD CME Continuous Sampler
WHILE DRILLING Dry
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING Dry
NOTES
AFTERDRILLING Dry

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ UCS (tsf) ☐ 1 2 3 4
		ASH: Gray SILT - FLY ASH, moist, **(ASH)**	0					
460		ASH: Black SILTY SAND - BOTTOM ASH, with gravel, moist, **(ASH)**		SS 1	44		NP	
			5					
455				SS 2	50		NP	
			10					
450		ASH: Gray SILTY LOAM - FLY ASH, trace fine gravel, moist, **(ASH)** % Gravel ~ 1.2% % Sand ~ 18.6% % Silt ~ 78.1% % Clay ~ 2.1%		SS 3	60		NP	
			15					
		Brown SAND AND GRAVEL, moist, medium dense, **(SP-GP)**		SS 4	87	14-17-11 (28)	NP	▲
		End of boring at 17.0 feet.						

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BORING NUMBER B19

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/17/17 **COMPLETED** 3/17/17
GROUND ELEVATION 463.793 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
WHILE DRILLING Dry
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING Dry
NOTES
AFTERDRILLING --

Elevation (ft)	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	MATERIAL DESCRIPTION
	0	SS 1	100	10-16-14 (30)	NP	FILL: Brown and gray SAND AND GRAVEL, moist, medium dense, **(GP-FILL)**
460		SS 2A	100	8-13-20 (33)	NP	FILL: Gray SILT, with gravel, moist, dense, **(ML-FILL)**
	5	SS 2B	100	19-32-24 (56)	NP	FILL: Dark brown SAND, with gravel, moist, very dense to loose, **(SP-FILL)**
		SS 3	75	10-7-6-6 (13)	NP	
455		SS 4A	17	3-3-4 (7)	NP	
	10	SS 4B	0	4-3-4 (7)	NP	
		SS 5	90	0-0-1-1 (1)	<0.25 P	FILL: Dark brown SILTY CLAY, trace gravel, moist, very soft, **(CL-FILL)**
450		SS 6A	83	0-1-2 (3)	<0.25 P	
	15	SS 6B	83	1-1-2 (3)	<0.25 P	FILL: Brown SANDY CLAY, trace gravel, moist, very soft, **(CL-FILL)**
		SS 7	85	0-0-1-1 (1)	<0.25 P	
445		SS 8A	100	0-0-1 (1)	NP	ASH: Gray SILT - FLY ASH, trace sand, wet, very loose, **(ASH)**
	20					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ UCS (tsf) ☐
1 2 3 4

(Continued Next Page)

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BORING NUMBER B19

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
			20				
		ASH: Gray SILT - FLY ASH, trace sand, wet, very loose, **(ASH)** *(continued)*		SS 8B	100	0-1-0 (1)	NP
				SS 9	90	0-0-1-2 (1)	NP
		Black SILTY CLAY, moist, medium stiff, **(CL)**					1.5 P
440				SS 10A	83	1-2-4 (6)	1.0 P
		Gray SILTY CLAY, moist, medium stiff, **(CL)**	25	SS 10B	83	4-5-5 (10)	1.0 P
				SS 11	100	2-2-3 (5)	1.0 P
435		Grades to brown.		SS 12	100	1-2-2-3 (4)	1.0 P
			30				
		End of boring at 30.0 feet.					

SPT N VALUE
20 40 60 80
PL MC LL
20 40 60 80
UCS (tsf)
1 2 3 4

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BORING NUMBER B20

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois
DATE STARTED 3/17/17 **COMPLETED** 3/17/17
GROUND ELEVATION 463.974 ft **BACKFILL** Bentonite/Ash
DRILLING CONTRACTOR Holcomb Foundation Engineering, Co
GROUND WATER LEVELS:
DRILLING METHOD HSA with Auto Hammer
▽ **WHILE DRILLING** 11.0 ft / Elev 453.0 ft
CEC REP CAC **CHECKED BY** MDJ
AT END OF DRILLING Dry, Cave in at 25 ft
NOTES
AFTERDRILLING --

Elevation (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
	0	FILL: Brown and gray SAND AND GRAVEL, moist, medium dense to dense, **(SP-FILL)**	SS 1	113	7-12-16-18 (28)	NP
460			SS 2A	63	34-22-17 (39)	NP
	5	FILL: Dark brown SILTY CLAY, some sand and gravel, moist, hard, **(CL-FILL)**	SS 2B	63	10-13-18 (31)	4.5+ P
		FILL: Brown and gray SAND AND GRAVEL, moist, medium dense, **(SP-FILL)**	SS 3	45	10-13-9-7 (22)	NP
455			SS 4A	33	4-5-5 (10)	NP
	10		SS 4B	33	4-4-3 (7)	NP
		▽ ASH: Gray SILT - FLY ASH, trace sand, moist to wet, very loose, **(ASH)**	SS 5	60	0-1-0-0 (1)	NP
450			SS 6A	93	1-1-1 (2)	NP
	15		SS 6B	93	1-2-2 (4)	NP
			SS 7	70	1-0-0-1 (0)	NP
445			SS 8A	50	0-0-0 (0)	NP
	20					

SPT N VALUE: 20 40 60 80
PL MC LL: 20 40 60 80
UCS (tsf): 1 2 3 4

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BORING NUMBER B20

CLIENT Dynegy Inc. - Hennepin Station
PROJECT NAME Old West Ash Pond System: Data Gap Analysis
PROJECT NUMBER 164-478
PROJECT LOCATION Hennepin Station, Hennepin, Illinois

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
			20	SS 8B	50	0-0-1 (1)	NP
		Black to gray SILTY CLAY, moist, medium stiff, **(CL-FILL)**		SS 9	40	2-3-3-4 (6)	1.0 P
440				SS 10	55	2-3-3-3 (6)	0.75 P
			25	SS 11	90	2-2-2-2 (4)	0.5 P
				SS 12	70	1-2-2-2 (4)	0.75 P
435		End of boring at 29.0 feet.					

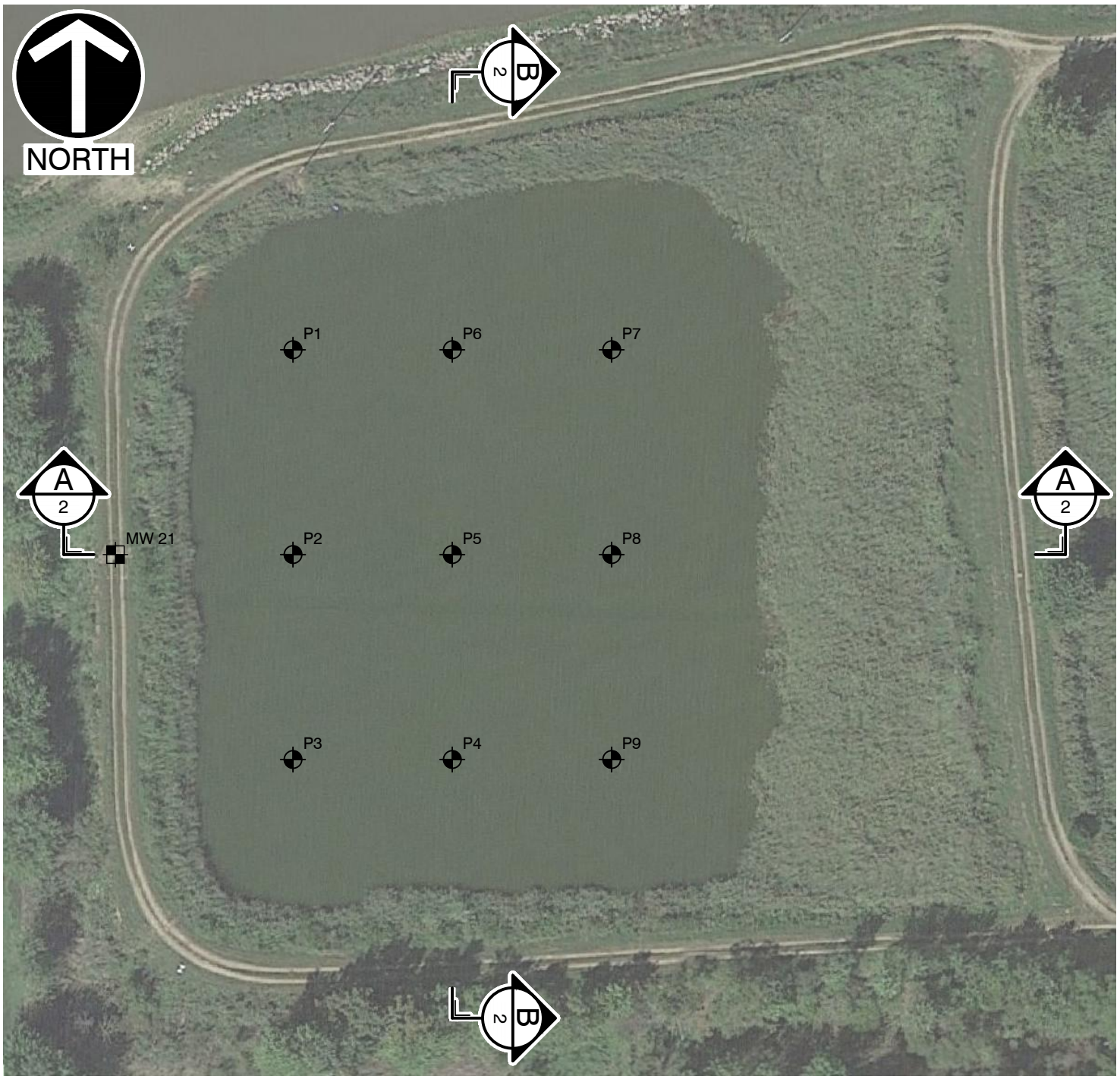
▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ UCS (tsf) ☐
1 2 3 4

Leachate Well Construction Details
West Ash Ponds 1 and 3
Hennepin Power Station

Monitoring Well:	TOP to TOC (ft)	TOP to GS (ft)	Bottom of Well to TOC (ft)	$ELEV_{GS}$	$ELEV_{BOT}$	$ELEV_{TOP}$	$ELEV_{TOC}$
LPZ-1	0.05	3	14.4	454.9	443.5	457.9	457.9
LPZ-3	0.0625	4.25	14.35	460.2	450.0	464.5	464.4
LPZ-5	0.05	3	10.46	463.1	455.6	466.1	466.0
LPZ-13	0.05	2.8	14.25	455.3	443.8	458.1	458.1
LPZ-15	0.05	3	15.3	460.8	448.5	463.8	463.8
LPZ-17	0.05	3	21.1	460.9	442.8	463.9	463.9

Notes:

GS	Ground Surface
BOT	Bottom of Well
TOC	Top of Well Casing
TOP	Top of Protective Pipe
GW	Ground Water



REFERENCE

1. IMAGE PROVIDED BY GOOGLE EARTH. DATE OF IMAGE: SEPTEMBER 20, 2015.
2. BASE TOPOGRAPHIC INFORMATION PROVIDED BY WEAVER CONSULTANTS GROUP. FILE 4153-300-11-01 DATED DECEMBER 1, 2015.

LEGEND

P8 — SAMPLE LOCATION

MW 21 — MONITORING WELL No. 21 INSTALLED BY JOHN MATHES & ASSOCIATES, DEC. 1992. GROUND SURFACE ELEV. = 460.0 FEET.

*HAND SIGNATURE ON FILE

SCALE IN FEET

0 80 160

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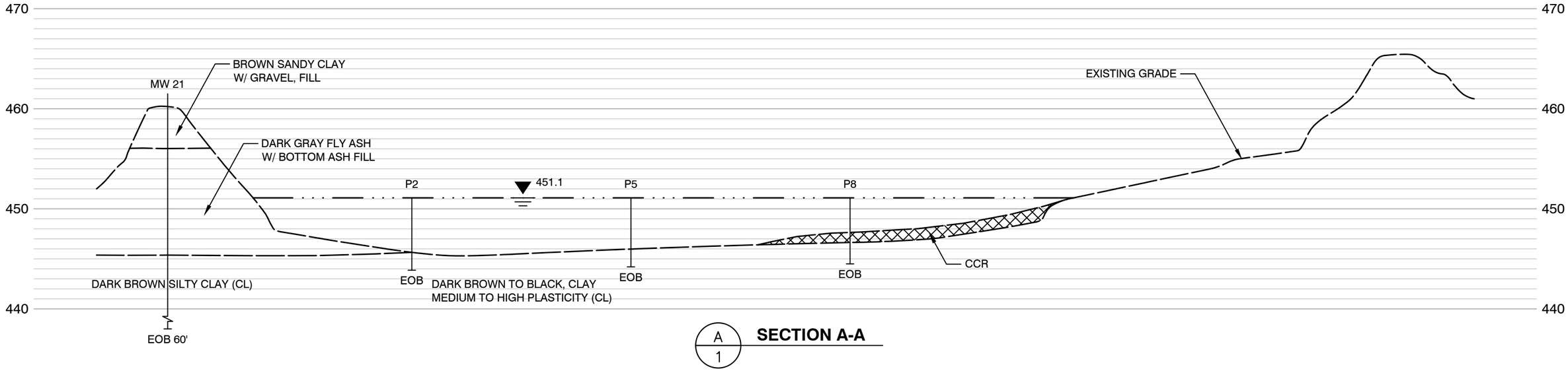
DYNEGY INC.
OLD WEST FINISHING POND
HENNEPIN POWER STATION
HENNEPIN, ILLINOIS

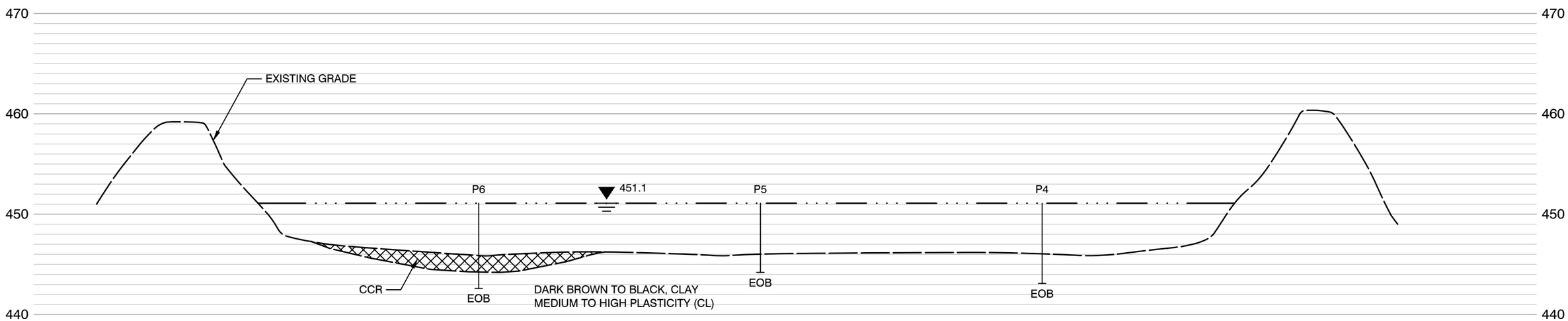
SAMPLE LOCATION PLAN

DRAWN BY:	MSK	CHECKED BY:	MDJ	APPROVED BY:	MDJ*	FIGURE NO.:	1
DATE:	04/01/2016	DWG SCALE:	1"=80'	PROJECT NO:	160-905.0100		

P:\2016\160-905\-CADD\Dwg\ENO1-Sample Locations\160905-ENO1-E100 Sample Location Plan.dwg{LAYOUT1} LS:(4/1/2016 - mkarpf) - LP: 4/1/2016 12:47 PM



A/1 **SECTION A-A**



B/1 **SECTION B-B**

***HAND SIGNATURE ON FILE**

HORIZONTAL SCALE
SCALE IN FEET
0 40 160

VERTICAL SCALE
SCALE IN FEET
0 10 20

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HENNEPIN POWER STATION
HENNEPIN, ILLINOIS

CROSS-SECTIONS

DRAWN BY:	MSK	CHECKED BY:	MDJ	APPROVED BY:	MDJ*	FIGURE NO.:	2
DATE:	04/01/2016	DWG SCALE:	AS SHOWN	PROJECT NO:	160-905.0100		

P:\2016\160-905\-CADD\Dwg\EN01-Sample Locations\160905-EN01-E100 Sample Location Plan.dwg[LAYOUT2] LS:(4/1/2016 - mkarpl) - LP: 4/1/2016 1:23 PM

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BORING NUMBER P1

CLIENT Dynegy, Inc.
PROJECT NAME Old West Polishing Pond Site Investigation
PROJECT NUMBER 160-905
PROJECT LOCATION Hennepin Power Station
DATE STARTED 3/29/16 **COMPLETED** 3/29/16
GROUND ELEVATION 451.1 ft **BACKFILL** none
DRILLING CONTRACTOR Patrick Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Sampling
WHILE DRILLING 0.0 ft / Elev 451.1 ft
CEC REP MDJ **CHECKED BY** CAC
AT END OF DRILLING 0.0 ft / Elev 451.1 ft
NOTES
AFTER DRILLING 0.0 ft / Elev 451.1 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
		WATER	0.0				
450.0			2.5				
447.5			5.0				
445.0		Dark brown to black CLAY, trace sand, wet, soft to medium stiff, medium to high plasticity, **(CL)**		SP 1			<0.25
		Sample S-1 collected 6.0 to 6.4 feet.					0.5 to 0.75
		End of boring at 6.4 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ UCS (tsf) ☐
1 2 3 4

GEOTECH - MDJ 160-905 BORING LOGS.GPJ GEOTECHDATA.GDT 3/31/16

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BORING NUMBER P2

CLIENT Dynegy, Inc.
PROJECT NAME Old West Polishing Pond Site Investigation
PROJECT NUMBER 160-905
PROJECT LOCATION Hennepin Power Station
DATE STARTED 3/29/16 **COMPLETED** 3/29/16
GROUND ELEVATION 451.1 ft **BACKFILL** none
DRILLING CONTRACTOR Patrick Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Sampling
WHILE DRILLING 0.0 ft / Elev 451.1 ft
CEC REP MDJ **CHECKED BY** CAC
AT END OF DRILLING 0.0 ft / Elev 451.1 ft
NOTES
AFTER DRILLING 0.0 ft / Elev 451.1 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ UCS (tsf) ☐ 1 2 3 4
		▼ WATER	0.0					
450.0			2.5					
447.5			5.0					
		Sample S-1 collected 5.6 to 6.0 feet.						
		Dark brown to black CLAY, wet, soft, **(CL)**					<0.25	
445.0		Dark brown to black CLAY, trace sand, wet to moist, soft to medium stiff, medium high plasticity, **(CL)**		SP 1				
		Sample S-2 collected 6.5 to 6.9 feet.					0.5 to 0.75	
		End of boring at 7.5 feet.	7.5					

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BORING NUMBER P3

CLIENT Dynegy, Inc.
PROJECT NAME Old West Polishing Pond Site Investigation
PROJECT NUMBER 160-905
PROJECT LOCATION Hennepin Power Station
DATE STARTED 3/29/16 **COMPLETED** 3/29/16
GROUND ELEVATION 451.1 ft **BACKFILL** none
DRILLING CONTRACTOR Patrick Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Sampling
WHILE DRILLING 0.0 ft / Elev 451.1 ft
CEC REP MDJ **CHECKED BY** CAC
AT END OF DRILLING 0.0 ft / Elev 451.1 ft
NOTES
AFTER DRILLING 0.0 ft / Elev 451.1 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	SPT N VALUE / PL MC LL / UCS (tsf)
		▼ WATER	0.0					
450.0			2.5					
447.5			5.0					
445.0		Dark brown to black CLAY, wet, very soft, **(CL)**					<0.25	
		Dark brown to black CLAY, trace sand, wet to moist, soft to medium stiff, medium high plasticity, **(CL)**		SP 1			0.5	
		Sample S-1 collected 6.4 to 6.8 feet.	7.5					
		End of boring at 7.6 feet.						

SPT N VALUE: 20 40 60 80
PL MC LL: 20 40 60 80
UCS (tsf): 1 2 3 4

GEOTECH - MDJ 160-905 BORING LOGS.GPJ GEOTECHDATA.GDT 3/31/16

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BORING NUMBER P4

CLIENT Dynegy, Inc.
PROJECT NAME Old West Polishing Pond Site Investigation
PROJECT NUMBER 160-905
PROJECT LOCATION Hennepin Power Station
DATE STARTED 3/29/16 **COMPLETED** 3/29/16
GROUND ELEVATION 451.1 ft **BACKFILL** none
DRILLING CONTRACTOR Patrick Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Sampling
WHILE DRILLING 0.0 ft / Elev 451.1 ft
CEC REP MDJ **CHECKED BY** CAC
AT END OF DRILLING 0.0 ft / Elev 451.1 ft
NOTES
AFTER DRILLING 0.0 ft / Elev 451.1 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ UCS (tsf) ☐ 1 2 3 4
		▼ WATER	0.0					
450.0			2.5					
447.5			5.0					
445.0		Dark brown to black CLAY, wet, soft, **(CL)**					<0.25	
		Dark brown to black CLAY, trace sand, wet to moist, soft to medium stiff, medium high plasticity, **(CL)**		SP 1			0.5	
			7.5					
		End of boring at 8.0 feet.						

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BORING NUMBER P5

CLIENT Dynegy, Inc.
PROJECT NAME Old West Polishing Pond Site Investigation
PROJECT NUMBER 160-905
PROJECT LOCATION Hennepin Power Station
DATE STARTED 3/29/16 **COMPLETED** 3/29/16
GROUND ELEVATION 451.1 ft **BACKFILL** none
DRILLING CONTRACTOR Patrick Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Sampling
WHILE DRILLING 0.0 ft / Elev 451.1 ft
CEC REP MDJ **CHECKED BY** CAC
AT END OF DRILLING 0.0 ft / Elev 451.1 ft
NOTES
AFTER DRILLING 0.0 ft / Elev 451.1 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	SPT N VALUE / PL MC LL / UCS (tsf)
		▼ WATER	0.0					
450.0			2.5					
447.5			5.0				<0.25	
		Dark brown to black CLAY, wet, soft, **(CL)**						
445.0		Dark brown to black CLAY, trace sand, wet to moist, soft to medium stiff, medium high plasticity, **(CL)**		SP 1			0.5	
		Sample S-1 collected 6.5 to 6.9 feet.						
		End of boring at 6.9 feet.						

SPT N VALUE: 20 40 60 80
PL MC LL: 20 40 60 80
UCS (tsf): 1 2 3 4

GEOTECH - MDJ 160-905 BORING LOGS.GPJ GEOTECHDATA.GDT 3/31/16

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BORING NUMBER P6

CLIENT Dynegy, Inc.
PROJECT NAME Old West Polishing Pond Site Investigation
PROJECT NUMBER 160-905
PROJECT LOCATION Hennepin Power Station
DATE STARTED 3/29/16 **COMPLETED** 3/29/16
GROUND ELEVATION 451.1 ft **BACKFILL** none
DRILLING CONTRACTOR Patrick Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Sampling
WHILE DRILLING 0.0 ft / Elev 451.1 ft
CEC REP MDJ **CHECKED BY** CAC
AT END OF DRILLING 0.0 ft / Elev 451.1 ft
NOTES
AFTER DRILLING 0.0 ft / Elev 451.1 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	SPT N VALUE / PL MC LL / UCS (tsf)
		WATER	0.0					
450.0			2.5					
447.5			5.0					
445.0		Light gray ASH, wet, very loose, **(ASH)** Sample S-1 collected 5.6 to 6.0 feet.		SP 1			NP	
		Dark brown to black CLAY, trace sand, wet to moist, soft to medium stiff, medium high plasticity, **(CL)** Sample S-2 collected 8.0 to 8.4 feet.	7.5				0.25 to 0.5	
		End of boring at 8.5 feet.						

SPT N VALUE: 20 40 60 80
PL MC LL: 20 40 60 80
UCS (tsf): 1 2 3 4

GEOTECH - MDJ 160-905 BORING LOGS.GPJ GEOTECHDATA.GDT 3/31/16

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BORING NUMBER P7

CLIENT Dynegy, Inc.
PROJECT NAME Old West Polishing Pond Site Investigation
PROJECT NUMBER 160-905
PROJECT LOCATION Hennepin Power Station
DATE STARTED 3/29/16 **COMPLETED** 3/29/16
GROUND ELEVATION 451.1 ft **BACKFILL** none
DRILLING CONTRACTOR Patrick Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Sampling
WHILE DRILLING 0.0 ft / Elev 451.1 ft
CEC REP MDJ **CHECKED BY** CAC
AT END OF DRILLING 0.0 ft / Elev 451.1 ft
NOTES
AFTER DRILLING 0.0 ft / Elev 451.1 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	SPT N VALUE / PL MC LL / UCS (tsf)
		WATER	0.0					
450.0			2.5					
447.5		Light gray ASH, wet, very loose, **(ASH)**						
		Sample S-1 collected 4.3 to 4.7 feet.	5.0	SP 1			NP	
445.0		Dark brown to black CLAY, trace sand, wet to moist, soft to medium stiff, medium high plasticity, **(CL)**						
		Sample S-2 collected 6.9 to 7.3 feet.	7.5				0.25 to 0.5	
		End of boring at 7.8 feet.						

GEOTECH - MDJ 160-905 BORING LOGS.GPJ GEOTECHDATA.GDT 3/31/16

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BORING NUMBER P8

CLIENT Dynegy, Inc.
PROJECT NAME Old West Polishing Pond Site Investigation
PROJECT NUMBER 160-905
PROJECT LOCATION Hennepin Power Station
DATE STARTED 3/29/16 **COMPLETED** 3/29/16
GROUND ELEVATION 451.1 ft **BACKFILL** none
DRILLING CONTRACTOR Patrick Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Sampling
WHILE DRILLING 0.0 ft / Elev 451.1 ft
CEC REP MDJ **CHECKED BY** CAC
AT END OF DRILLING 0.0 ft / Elev 451.1 ft
NOTES
AFTER DRILLING 0.0 ft / Elev 451.1 ft

Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ UCS (tsf) ☐ 1 2 3 4
		WATER	0.0					
450.0			2.5					
447.5		Light gray ASH, wet, very loose, **(ASH)**		SP 1			NP	
445.0		Dark brown to black CLAY, trace sand, wet to moist, soft to medium stiff, medium high plasticity, **(CL)**	5.0				<0.25 to 0.5	
		End of boring at 6.2 feet.						

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BORING NUMBER P9

CLIENT Dynegy, Inc.
PROJECT NAME Old West Polishing Pond Site Investigation
PROJECT NUMBER 160-905
PROJECT LOCATION Hennepin Power Station
DATE STARTED 3/29/16 **COMPLETED** 3/29/16
GROUND ELEVATION 451.1 ft **BACKFILL** none
DRILLING CONTRACTOR Patrick Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Sampling
WHILE DRILLING 0.0 ft / Elev 451.1 ft
CEC REP MDJ **CHECKED BY** CAC
AT END OF DRILLING 0.0 ft / Elev 451.1 ft
NOTES
AFTER DRILLING 0.0 ft / Elev 451.1 ft

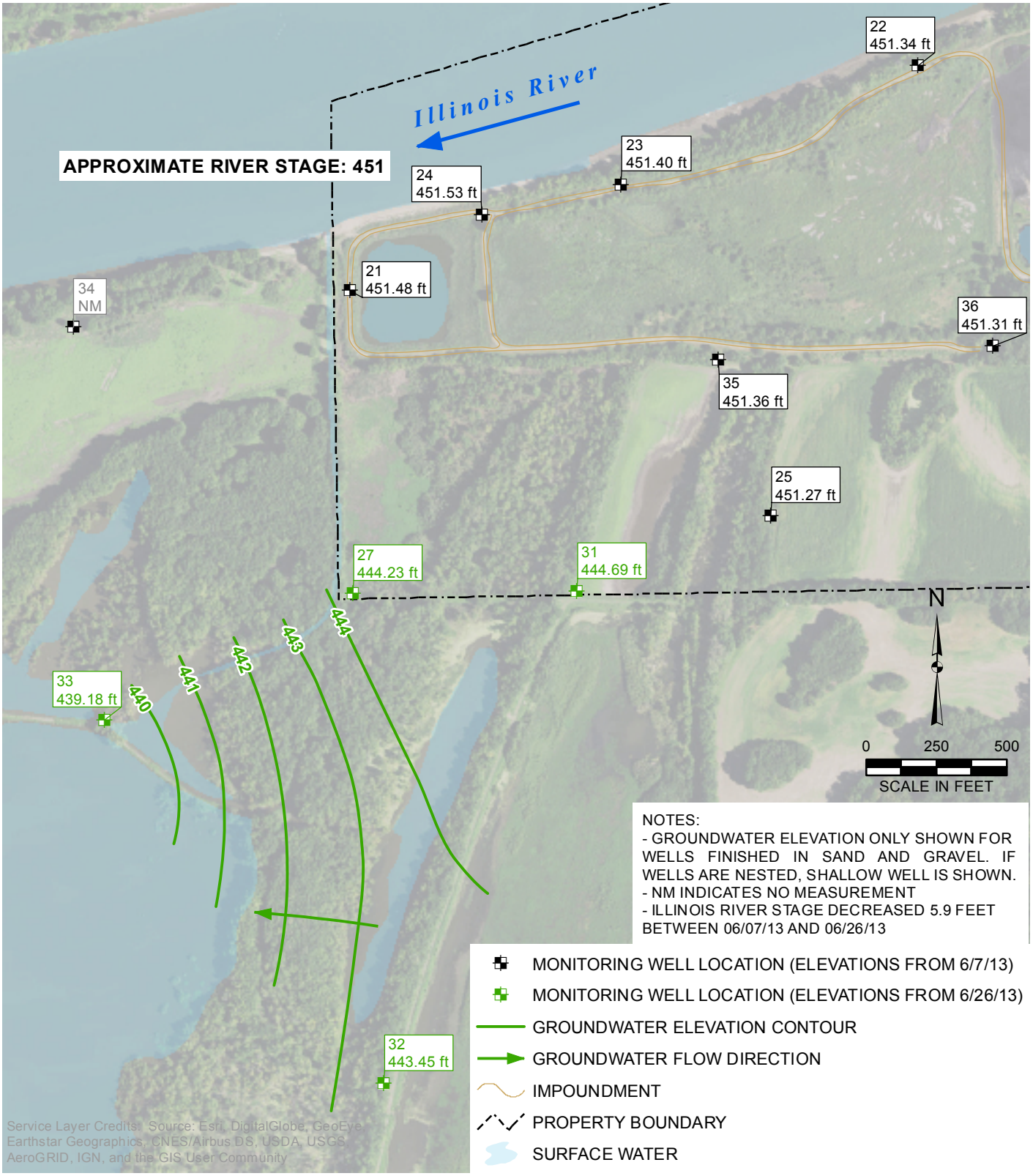
Elevation (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	SPT N VALUE / PL MC LL / UCS (tsf)
		WATER	0.0					
450.0			2.5					
447.5		Light gray ASH, wet, very loose, **(ASH)**	5.0	SP 1			NP	
445.0		Dark brown to black CLAY, trace sand, wet to moist, soft to medium stiff, medium high plasticity, **(CL)**					<0.25 to 0.75	
		Sample S-1 collected 6.7 to 7.1 feet.						
		End of boring at 7.1 feet.						

SPT N VALUE: 20 40 60 80
PL MC LL: 20 40 60 80
UCS (tsf): 1 2 3 4

GEOTECH - MDJ 160-905 BORING LOGS.GPJ GEOTECHDATA.GDT 3/31/16

Appendix B

Water Table Contour Maps 2013 through 2016



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DRAWN BY/DATE:
SDS 4/19/17
REVIEWED BY/DATE:
RJK 4/19/17
APPROVED BY/DATE:
RJK _/_/17

WATER TABLE CONTOUR MAP
JUNE 7 AND 26, 2013

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

APPENDIX B

Natural Resource Technology
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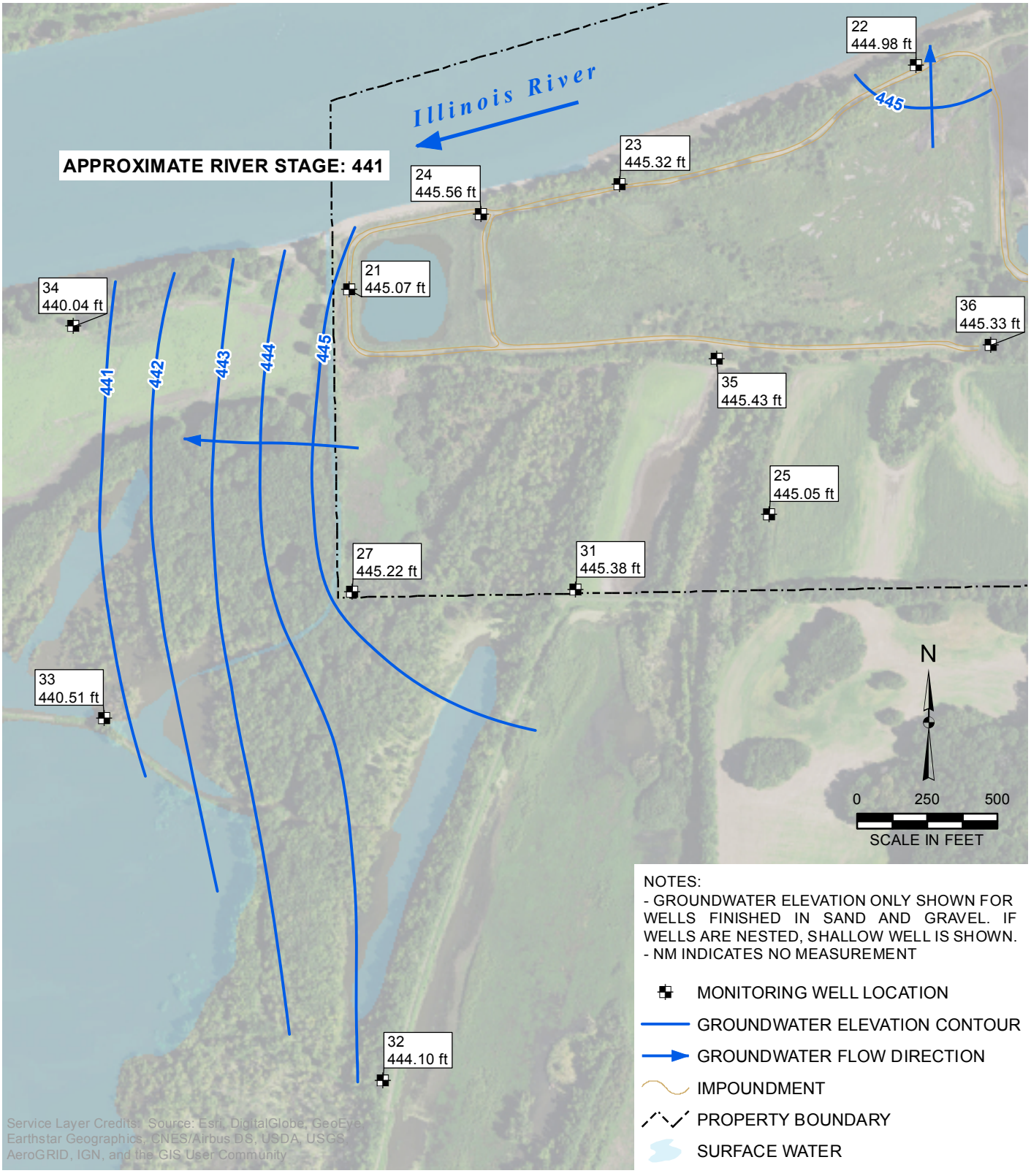

NOTES:
- GROUNDWATER ELEVATION ONLY SHOWN FOR WELLS FINISHED IN SAND AND GRAVEL. IF WELLS ARE NESTED, SHALLOW WELL IS SHOWN.
- NM INDICATES NO MEASUREMENT

- MONITORING WELL LOCATION
- GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- IMPOUNDMENT
- PROPERTY BOUNDARY
- SURFACE WATER

DRAWN BY/DATE:
SDS 4/19/17
REVIEWED BY/DATE:
RJK 4/19/17
APPROVED BY/DATE:
RJK _/_/17

WATER TABLE CONTOUR MAP
SEPTEMBER 3, 2013

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

APPENDIX B

Natural Resource Technology
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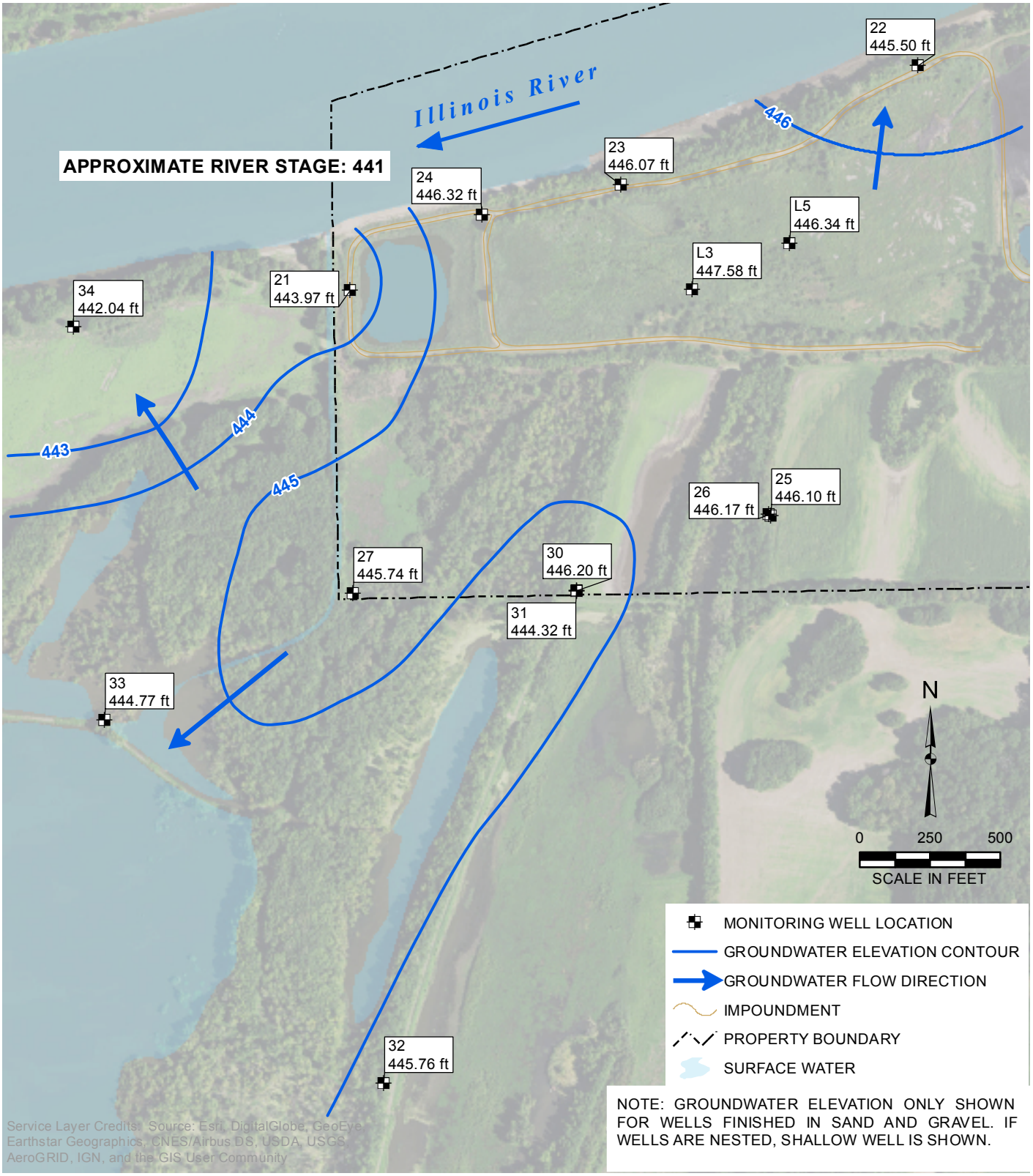
Y:\Mapping\Projects\2412413\MXD\AppB_2_GWE Contour Map_Sept2013.mxd Author: stolzsd; Date/Time: 4/20/2017, 11:42:42 AM



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DRAWN BY/DATE:
SDS 4/19/17
REVIEWED BY/DATE:
RJK 4/19/17
APPROVED BY/DATE:
RJK _/_/17

WATER TABLE CONTOUR MAP
DECEMBER 10, 2013

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

APPENDIX B

Natural Resource Technology
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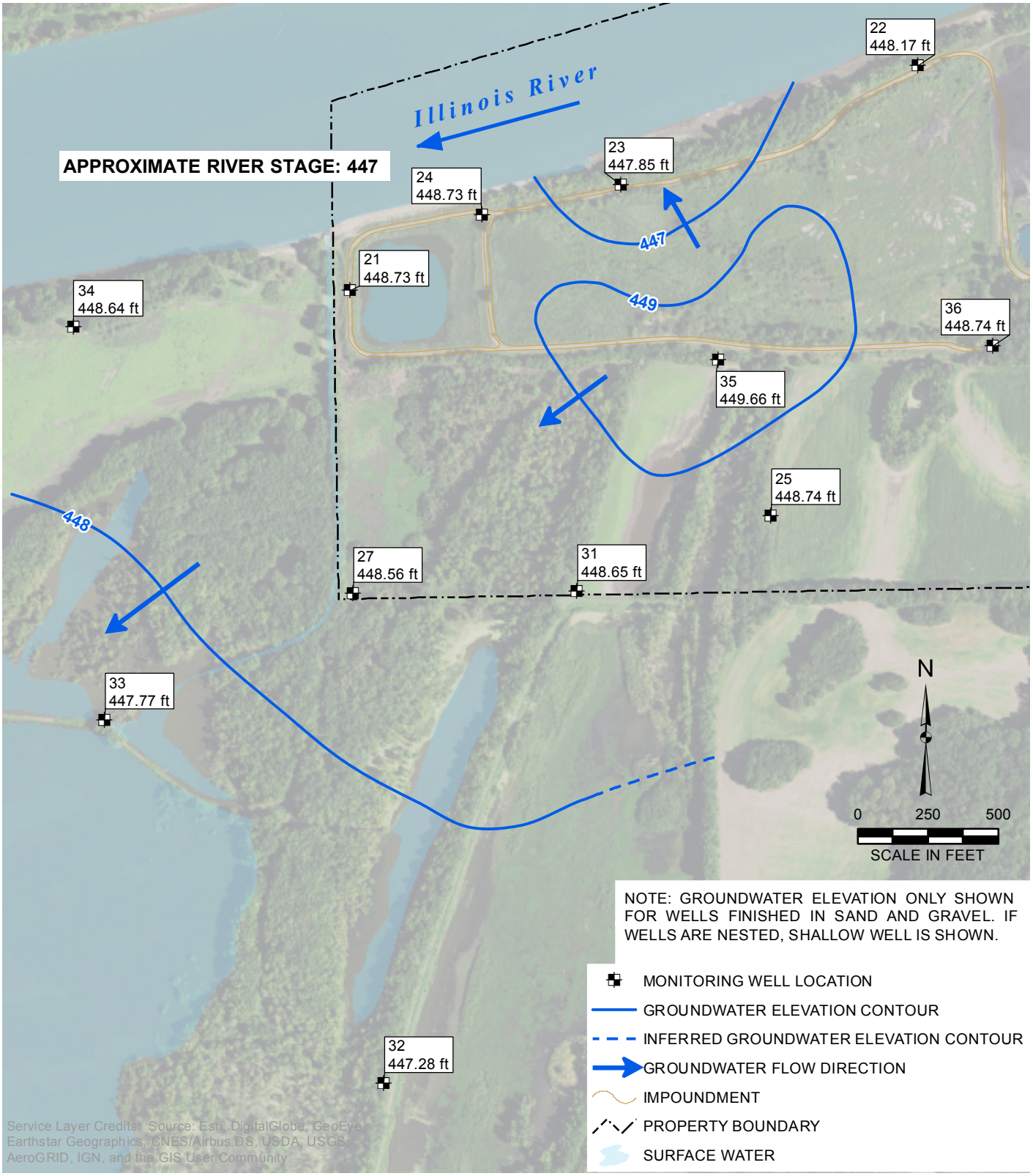

NOTE: GROUNDWATER ELEVATION ONLY SHOWN FOR WELLS FINISHED IN SAND AND GRAVEL. IF WELLS ARE NESTED, SHALLOW WELL IS SHOWN.

- MONITORING WELL LOCATION
- GROUNDWATER ELEVATION CONTOUR
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- IMPOUNDMENT
- PROPERTY BOUNDARY
- SURFACE WATER

DRAWN BY/DATE:
SDS 4/19/17
REVIEWED BY/DATE:
RJK 4/19/17
APPROVED BY/DATE:
RJK _/_/17

WATER TABLE CONTOUR MAP
MARCH 25, 2014

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

APPENDIX B

Natural Resource Technology
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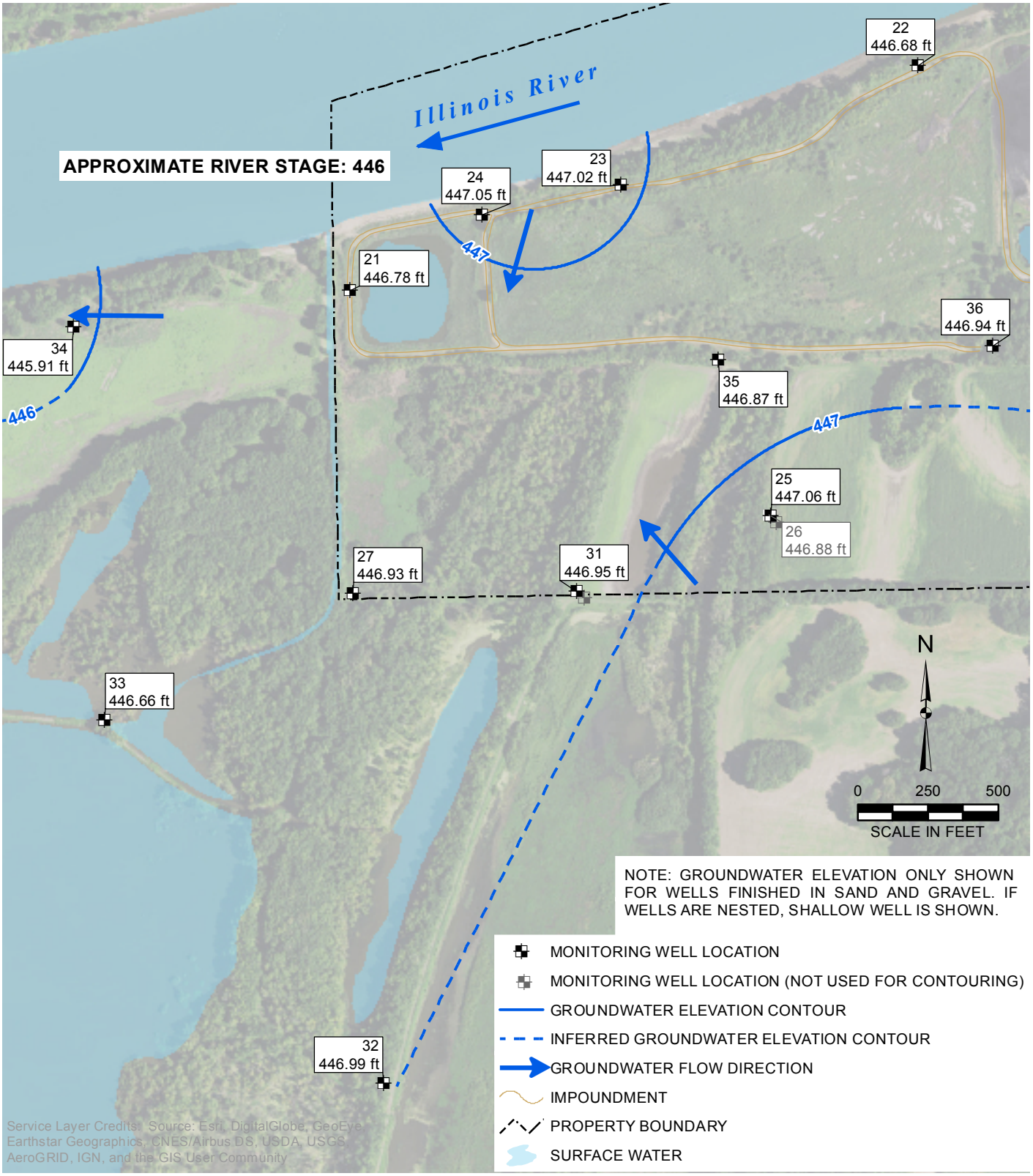
Y:\Mapping\Projects\2412413\MXD\AppB_4_GWE Contour Map_March 2014.mxd Author: stolzsd; Date/Time: 4/20/2017, 11:45:09 AM



DRAWN BY/DATE:
SDS 4/19/17
REVIEWED BY/DATE:
RJK 4/19/17
APPROVED BY/DATE:
RJK _/_/17

WATER TABLE CONTOUR MAP
MARCH 18, 2015

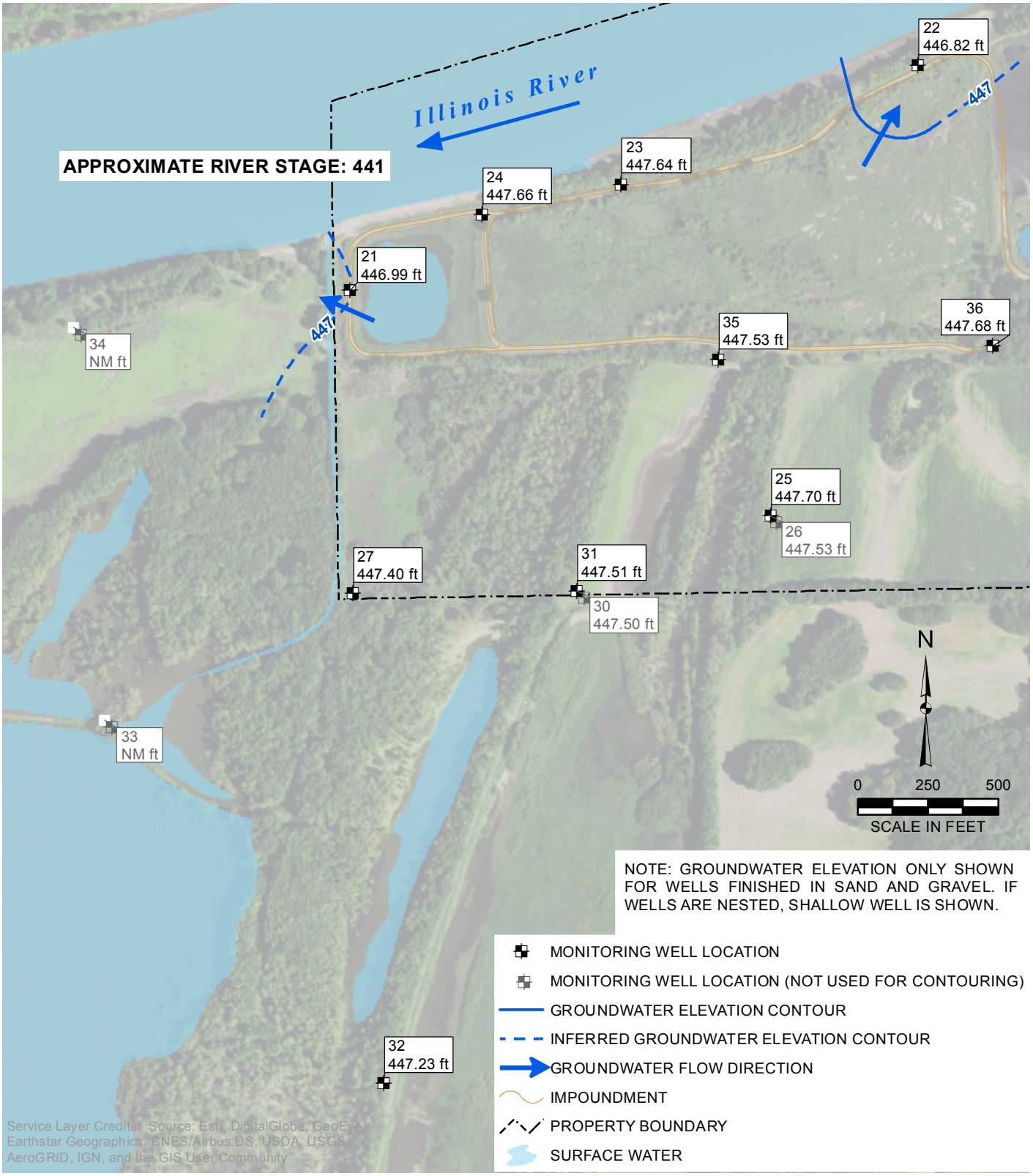
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

APPENDIX B

Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\2412413\MXD\AppB_5_GWE Contour Map_March 2015.mxd Author: stolzsd; Date/Time: 4/20/2017, 11:48:25 AM



DRAWN BY/DATE:
SDS 4/19/17
REVIEWED BY/DATE:
RJK 4/19/17
APPROVED BY/DATE:
RJK _/_/17

WATER TABLE CONTOUR MAP
SEPTEMBER 16, 2015

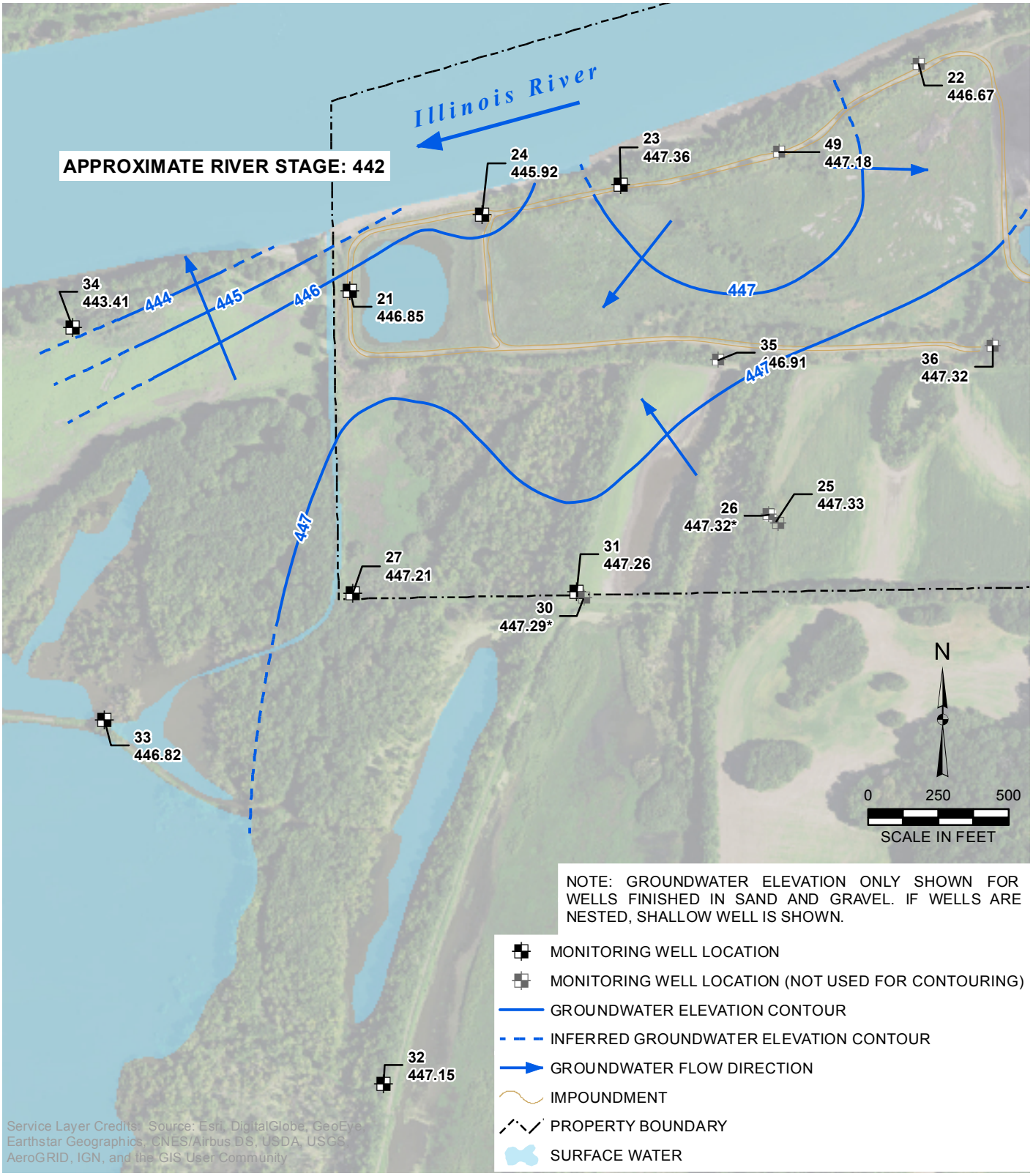
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

APPENDIX B

Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\2412413\MXD\AppB_6_GWE Contour Map_Sept2015.mxd Author: stolzsd; Date/Time: 4/20/2017, 11:49:37 AM



DRAWN BY/DATE:
SDS 4/19/17
REVIEWED BY/DATE:
RJK 4/19/17
APPROVED BY/DATE:
RJK _/_/17

WATER TABLE CONTOUR MAP
MARCH 8, 2016

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

APPENDIX B

Natural Resource Technology
AN OBG COMPANY

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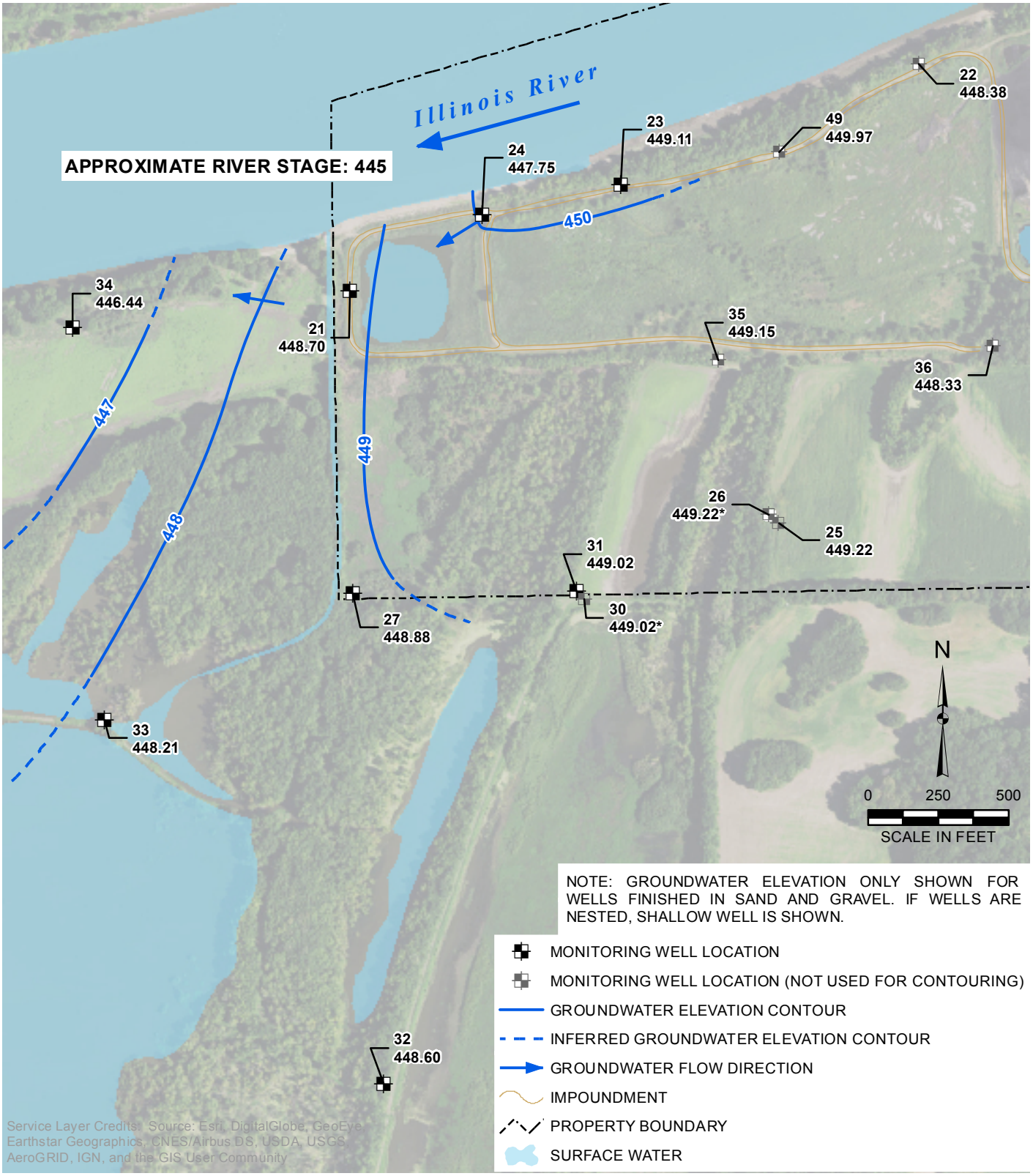


NOTE: GROUNDWATER ELEVATION ONLY SHOWN FOR WELLS FINISHED IN SAND AND GRAVEL. IF WELLS ARE NESTED, SHALLOW WELL IS SHOWN.

- MONITORING WELL LOCATION
- MONITORING WELL LOCATION (NOT USED FOR CONTOURING)
- GROUNDWATER ELEVATION CONTOUR
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- IMPOUNDMENT
- PROPERTY BOUNDARY
- SURFACE WATER

DRAWN BY/DATE:
SDS 4/19/17
REVIEWED BY/DATE:
RJK 4/19/17
APPROVED BY/DATE:
RJK _/_/17

WATER TABLE CONTOUR MAP
SEPTEMBER 18, 2016

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

APPENDIX B

Natural Resource Technology
AN OBG COMPANY

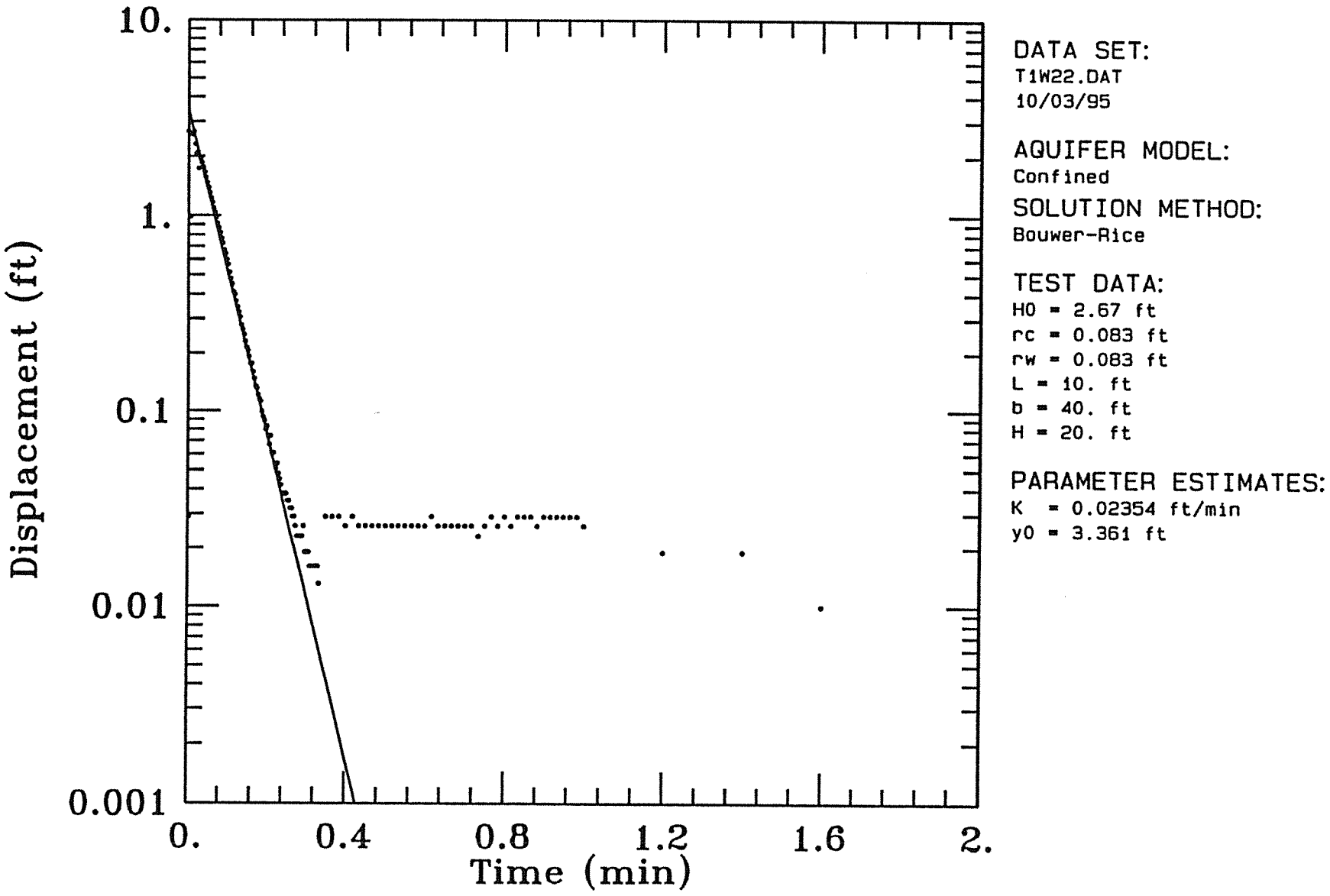
Y:\Mapping\Projects\2412413\MXD\AppB_8_GWE Contour Map_Sept2016.mxd Author: stolzsd; Date/Time: 4/20/2017, 11:56:38 AM

Appendix C

Hydraulic Conductivity Test Data

Appendix C1

STMI Field Hydraulic Conductivity Tests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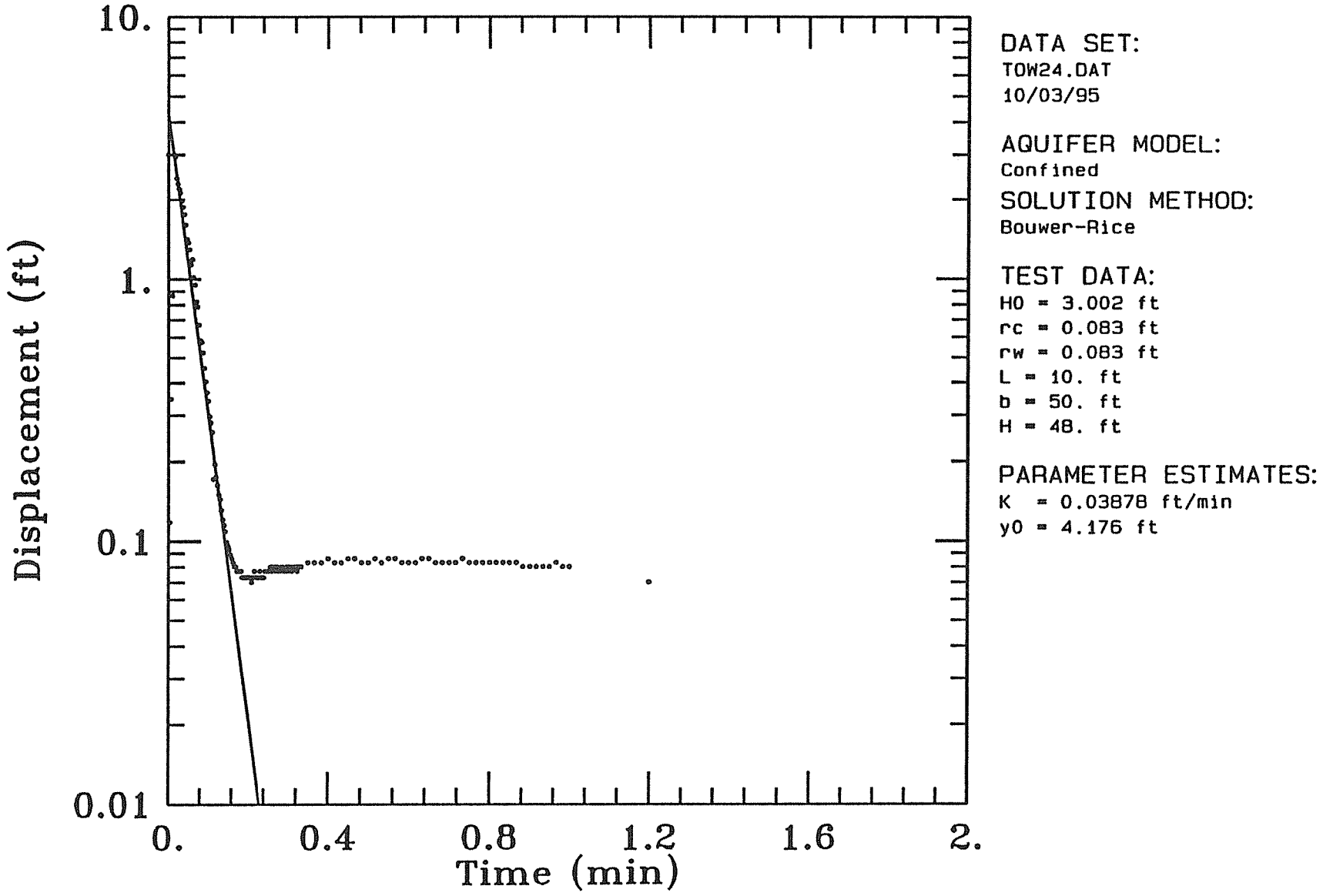
1.
0.1
0.01
0.001
Displacement (ft)
0.
0.4
0.8
1.2
1.6
2.
Time (min)
DATA SET:
T1W22.DAT
10/03/95
AQUIFER MODEL:
Confined
SOLUTION METHOD:
Bouwer-Rice
TEST DATA:
H0 = 2.67 ft
rc = 0.083 ft
rw = 0.083 ft
L = 10. ft
b = 40. ft
H = 20. ft
PARAMETER ESTIMATES:
K = 0.02354 ft/min
y0 = 3.361 ft

AQTESOLV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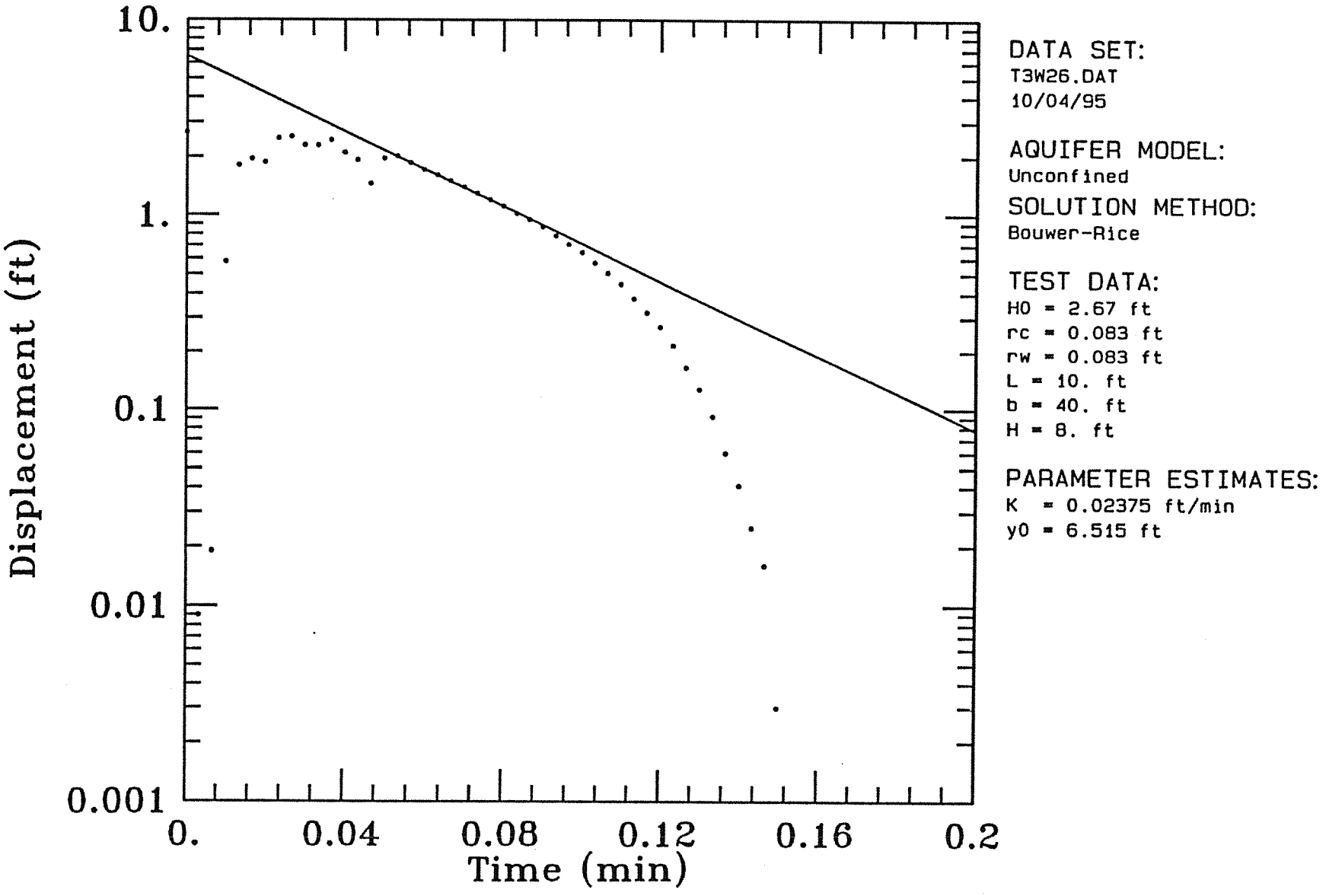
1.6
2.
Time (min)
DATA SET:
TOW24.DAT
10/03/95
AQUIFER MODEL:
Confined
SOLUTION METHOD:
Bouwer-Rice
TEST DATA:
H0 = 3.002 ft
rc = 0.083 ft
rw = 0.083 ft
L = 10. ft
b = 50. ft
H = 48. ft
PARAMETER ESTIMATES:
K = 0.03878 ft/min
y0 = 4.176 ft

AQTESOLV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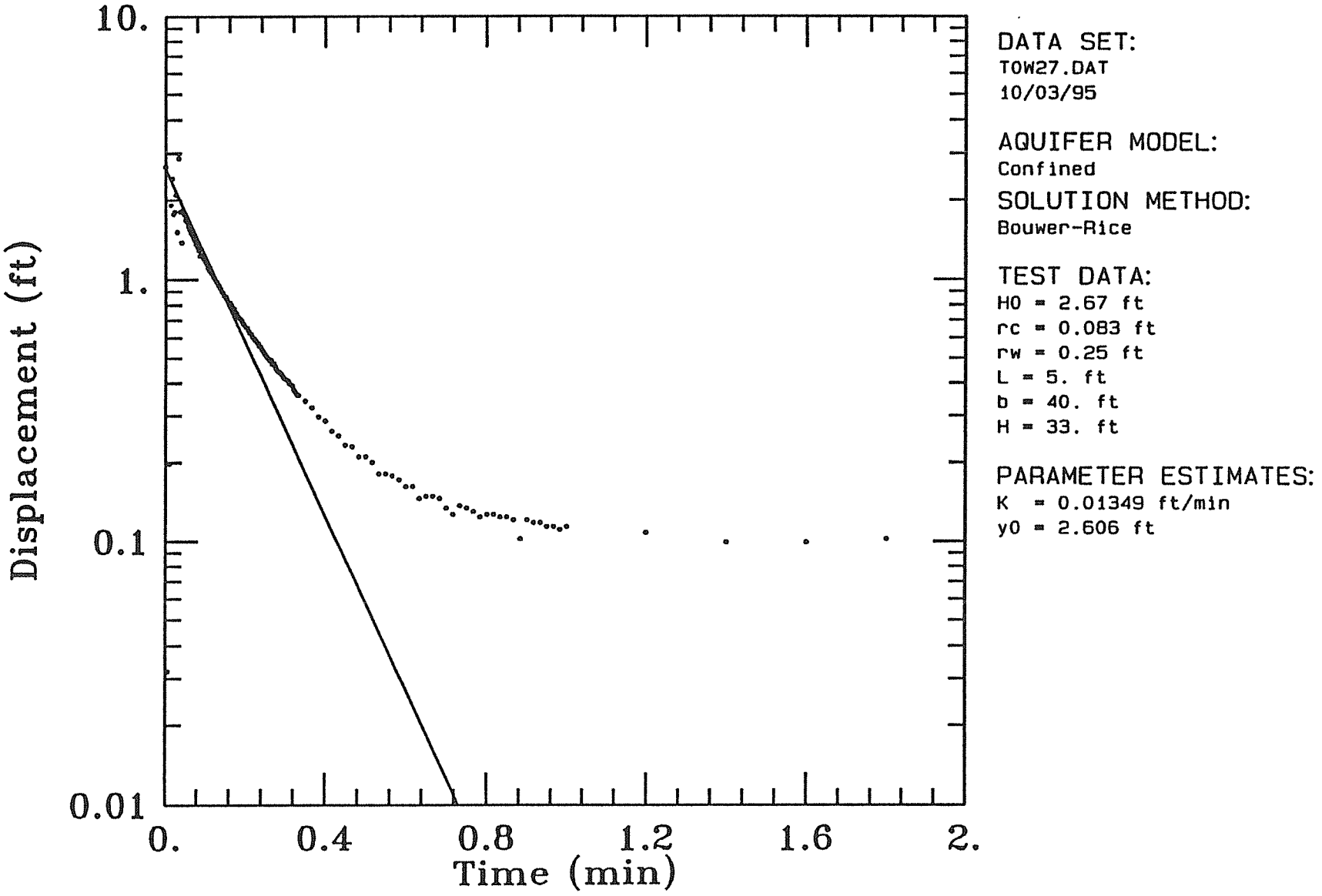
0.001
Displacement (ft)
0.
0.04
0.08
0.12
0.16
0.2
Time (min)
DATA SET:
T3W26.DAT
10/04/95
AQUIFER MODEL:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATA:
H0 = 2.67 ft
rc = 0.083 ft
rw = 0.083 ft
L = 10. ft
b = 40. ft
H = 8. ft
PARAMETER ESTIMATES:
K = 0.02375 ft/min
y0 = 6.515 ft

AQTESOLV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Displacement (ft)
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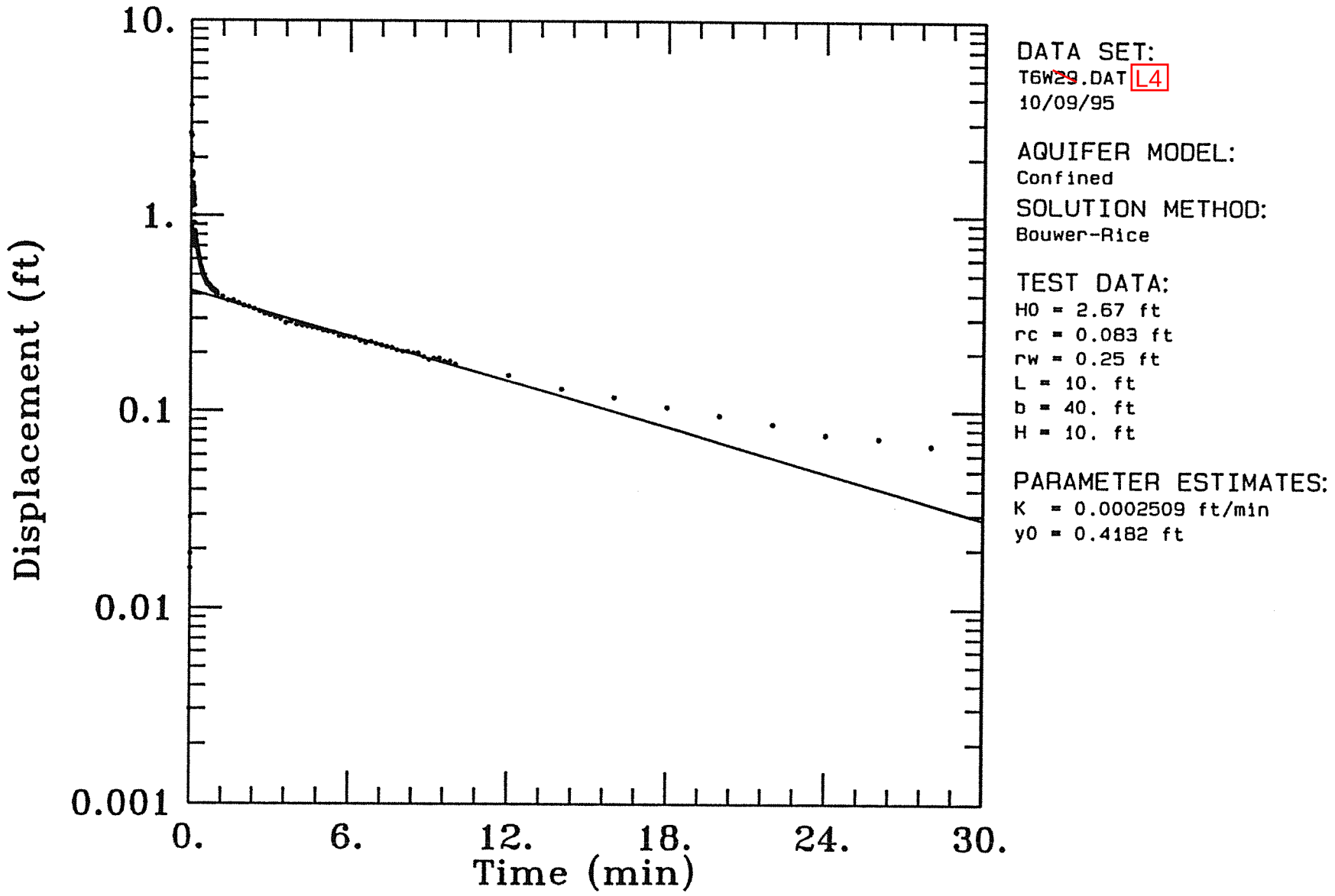
0.4
0.8
1.2
1.6
2.
Time (min)
DATA SET:
TOW27.DAT
10/03/95
AQUIFER MODEL:
Confined
SOLUTION METHOD:
Bouwer-Rice
TEST DATA:
H0 = 2.67 ft
rc = 0.083 ft
rw = 0.25 ft
L = 5. ft
b = 40. ft
H = 33. ft
PARAMETER ESTIMATES:
K = 0.01349 ft/min
y0 = 2.606 ft

AQTESOLV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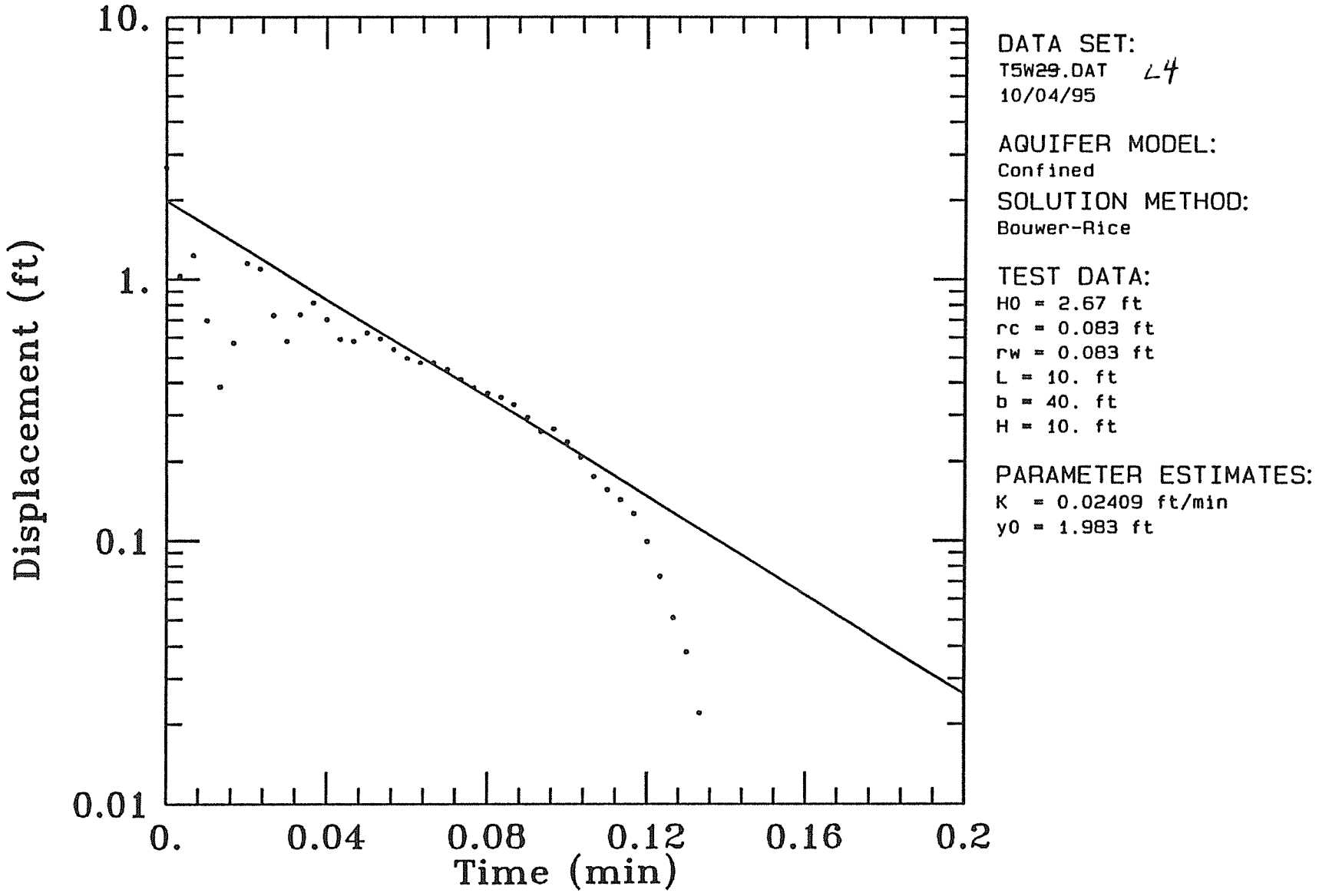
0.001
Displacement (ft)
0.
6.
12.
18.
24.
30.
Time (min)
DATA SET:
T6W29.DAT L4
10/09/95
AQUIFER MODEL:
Confined
SOLUTION METHOD:
Bouwer-Rice
TEST DATA:
H0 = 2.67 ft
rc = 0.083 ft
rw = 0.25 ft
L = 10. ft
b = 40. ft
H = 10. ft
PARAMETER ESTIMATES:
K = 0.0002509 ft/min
y0 = 0.4182 ft

AQTESOLV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Displacement (ft)
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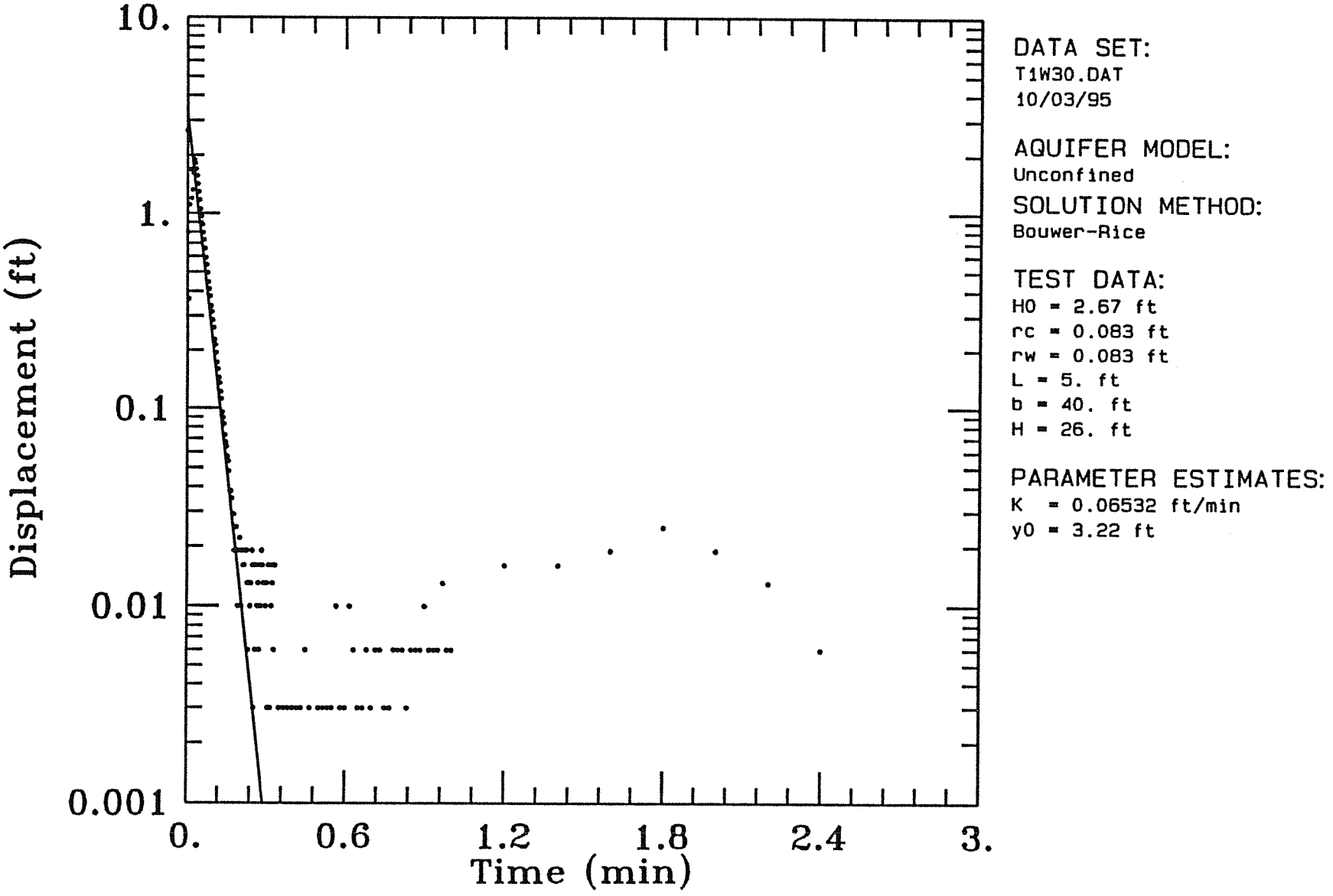
0.04
0.08
0.12
0.16
0.2
Time (min)
DATA SET:
T5W29.DAT
10/04/95
AQUIFER MODEL:
Confined
SOLUTION METHOD:
Bouwer-Rice
TEST DATA:
H0 = 2.67 ft
rc = 0.083 ft
rw = 0.083 ft
L = 10. ft
b = 40. ft
H = 10. ft
PARAMETER ESTIMATES:
K = 0.02409 ft/min
y0 = 1.983 ft

AQTESOLV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1.
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Displacement (ft)
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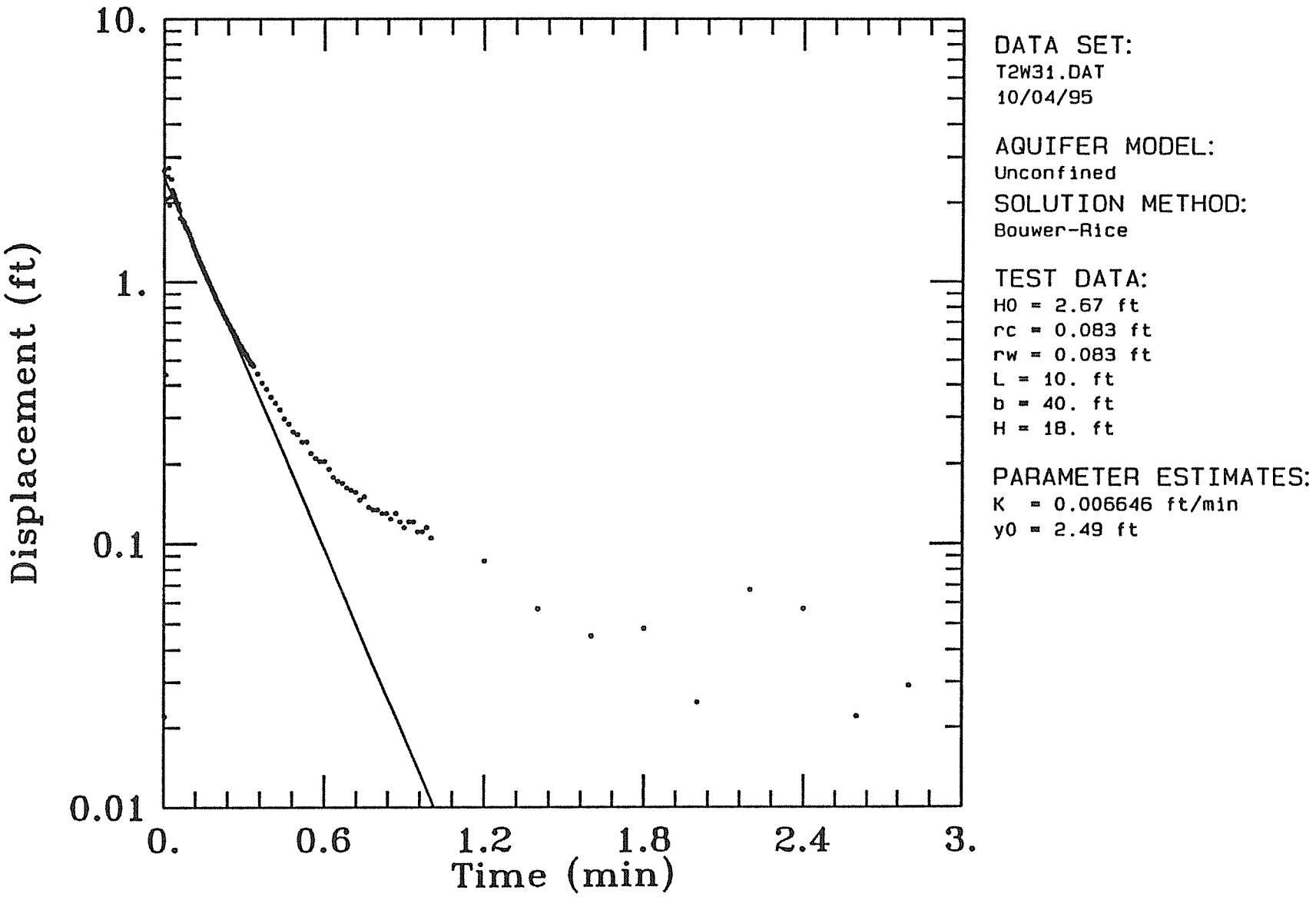
0.6
1.2
1.8
2.4
3.
Time (min)
DATA SET:
T1W30.DAT
10/03/95
AQUIFER MODEL:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATA:
H0 = 2.67 ft
rc = 0.083 ft
rw = 0.083 ft
L = 5. ft
b = 40. ft
H = 26. ft
PARAMETER ESTIMATES:
K = 0.06532 ft/min
y0 = 3.22 ft

AQTESOLV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0.01
Displacement (ft)
0.
0.6
1.2
1.8
2.4
3.
Time (min)
DATA SET:
T2W31.DAT
10/04/95
AQUIFER MODEL:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATA:
H0 = 2.67 ft
rc = 0.083 ft
rw = 0.083 ft
L = 10. ft
b = 40. ft
H = 18. ft
PARAMETER ESTIMATES:
K = 0.006646 ft/min
y0 = 2.49 ft

AQTESOLV

Appendix C2

AECOM Laboratory Hydraulic Conductivity Tests

File: P:\PROJECTS\GEOTECH\DYNEGY - BALDWIN 2014\CCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 1 BORING LOCATION PLAN (HENNEPIN OLD WEST ASH POND NO. 1 AND NO. 3).DWG Last edited: JUL. 15, 15 @ 11:19 a.m. by: david_deguire

HEN-B007
HEN-B006
HEN-C005
HEN-B005
HEN-B004
HEN-C004
HEN-P003
HEN-C006
HEN-B008
HEN-B009
HEN-C007
HEN-C014
HEN-B019
HEN-B018
HEN-C018
HEN-P001
HEN-P002
HEN-C002
HEN-B002
HEN-C012
HEN-C013
HEN-C001
HEN-B001
HEN-C003
HEN-B003
HEN-B017
HEN-C019
HEN-B016
HEN-C017
HEN-B012
HEN-C010
HEN-B010
HEN-C008
HEN-B014
HEN-C015
HEN-B013
HEN-C011
HEN-C009
HEN-B011
HEN-B015
HEN-C016

HENNEPIN OLD WEST ASH POND
(POND NO. 1 AND POND NO. 3)

XXX-X### — EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER); ID NUMBER; STATION ABBREVIATION

LEGEND

- PROPOSED BORING LOCATION
- PROPOSED CPT LOCATION
- PROPOSED PIEZOMETER LOCATION
- PROPOSED CROSS SECTION LOCATION
- CCR UNIT BERM ALIGNMENT

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

8

DRAFT

0 200

APPROXIMATE SCALE FEET

N

DYNEGY, INC	PROJECT NO. 60428794
AECOM	
DRN. BY: djd July 2015 DSGN. BY: eg CHKD. BY: eg	Hennepin Old West Ash Pond (Pond No. 1 and Pond No. 3) Field Investigation Plan
	FIG. NO. D-03

PRIVILEGED & CONFIDENTIAL - ATTORNEY CLIENT PRIVILEGED

EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)

XXX–X###

ID NUMBER

STATION ABBREVIATION

LEGEND

- PROPOSED BORING LOCATION
- PROPOSED CPT LOCATION
- PROPOSED PIEZOMETER LOCATION
- PROPOSED CROSS SECTION LOCATION
- CCR UNIT BERM ALIGNMENT

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

9

DRAFT

0 200

APPROXIMATE SCALE FEET

N

DYNEGY, INC	PROJECT NO. 60428794
AECOM	
DRN. BY: djd July 2015 DSGN. BY: eg CHKD. BY: eg	Hennepin Old West Polishing Pond Field Investigation Plan
	FIG. NO. D-04

File: P:\PROJECTS\GEOTECH\DYNEGY – BALDWIN 2014\CCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 1 BORING LOCATION PLAN (HENNEPIN OLD WEST ASH POND NO. 1 AND NO. 3).DWG Last edited: JUL. 15, 15 @ 11:19 a.m. by: david_deguire

PRIVILEGED & CONFIDENTIAL - ATTORNEY CLIENT PRIVILEGED

Terracon
Consulting Engineers & Scientists

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(847) 793-0306 Fax:(847) 793-0309

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

TERRACON PROJECT NO.: **MR155233** **12/21/2015**
PROJECT NAME: **DYNERGY - HENNEPIN SITE**
CLIENT: **AECOM**
LOCATION : **HENNEPIN, IL**

SUMMARY OF TEST RESULTS

BORING NO. HEN-B010

SAMPLE NO. S-5

DEPTH: 10.0'-11.5'

CLASSIFICATION VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	86.6	93.3
WATER CONTENT (%)	26.5	23.2
DIAMETER (cm)	7.215	6.956
LENGTH (cm)	4.527	4.521

SAMPLE PHOTO

HYDRAULIC GRADIENT (MAXIMUM) 20.83

PERCENT SATURATION 99.5 (Percent saturation calculation is based on final measurements and an estimated specific gravity.)

HYDRAULIC CONDUCTIVITY k (cm/sec) 1.16E-05

Deaired water was used as the liquid permeant.

Terracon
Consulting Engineers & Scientists

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(847) 793-0306 Fax:(847) 793-0309

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

TERRACON PROJECT NO.: **MR155233** **12/21/2015**
PROJECT NAME: **DYNERGY - HENNEPIN SITE**
CLIENT: **AECOM**
LOCATION : **HENNEPIN, IL**

SUMMARY OF TEST RESULTS

BORING NO. HEN-B017

SAMPLE NO. S-3

DEPTH: 5.0'-7.0'

CLASSIFICATION VERY DARK GRAY LEAN CLAY WITH SAND

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	76.0	82.8
WATER CONTENT (%)	36.7	38.2
DIAMETER (cm)	6.929	6.692
LENGTH (cm)	7.541	7.425
HYDRAULIC GRADIENT (MAXIMUM)	26.49	
PERCENT SATURATION	99.3	
HYDRAULIC CONDUCTIVITY k (cm/sec)	6.79E-07	

SAMPLE PHOTO

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

Deaired water was used as the liquid permeant.

Terracon
Consulting Engineers & Scientists

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(847) 793-0306 Fax:(847) 793-0309

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

TERRACON PROJECT NO.: **MR155233** **12/21/2015**
PROJECT NAME: **DYNERGY - HENNEPIN SITE**
CLIENT: **AECOM**
LOCATION : **HENNEPIN, IL**

SUMMARY OF TEST RESULTS

BORING NO. HEN-B023

SAMPLE NO. S-9

DEPTH: 27.0'-29.0'

CLASSIFICATION VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	81.8	83.2
WATER CONTENT (%)	28.3	31.5
DIAMETER (cm)	7.154	7.063
LENGTH (cm)	5.432	5.479

SAMPLE PHOTO

HYDRAULIC GRADIENT (MAXIMUM) 17.36

PERCENT SATURATION 100.4 (Percent saturation calculation is based on final measurements and an estimated specific gravity.)

HYDRAULIC CONDUCTIVITY k (cm/sec) 1.00E-05

Deaired water was used as the liquid permeant.

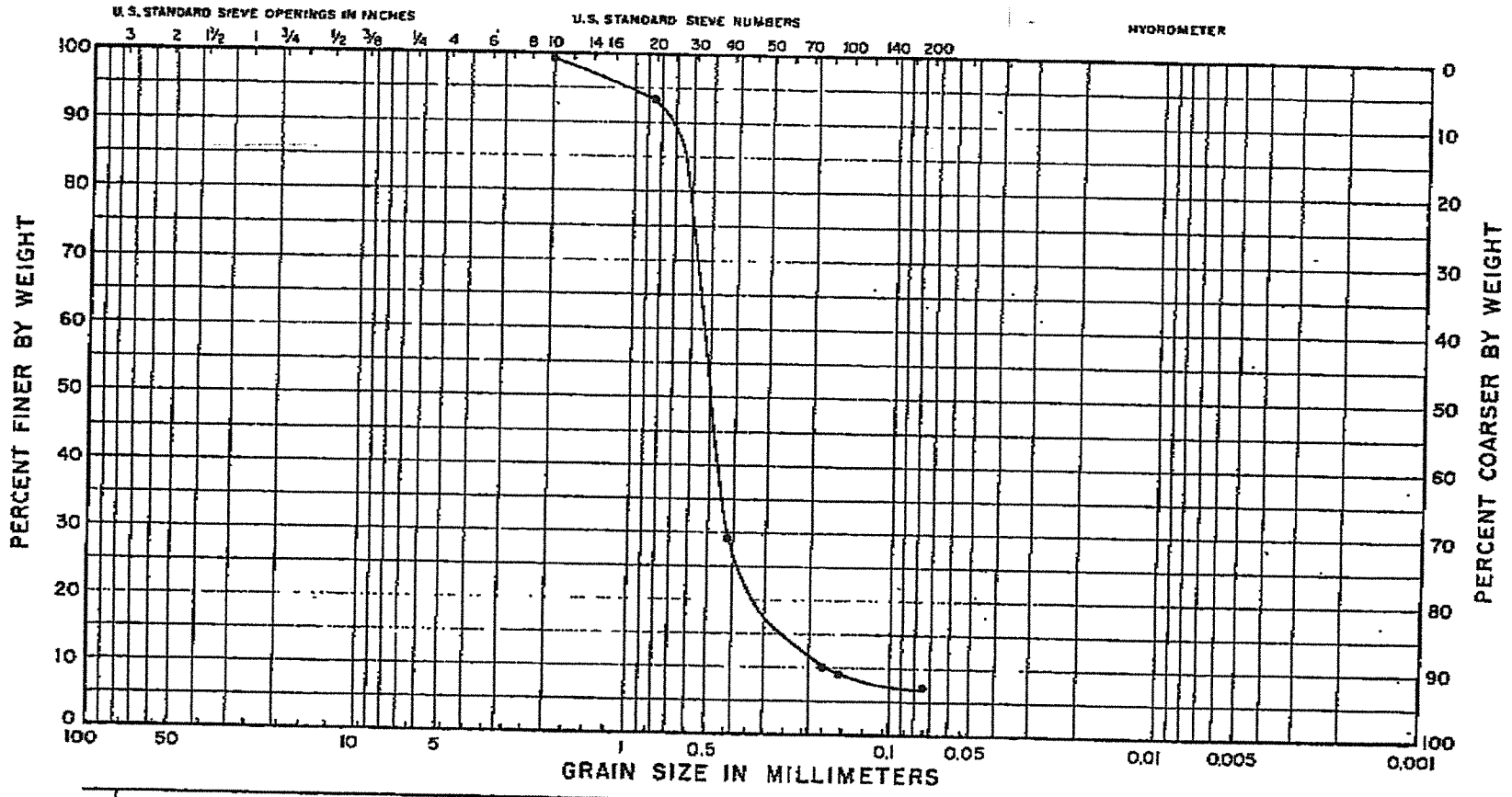
Appendix D

Geotechnical Test Data

Appendix D1

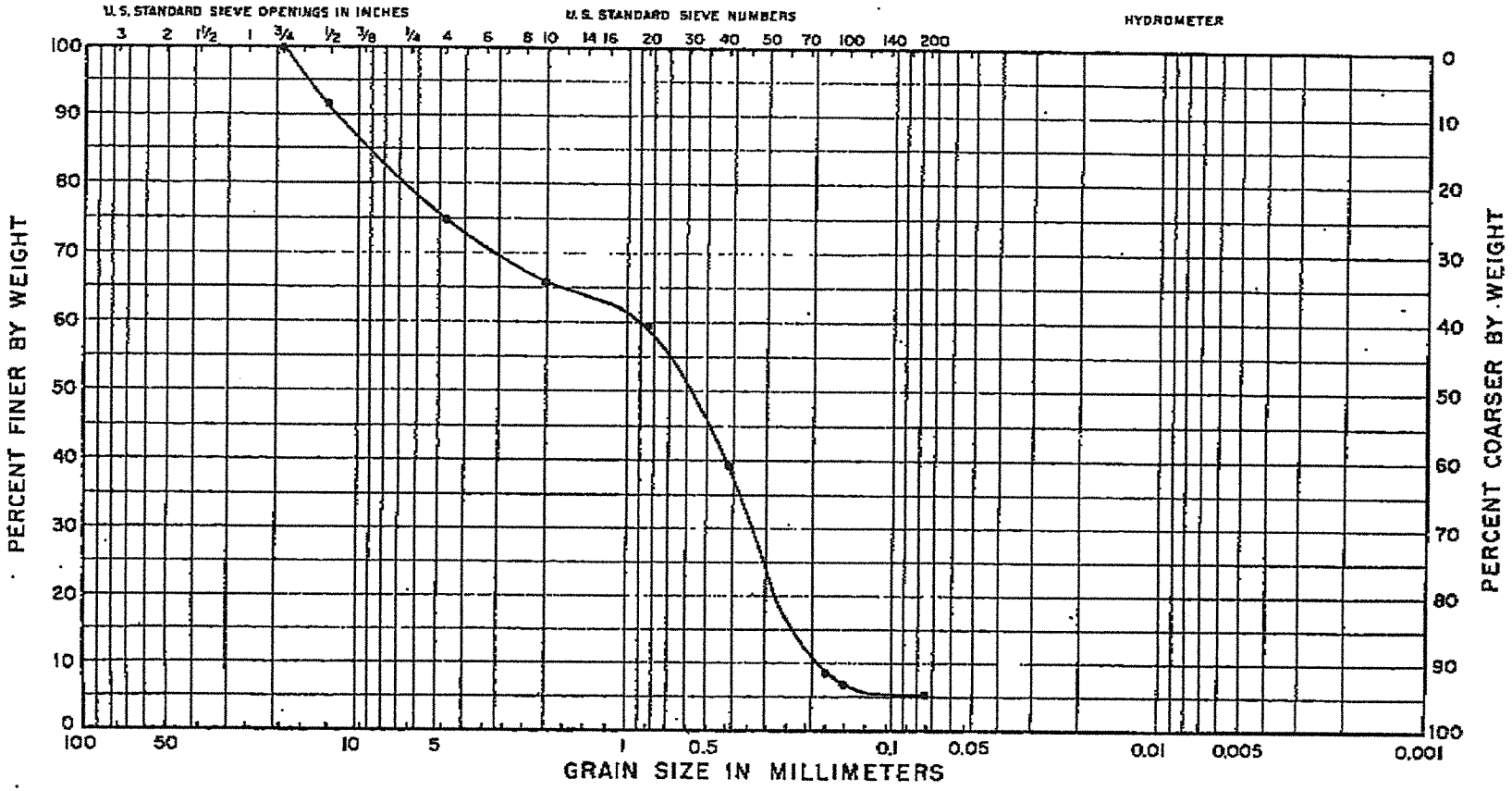
MATHES Grain Size Analysis

GRAIN SIZE CURVES



Boring	Sample	Depth	D_{10}	Description
W1	11	54.0-55.5'	.2	Gray Fine-Medium SAND w/Shells Trace Silt, SP-SM

GRAIN SIZE CURVES



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

Boring	Sample	Depth	D_{10}	Description
W4	13	59.0-60.5'	.19	Dark Gray Gravelly Fine-Medium SAND Trace Silt, SP-SM

Appendix D2

AECOM Geotechnical Test Results

January 12, 2016

Mr. Matt Ballance, PE
Senior Project Engineer
Dynegy Inc.
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

RE: 30% Design Data Report for Dynegy Hennepin Power Station; West Polishing Pond, West Ash Pond, East Ash Pond and Ash Pond No. 2 CCR Units

Dear Mr. Ballance:

AECOM is pleased to provide this 30% Design Data Package for the West Polishing Pond, West Ash Pond, East Ash Pond and Ash Pond No. 2 Coal Combustion Residuals (CCR) units at Hennepin Power Station (Hennepin, IL). The Data Package includes summary tables, field exploration plan, and laboratory data.

At Hennepin, the geotechnical exploratory program included the following:

- 32 auger borings
- 38 CPT soundings
- 7 standpipe piezometers installed at selected boring locations.

AECOM looks forward to providing continued support to Dynegy and working together on this important program. Please do not hesitate to call the undersigned, if you have any questions or comments on this 30% Design Data Package.

Sincerely,

AECOM

Jeremy M. Thomas, P.E.
Project Manager
jeremy.thomas@aecom.com

Victor Modeer, PE, D.GE
Program Manager
victor.modeer@aecom.com

Attachments:
Tables
Table 1-1 Exploration Location Table
Table 1-2 Water Level Measurements – Piezometers
Figures
D-01 Ash Pond No. 2 and East Ash Pond
D-02 Ash Pond No. 2
D-03 West Ash Pond
D-04 West Polishing Pond
Appendices
Appendix A Boring Logs
Appendix B Piezometer Installation Logs
Appendix C CPT Sounding Logs
Appendix D Laboratory Test Results

TABLES

Hennepin Power Station

Table 1-1 Exploration Location Table

Location ID	Depth	Longitude	Latitude	Elevation
HEN-B001	56.5	-89.327282	41.299899	452
HEN-B002	60.5	-89.327143	41.299917	460
HEN-B003	57.5	-89.327097	41.299922	456
HEN-B004	46.5	-89.324817	41.300893	460
HEN-B005	28.5	-89.324801	41.301437	444
HEN-B006	41.5	-89.321438	41.302013	456
HEN-B007	21.5	-89.321403	41.302391	444
HEN-B008	21.5	-89.320751	41.3009	464
HEN-B009	51.5	-89.320468	41.300909	463
HEN-B010	41.5	-89.322512	41.299269	464
HEN-B011	21.5	-89.322576	41.299188	456
HEN-B012	46.5	-89.325988	41.299317	465
HEN-B014	61.5	-89.327894	41.299266	458
HEN-B015	46.5	-89.327898	41.299214	449
HEN-B016	76.5	-89.328924	41.299861	450
HEN-B017	66.5	-89.329005	41.299873	448
HEN-B018	71.5	-89.328149	41.300492	458
HEN-B019	55.5	-89.328089	41.300723	444
HEN-B020	41.5	-89.307558	41.302859	495
HEN-B021	45.1	-89.309977	41.302545	495
HEN-B022	21.5	-89.310208	41.302239	478
HEN-B023	76.5	-89.309977	41.303581	495
HEN-B024	62.7	-89.307606	41.304701	493
HEN-B025	56.5	-89.305546	41.304133	503
HEN-B026	26.5	-89.310696	41.304504	444
HEN-B027	31.5	-89.307864	41.305141	444
HEN-B029	41.5	-89.306181	41.302195	500
HEN-B030	11.0	-89.304073	41.303807	495
HEN-B032	41.5	-89.302368	41.303242	493
HEN-B034	41.5	-89.303172	41.301634	500
HEN-B037	41.5	-89.301091	41.304257	494
HEN-B038	21.5	-89.300939	41.304427	480
HEN-C002	55.6	-89.327143	41.299917	461
HEN-C004	41.3	-89.324817	41.300893	465
HEN-C005	62.7	-89.321438	41.302013	457
HEN-C006	26.7	-89.320751	41.3009	464
HEN-C007	88.9	-89.320468	41.300909	462
HEN-C008	85.8	-89.322512	41.299269	463
HEN-C009	23.5	-89.322576	41.299188	454
HEN-C010	42.2	-89.325988	41.299317	465
HEN-C012	34.0	-89.324899	41.300184	461
HEN-C013	6.2	-89.323204	41.300285	463
HEN-C014	24.3	-89.321772	41.300519	463
HEN-C015	52.3	-89.327894	41.299266	458
HEN-C017	66.4	-89.328924	41.299861	450
HEN-C019	62.8	-89.328149	41.300492	458
HEN-C020	18.4	-89.307558	41.302859	494
HEN-C021	32.5	-89.309977	41.302545	495
HEN-C022	13.9	-89.310208	41.302239	478
HEN-C023	16.6	-89.309977	41.303581	495
HEN-C024	13.6	-89.307606	41.304701	493
HEN-C025	47.2	-89.305546	41.304133	503
HEN-C026	30.0	-89.30957	41.303106	495
HEN-C027	30.0	-89.307199	41.303864	495
HEN-C029	21.2	-89.306181	41.302195	500
HEN-C030	11.2	-89.304073	41.303807	495
HEN-C032	12.3	-89.302368	41.303242	493
HEN-C034	29.5	-89.303172	41.301634	500
HEN-C038	9.2	-89.301091	41.304257	494
HEN-C039	4.4	-89.300939	41.304427	480

Hennepin Power Station

Table 1-2 Water Level Measurements - Piezometers

Piezometer	Ground Surface Elevation (ft)	Screen Depth Interval (ft)		Water Surface Elevation (ft)		
		Top	Bottom	10/27/2015	11/24/2015	12/17/2015
HEN-P001	457.9	8.0	18.0	446.6	447.8	449.7
HEN-P002	463.6	15.3	25.3		451.0	452.5
HEN-P003	464.0	38.7	43.4		447.4	447.9
HEN-P004	495.0	55.4	60.4	448.3	448.8	449.5
HEN-P005	494.0	50.5	55.5		448.6	449.3
HEN-P006	495.3	38.3	43.3	452.0	452.0	452.1
HEN-P007	494.0	42.1	47.1	450.4	449.1	449.4

FIGURES

File: P:\PROJECTS\GEOTECH\DYNEGY – BALDWIN 2014\CCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 1 BORING LOCATION PLAN (HENNEPIN OLD WEST ASH POND NO. 1 AND NO. 3).DWG Last edited: JUL. 15, 15 @ 11:19 a.m. by: david_dejuire

HEN-B027

HEN-B026

HEN-B024
HEN-C024
HEN-P005

HEN-B025
HEN-C025

HEN-C027

HEN-B031
HEN-C031

HEN-B030
HEN-C030
HEN-P006

HENNEPIN
ASH POND
NO. 2

HEN-B023
HEN-C023
HEN-P004

HEN-C026

HEN-B020
HEN-C020

HENNEPIN
EAST ASH POND

HEN-B021
HEN-C021

HEN-C035

HEN-B022
HEN-C022

HEN-C028
HEN-B028

HEN-B029
HEN-C029

HEN-B033
HEN-C033

HEN-B
HEN-C

XXX–X###
- EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)
- ID NUMBER
- STATION ABBREVIATION

LEGEND

- PROPOSED BORING LOCATION
- PROPOSED CPT LOCATION
- PROPOSED PIEZOMETER LOCATION
- PROPOSED CROSS SECTION LOCATION
- CCR UNIT BERM ALIGNMENT

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

DRAFT

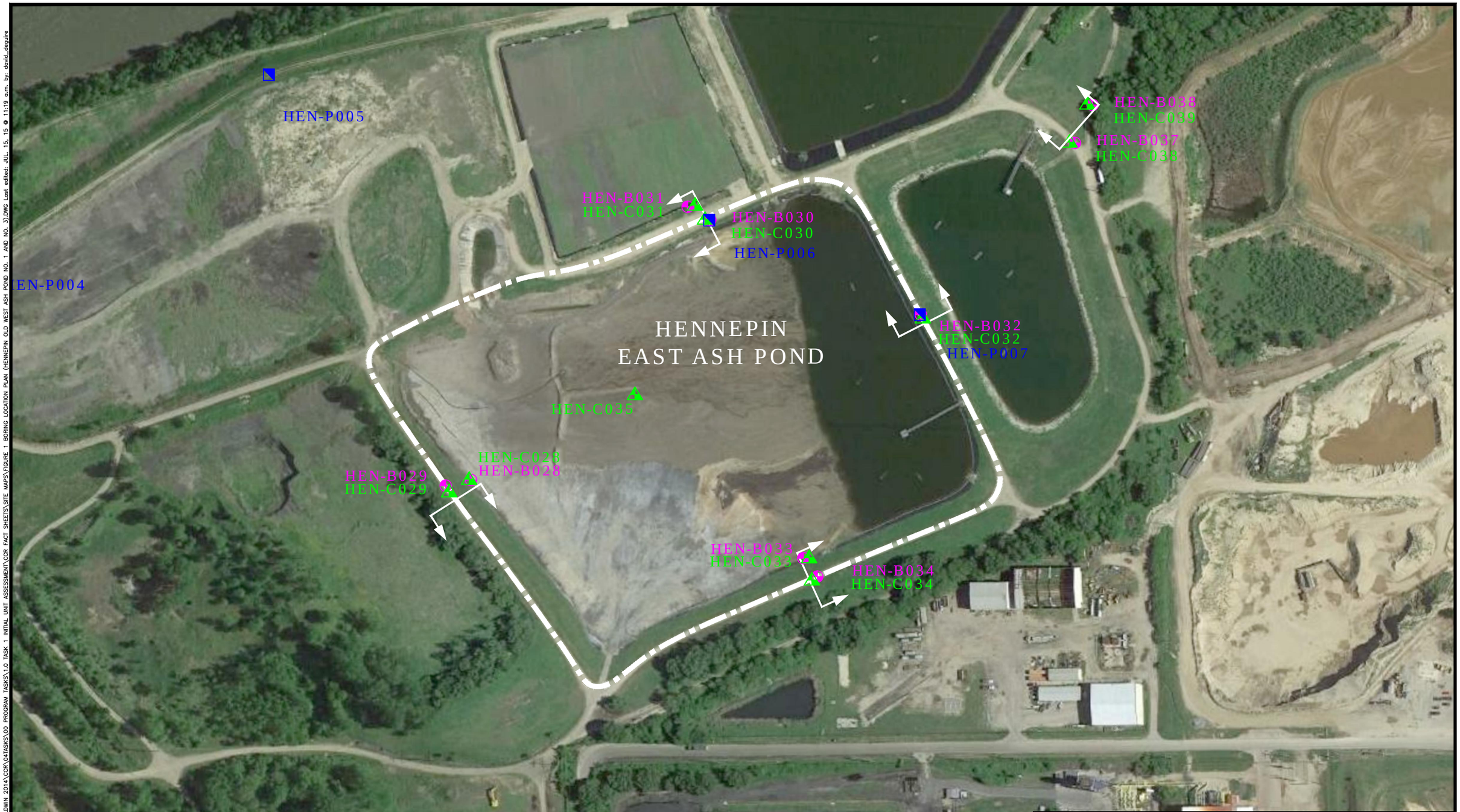
0 200

APPROXIMATE SCALE FEET

N

DYNEGY, INC	PROJECT NO. 60428794
AECOM	
DRN. BY: djd July 2015 DSGN. BY: eg CHKD. BY: eg	Hennepin Ash Pond No. 2 Field Investigation Plan
	FIG. NO. D-01

PRIVILEGED & CONFIDENTIAL - ATTORNEY CLIENT PRIVILEGED



EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)

XXX–X###

ID NUMBER

STATION ABBREVIATION

LEGEND

- PROPOSED BORING LOCATION
- PROPOSED CPT LOCATION
- PROPOSED PIEZOMETER LOCATION
- PROPOSED CROSS SECTION LOCATION
- CCR UNIT BERM ALIGNMENT

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

7

DRAFT

0 200

APPROXIMATE SCALE FEET

N

DYNEGY, INC	PROJECT NO. 60428794
AECOM	
DRN. BY: djd July 2015 DSGN. BY: eg CHKD. BY: eg	Hennepin East Ash Pond Field Investigation Plan
	FIG. NO. D-02

File: P:\PROJECTS\GEOTECH\DYNEGY – BALDWIN 2014\CCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 1 BORING LOCATION PLAN (HENNEPIN OLD WEST ASH POND NO. 1 AND NO. 3).DWG Last edited: JUL. 15, 15 @ 11:19 a.m. by: david_dejuire

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File: P:\PROJECTS\GEOTECH\DYNEGY - BALDWIN 2014\CCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 1 BORING LOCATION PLAN (HENNEPIN OLD WEST ASH POND NO. 1 AND NO. 3).DWG Last edited: JUL. 15, 15 @ 11:19 a.m. by: david_deguire

HEN-B007
HEN-B006
HEN-C005
HEN-B005
HEN-B004
HEN-C004
HEN-P003
HEN-C006
HEN-B008
HEN-B009
HEN-C007
HEN-C014
HEN-B019
HEN-B018
HEN-C018
HEN-P001
HEN-P002
HEN-C002
HEN-B002
HEN-C012
HEN-C013
HEN-C001
HEN-B001
HEN-C003
HEN-B003
HEN-B017
HEN-C019
HEN-B016
HEN-C017
HEN-B012
HEN-C010
HEN-B010
HEN-C008
HEN-B014
HEN-C015
HEN-B013
HEN-C011
HEN-C009
HEN-B011
HEN-B015
HEN-C016

HENNEPIN OLD WEST ASH POND
(POND NO. 1 AND POND NO. 3)

XXX-X### — EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER); ID NUMBER; STATION ABBREVIATION

LEGEND

- PROPOSED BORING LOCATION
- PROPOSED CPT LOCATION
- PROPOSED PIEZOMETER LOCATION
- PROPOSED CROSS SECTION LOCATION
- CCR UNIT BERM ALIGNMENT

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

8

DRAFT

0 200

APPROXIMATE SCALE FEET

N

DYNEGY, INC	PROJECT NO. 60428794
AECOM	
DRN. BY: djd July 2015 DSGN. BY: eg CHKD. BY: eg	Hennepin Old West Ash Pond (Pond No. 1 and Pond No. 3) Field Investigation Plan
	FIG. NO. D-03

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EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)

XXX–X###

ID NUMBER

STATION ABBREVIATION

LEGEND

- PROPOSED BORING LOCATION
- PROPOSED CPT LOCATION
- PROPOSED PIEZOMETER LOCATION
- PROPOSED CROSS SECTION LOCATION
- CCR UNIT BERM ALIGNMENT

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

9

DRAFT

0 200

APPROXIMATE SCALE FEET

N

DYNEGY, INC	PROJECT NO. 60428794
AECOM	
DRN. BY: djd July 2015 DSGN. BY: eg CHKD. BY: eg	Hennepin Old West Polishing Pond Field Investigation Plan
	FIG. NO. D-04

File: P:\PROJECTS\GEOTECH\DYNEGY – BALDWIN 2014\CCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 1 BORING LOCATION PLAN (HENNEPIN OLD WEST ASH POND NO. 1 AND NO. 3).DWG Last edited: JUL. 15, 15 @ 11:19 a.m. by: david_deguire

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APPENDIX A

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B001

Date(s) Drilled	10/08/2015 to 10/08/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	56.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	7 6 6	67		Medium dense, dry, brown, clayey GRAVEL (GC) [Fill].					2.0			
					2.5								
	SS-2	4 4 4	100		Loose, dry, brown, clayey SAND (SC) [Fill].					0.5			
5					5.0								
	SS-3	3 4 5			Soft, moist, brown, sandy lean CLAY (CL).					0.5			
	ST-4		100							2.0			*Pushed shelby tube from 7.5 to 9.5 feet*
10	SS-5	WOH 3 3	89							0.5			*10.0 feet of casing set*
15					15.0								
	SS-6	WOH	44		Very soft, moist to wet, gray, SILT (ML).								
20	ST-7		90							0.25			*Pushed shelby tube from 20.0 to 22.0 feet*
25					25.0								
	SS-8	WOH	89		Very soft, moist to wet, dark gray mottled with brown, clayey SILT (ML-CL), trace white shells.					0.25			
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:19 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B001

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH 3 4	22							0.25			
35	SS-10	3 3 4	100		35.0 Medium dense, wet, black to dark gray, lean CLAY (CL).					0.25			
40	SS-11	WOH WOH 4	100							0.25			
45	SS-12	6 3 3	78		45.0 Medium dense, wet, dark gray, sandy SILT (ML) with wood fragments.					0.25			*45.1 feet: Sand seam from 45.1 to 45.2 feet*
50	SS-13	6 6 8	56		50.0 Very dense, wet, gray, silty SAND (SM), trace fine to coarse gravel.								
55	SS-14	43 37 47	67		55.0 Very dense, wet, brown, clayey fine to coarse GRAVEL (GC).								
					56.5 End of Boring at 56.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:19 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B002

Sheet 1 of 2

Date(s) Drilled	10/07/2015 to 10/08/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	60.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	10.0 ft on 10/8/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	14 15 17	100		Medium dense, dry, brown, clayey fine to coarse GRAVEL (GC)	0.0								
	SS	SS-2	28 27 12	100											
5	SS	SS-3	9 21 24	100		Hard, dry, black to dark gray, clayey SILT (ML-CL), trace fine to coarse gravel.	5.5 6.5								
	SS	SS-4	10 5 5	78		Stiff, dry brown, sandy lean CLAY (CL) with fine to coarse gravel.						0.5 1.5			
10	SS	SS-5	6 4 3	0											*10.0 feet of casing set* *Drove wood in Sample 5, no recovery*
15	SS	SS-6	5 5 3	22		Loose to medium dense, moist to wet, brown, silty SAND (SM), trace fine to coarse gravel.	15.0								
20	SS	SS-7	4 4 4	67		Loose, moist to wet, brown, clayey SAND (SC).	20.0 20.8					0.5 <0.25			
						Ash, medium dense, wet, gray, SILT (ML) [Fill].									
25	ST	ST-8		100								0.25 0.5			*Pushed shelby tube from 25.0 to 27.0 feet*
30							30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:25 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B002

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	1 3 3	94		Soft to medium, wet, dark gray mottled with brown, lean CLAY (CL), trace shell fragments.					0.25 0.5			
35	ST-10		80							0.25 0.5			*Pushed shelby tube from 35.0 to 37.0 feet*
40	SS-11	WOH 2 7	100		40.0 Very soft to medium, wet, black, lean CLAY (CL), trace wood fragments.					0.5 0.75			
45	SS-12	2 5 7	94		45.0 Medium dense, moist, black, SILT (ML) with wood fragments, trace shells. 46.0 Medium dense, wet, dark gray, CLAYEY SAND (SC).					0.5			
50	SS-13	4 11 11	100		50.0 Medium dense, gray, well graded medium to fine SAND (SW).								
55	SS-14	18 17 23	100		55.0 Dense, wet, brown, well graded SAND (SW), little fine to coarse gravel.								
60	SS-15	54/6"			60.0 Very dense, wet, well graded GRAVEL (GW). 61.5 End of Boring at 60.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:25 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B003

Sheet 1 of 2

Date(s) Drilled	10/06/2015 to 10/06/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	57.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	0.0 ft on 10/6/2015		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	WOH	33		Ash, very stiff, moist to wet, gray, sandy SILT (ML) [Fill].					<0.25			
	SS-2	WOR	100							<0.25			
5	SS-3	WOR	100							<0.25			
	SS-4	WOR	100							<0.25			
10	ST-5		100							<0.25			*Pushed shelby tube from 10.0 to 12.0 feet*
15					15.0								
	SS-6	WOH WOH 4	89		Very soft, moist to wet, dark gray to black, clayey SILT (CL-ML).					<0.25			
20	SS-7	WOH	94							<0.25			*Mottled with dark brown and trace shells in Sample 7*
25	ST-8		100							0.5			*Pushed shelby tube from 25.0 to 27.0 feet*
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:30 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B003

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH 3 4	100							0.5			*Wood fragments in Sample 9*
35	SS-10	WOH WOH 3	100							0.5			
40	SS-11	10 8 7	56		40.0 Medium dense, wet, gray, silty fine SAND (SM).								
45	SS-12	20 26 16	44		45.0 Dense to very dense, wet, grayish brown to brown, silty fine to coarse GRAVEL (GM).								
50	SS-13	30 47 50											
55					57.5 End of Boring at 57.5 ft								*Boring backfilled with Portland Cement and bentonite*
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:30 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B004

Sheet 1 of 2

Date(s) Drilled	10/02/2015 to 10/02/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	46.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	20.0 ft on 10/5/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS	SS-1	9 14 18	100		Brown, silty GRAVEL (GM) [Fill].	0.5								
						Dense, brown, clayey fine to medium coarse GRAVEL (GC).									
	SS	SS-2	32 18 30	100											
5	SS	SS-3	13 40 42	33											
							7.5								
	SS	SS-4	5 7 8	100		Stiff, dry, gray, SILT (ML), trace fine to coarse gravel.						1.5 3.0			
10	ST	ST-5		50								<0.5			*Pushed shelby tube from 10.0 to 12.0 feet*
							15.0								
15	SS	SS-6	2 3 1	67		Medium dense to soft, moist, brown, lean CLAY (CL) with sand.						<0.5			
20	ST	ST-7		67								0.5			*Pushed shelby tube from 20.0 to 22.0 feet*
							25.0								
25	SS	SS-8	WOH WOH WOH	100		Clayey silt, gray, very soft, moist, clayey SILT (CL-ML).						0.5			
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:36 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B004

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	ST-9		79							0.25			*Pushed shelby tube from 30.0 to 32.0 feet*
					35.0								
35	SS-10	2 2 4	89		Soft, wet, brownish gray, sandy SILT (ML).					0.5			*38.0 feet: Drillers Note - hard drilling*
					40.0								
40	SS-11	7 10 23	83		Medium dense, wet, brown, clayey GRAVEL (GC).								
45	SS-12	30 30 29	78		46.5								
					End of Boring at 46.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:36 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B005

Sheet 1 of 1

Date(s) Drilled	09/24/2015 to 09/24/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	28.5 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
Boring Location	East due to sunken barge (ft NAD83)	Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0 Barge.								
					1.5 Water.								
					4.0								
5	SS-1	WOH 1 2 1	33		Dark gray to black silty SAND (SM), some organics and clay.								
					7.5								
	ST-2		83		Dark gray silty organic CLAY (OH), some sand.					0.5			
10	SS-3	WOH WOH WOH	56										
	ST-4		92							0.5			
					14.5								
15	SS-5	3 3 2	33		Dark green, gravelly CLAY (CL), trace sand and silt.								
					19.0								
20	SS-6	7 6 12	11		Green to dark green fine to coarse SAND and gravel (SP-GP), trace silt.								
25	SS-7	6 5 9	17										
					28.5 End of Boring at 28.5 ft								*28.0 feet: Drillers Note - obstruction or boulder*
30													

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B006

Date(s) Drilled	10/13/2015 to 10/13/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	25 26 22	78		Dense, dry, brown, clayey fine to coarse GRAVEL (GC).	0.0								
	SS	SS-2	15 17 26	100								0.5 1.5			
5	SS	SS-3	15 23 15	78			7.5								
	SS	SS-4	5 7 8	89		Medium dense, dry, brown, clayey SAND (SC), little fine to coarse gravel.						0.5 1.5			
10	SS	SS-5	7 6 7	89								0.25			
15	SS	SS-6	8 9 11	78								0.25			
20	SS	SS-7	13 12 20	89		Medium dense, moist to wet, brown, well graded fine to coarse GRAVEL (GW), trace fines and sand.	20.0								
25	SS	SS-8	39 43 43	44		Very dense, moist to wet, brown, fine to coarse GRAVE (GM) with sand.	25.0								
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:44 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B006

Sheet 2 of 2

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	29 32 30	67										
35	SS-10	9 9 9	33		35.0 Medium dense, moist to wet, yellowish brown, silty fine to coarse GRAVEL (GM), little fine to coarse sand.								
40	SS-11	10 8 6	22		41.5 End of Boring at 41.5 ft								*Boring backfilled with 95 pounds of Portland Cement and 25 pounds of bentonite*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:45 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B007

Sheet 1 of 1

Date(s) Drilled	09/23/2015 to 09/23/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	21.5 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0 Barge.								
					1.5 Water.								
					3.5								
	SS-1	WOR 1 3	11		Dark gray to brown, fine SAND and organic CLAY (OH-SP).								
5	SS-2	7 7 4	56		5.5 Dark gray organic CLAY (OH), trace sand.								
					7.5								
	SS-3	20 24 33	33		Brown to black, fine to coarse SAND and GRAVEL (SP-GP), trace silt.								*7.5 feet: Drillers Note - harder drilling*
10	SS-4	16 19 8	56		11.0 Brown, clayey GRAVEL (GC), trace silt and sand.								
	SS-5	12 12 13	33		14.5								
15	SS-6	8 15 17	44		Brown, fine to coarse SAND and GRAVEL (SP-GP), some clay.								
20	SS-7	10 9 6	17		21.5 End of Boring at 21.5 ft								*Boring backfilled with bentonite cement fluid*
25													
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:50 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B008

Sheet 1 of 1

Date(s) Drilled	10/13/2015 to 10/13/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	21.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	17.0 ft on 10/13/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS-1		1 2 2	100		Ash, gray sandy SILT (ML) [Fill].						0.50			
	SS-2		2 3 3	94								0.50			
5	SS-3		11 7 5	100								0.50			*5.5 feet: Wet layer from 5.5 to 6.0 feet*
							7.5								
	ST-4			100		Very stiff, dry, brown, lean CLAY (CL), few fine to coarse gravel.						4.0			*Pushed shelby tube from 7.5 to 9.5 feet*
10	SS-5		9 9 23	67											
							15.0								
15	SS-6		13 15 19	78		Medium dense, moist to dry, brown, well graded fine to coarse GRAVEL (GW) with sand, trace fines.									*17.0 feet: Drillers note - water*
							20.0								
20	SS-7		14 41 42	67		Very dense, brown, well graded fine to coarse GRAVEL (GW-GM) with silt.									
							21.5								
						End of Boring at 21.5 ft									*Boring backfilled with 49 pounds of Portland Cement and 15 pounds of bentonite*
25															
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:53 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B009

Sheet 1 of 2

Date(s) Drilled	10/13/2015 to 10/13/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	51.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	5 7 10	78		Gravelly lean CLAY (CL) with sand.	0.0					2.0			
	SS	SS-2	17 22 29	100								1.5			
5	SS	SS-3	26 50/5"	61		Dry, black to dark gray, fine to coarse gravelly SILT (ML), trace coal.	5.0					0.25			
	SS	SS-4	17 10 17	89		Stiff to very stiff, dry, black and dark brown, sandy lean CLAY (CL), trace fine to coarse gravel.	7.5					1.5 2.0			
10	SS	SS-5	4 5 6	78		Stiff, dry to moist, reddish brown, lean CLAY (CL) with sand, trace fine to coarse gravel.	10.0					.75 1.75			*12.5 feet: Drillers Note - hard drilling*
15	SS	SS-6	27 31 29	78		Very dense, dry to moist, brown, well graded SAND (SW-SM) with silt, and fine to coarse gravel.	15.0								
20	SS	SS-7	23 27 25	94		Very dense, moist to wet, brown, well graded fine to coarse GRAVEL (GW-GM) with silt, little fine to coarse sand.	20.0								
25	SS	SS-8	22 22 22	100		Dense, moist to wet, brown, well graded fine to coarse SAND (SW).	25.0								
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:56 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B009

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	20 28 28	100										
35	SS-10	4 5 7	100		35.0 Brown lean CLAY (CL). 35.5 Brown silty SAND (SM). 36.0 Brown sandy SILT (ML).					0.25 0.75			
40	SS-11	9 9 12	100		40.0 Medium dense, moist to wet, brown, well graded SAND (SW).								
45	SS-12	9 10 11	94		45.0 Brown SILT (ML). 45.5 Wet, brown, well graded SAND (SW-SM) with silt.					0.5			
50	SS-13	12 30 20	67		50.0 Dense to very dense, wet, brown, clayey fine to coarse GRAVEL (GC). 51.5 End of Boring at 51.5 ft								*Boring backfilled with 94 pounds of Portland cement and 25 pounds of bentonite*
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:41:56 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B010

Sheet 1 of 2

Date(s) Drilled	10/07/2015 to 10/07/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	19 30 23	100		Dense, dry, brown, clayey fine to coarse GRAVEL (GC).		0.0								
								2.5								
	SS	SS-2	10 24 20	100		Hard, dry, brown, cohesive sandy lean CLAY (CL), trace fine to coarse gravel.		3.5					1.5 2.0			
						Dense, dry, brown, clayey fine to coarse GRAVEL (GC).		5.0								
5	SS	SS-3	12 17 22	100		Very stiff to hard, dry, black to dark gray SILT (ML).							0.2 0.5			
								7.5								
	SS	SS-4	15 19 17	100		Hard, dry, black to dark gray, sandy SILT (ML), trace black coal fragments.							0.5			
10	ST	ST-5		94									4.0			*Pushed shelby tube from 10.0 to 11.5 feet*
15	SS	SS-6	4 3 4	61		Medium, moist, dark brown, sandy lean CLAY (CL).		15.0					.75			
								20.0								
20	SS	SS-7	10 11 15	56		Medium dense, moist to wet, brown, well graded SAND (SW), trace to little fine to coarse gravel.										
25	SS	SS-8	20 13 13	56												
30								30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:01 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B010

Sheet 2 of 2

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	25 28 30	67		Very dense, wet, brown, well graded fine to coarse GRAVEL (GW-GM) with silt and sand.								
35	SS-10	15 18 25	89		35.0 Dense, wet, brown, well graded fine to coarse SAND (SW), trace fine to coarse gravel.								
40	SS-11	10 9 10	67		41.5 End of Boring at 41.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:02 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B011

Sheet 1 of 1

Date(s) Drilled	10/06/2015 to 10/06/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	21.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	7.0 ft on 10/7/2015		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	4 6 11	100		Stiff, dry, dark brown, sandy lean CLAY (CL), trace fine to coarse gravel.					0.75			
	SS-2	5 5 8	100							1.0			*4.0 feet: Drillers Note - rock*
5	SS-3	9 6 6	100		5.5 Medium dense, wet, brown, poorly graded SAND (SP), trace gravel.								*6.0 feet: Drillers Note - wet at 6.0 feet WD with HSA*
	SS-4	11 12 12	78										
10	SS-5	14 15 20	78		10.0 Medium dense, wet, brown, well graded SAND (SW) with fine to coarse gravel.								
15	SS-6	13 26 27	78		15.0 Dense, wet, brown, silty fine to coarse GRAVEL (GM) with fine to coarse sand.								
20	SS-7	20 33 32	6		21.5 End of Boring at 21.5 ft								*20.0 feet: Drillers Note - pushed rock in Sample 7* *Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
25													
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:07 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B012

Sheet 1 of 2

Date(s) Drilled	10/07/2015 to 10/07/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	46.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	7 9 15	44		Medium dense, dry, brown, clayey fine to coarse GRAVEL (GC).								
	SS-2	12 17 17	100							1.0 2.5			
5	SS-3	4 13 21	89							0.5 2.0			
	SS-4	9 9 27	89		8.0 Dry, brown to dark gray, sandy lean CLAY to clayey silt (CL-ML).					1.0			
10	SS-5	5 8 7	78		10.0 Stiff, moist, brown and black, sandy lean CLAY (CL).					1.0 2.0			
15	SS-6	11 19 28			15.0 Hard, moist, dark gray to black, sandy SILT (ML) with Ash [Fill].								
20	ST-7		87.5							1.0			*Pushed shelby tube from 20.0 to 22.0 feet*
25	SS-8	2 3 5	78		25.0 Medium, moist, black lean CLAY (CL).					0.75 1.0			
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:10 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B012

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	ST-9		95		31.0 Soft, moist to wet, yellowish brown mottled with gray and brown, lean CLAY (CL).					0.5			*Pushed shelby tube from 30.0 to 32.0 feet*
35	SS-10	WOH 4 5	94							0.75			
40	SS-11	10 17 11	67		40.0 Medium dense, moist to wet, brown, clayey fine to coarse GRAVEL (GC).								
45	SS-12	18 18 17	44		46.5 End of Boring at 46.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:10 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B014

Sheet 1 of 2

Date(s) Drilled	10/12/2015 to 10/12/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	61.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS	SS-1	19 20 18	78		Dense, brown, clayey fine to coarse GRAVEL (GC) [Fill].									
	SS	SS-2	15 30 17	67											
5	SS	SS-3	4 7 5	89			5.5					0.4			
						Stiff, moist, brown, SILT (ML).	7.5								
	SS	SS-4	13 14 18	100		Very stiff, dry to moist, dark gray, sandy SILT (ML) with Ash, trace fine to coarse gravel [Fill].						0.25 0.75			
10	SS	SS-5	8 11 13	78			11.0					0.5			
						Very stiff, moist, dark gray SILT (ML).									
15	SS	SS-6	5 6 6	100			16.0					0.25 1.5			
						Stiff, moist, black, lean CLAY (CL).	20.0								
20	SS	SS-7	WOH 2 4	100		Soft, wet, dark gray to greenish gray, silty CLAY (CL-ML).						0.25			
25	ST	ST-8		65								0.25			*Pushed shelby tube from 25.0 to 27.0 feet*
30							30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:15 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B014

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH WOH 4	100		Very soft, moist to wet, dark gray, lean to silty CLAY (CL-ML).					0.25 0.5			
35	ST-10		100							0.5			*Pushed shelby tube from 35.0 to 37.0 feet*
40	SS-11	WOH 5 6	100		40.0 Soft, moist, dark gray to black SILT (ML), trace wood fragments.					0.5			
45	SS-12	2 7 10	89		45.0 Medium dense to dense, wet, gray, silty SAND (SM).								
50	SS-13	13 17 16	78										*Trace fine to coarse gravel in Sample 13*
55	SS-14	46 52 37	78		55.0 Very dense, wet, light gray to light brown, silty fine to coarse GRAVEL (GM) with fine to coarse sand.								
60	SS-15	27 40 38	67		61.5 End of Boring at 61.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:16 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B015

Date(s) Drilled	10/05/2015 to 10/06/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	46.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	3.0 ft on 10/5/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS	1	3 3 5	67		Black topsoil, lean CLAY (CL).	0.5					0.25			
						Loose, moist, brown, clayey SAND (SC).	2.5								
	SS	2	6 8 12	100		Stiff, moist, black, lean CLAY (CL).						2.0 3.0			
5							5.0								
	SS	3	3 6 5	100		Stiff, moist, dark gray, clayey SILT (CL-ML).						0.5 0.75			
	ST	4		80								0.5			*Pushed shelby tube from 7.5 to 9.5 feet*
10	SS	5	WOH 2 1	100								0.25			
15	SS	6	1 2 3	78								0.25			
20	SS	7	WOH	89								0.25			
25	ST	8		95								0.25			*Pushed shelby tube from 25.0 to 27.0 feet*
30							30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:21 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B015

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH 2 5	100		Soft, wet, dark gray SILT (ML), trace wood and shells, occasional sand seam.					0.25			
35	SS-10	2 3 7	100		35.2 Medium dense, wet, well graded SAND (SW).								
40	SS-11	21 27 20	56		39.0 Dense to very dense, moist to wet, brown to grayish brown, silty fine to coarse GRAVEL (GM), little sand.								*39.0 feet: Drillers Note - change in drilling*
45	SS-12	24 53 50	89		46.5 End of Boring at 46.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:21 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B016

Sheet 1 of 3

Date(s) Drilled	10/09/2015 to 10/12/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	76.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	21 21 13	100		Dense to very dense, dry, brown, clayey fine to coarse GRAVEL (GC).								
	SS-2	18 33 18	100										
5	SS-3	10 9 19	100										
	SS-4	28 23 36	100							2.5 3.0			
10					10.0								
	SS-5	15 9 3	67		Stiff to very stiff, moist, black to dark gray, sandy SILT (ML) with Ash, trace hard ash pieces [Fill].					0.25			
15					15.0								
	SS-6	4 5 3	100		Medium to stiff, moist, black, lean CLAY (CL), some wood fragments.					0.25 0.5			
20					20.0								
	ST-7		100		Soft, black to dark gray silty CLAY (ML-CL).					0.25			*Pushed shelby tube from 20.0 to 22.0 feet*
25					25.0								
	SS-8	WOH WOH 2	100		Soft, wet, grayish brown mottled with brown to dark gray, lean CLAY (CL).					0.25			
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:27 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B016

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH WOH 4	83							0.25 0.5			
35	ST-10		100							0.25			*Pushed shelby tube from 35.0 to 37.0 feet*
40	SS-11	WOH 2 4	67		40.0 Very soft, wet, dark gray, SILT (ML), trace shells.					0.25			
45	SS-12	WOH WOH WOH	22							0.25			
50	SS-13	3 7 8	67		51.0 Medium dense, wet, gray, silty SAND (SM), trace fine gravel.								
55	SS-14	8 8 10	56										
60	SS-15	WOR WOH WOH	100		60.0 Very soft, wet, clayey SILT (CL-ML), trace shells.					0.25			
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:27 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B016

Sheet 3 of 3

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	SS-16	WOR WOH WOH	100										
					67.0 — Dense, wet, gray, well graded fine to coarse GRAVEL (GW-GM) with sand.								*67.0 feet: Drillers Note - change in drilling*
70	SS-17	19 16 15	44										
75	SS-18	22 28 39	44		76.5 — End of Boring at 76.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
80													
85													
90													
95													
100													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:27 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B017

Sheet 1 of 3

Date(s) Drilled	10/05/2015 to 10/05/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	66.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	3.0 ft on 10/5/2015		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	2 4 3	67		Topsoil, lean CLAY (CL). 0.5 Soft, moist, brown, lean CLAY (CL) with sand.					<0.5			
					2.5								
	SS-2	6 9 12	100		Stiff to soft, moist to wet, black, clayey SILT (ML-CL).					1.25			
5	ST-3		87										*Pushed shelby tube from 5.0 to 7.0 feet*
	SS-4	2 2 3	100							0.25			*Trace sand seams in Samples 4, 5, 7, and 8*
10	SS-5	WOH WOH 2	78							0.25			
15	ST-6		75							0.25			*Pushed shelby tube from 15.0 to 17.0 feet*
20	SS-7	WOH	100							0.25			
25	SS-8	WOR WOH WOH	100							0.25			
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:34 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B017

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	ST-9		95							0.75			*Pushed shelby tube from 30.0 to 32.0 feet*
35	SS-10	WOH	100							0.5			*Trace sand seams and shells in Samples 10 and 11*
40	SS-11	1 6 6	100		40.5 Medium dense, wet, dark gray, silty fine to coarse SAND (SM), trace shells and gravel.					0.25 0.5			
45	SS-12	3 7 7	78										
50	SS-13	WOR WOH WOH	100		50.0 Very soft, wet, dark gray, clayey SILT (CL-ML), trace shells.					0.25			
55	SS-14	WOR WOH WOH	100							0.25			
60	SS-15	15 16 15	67		58.0 Dense, wet, gray, well graded fine to coarse GRAVEL (GW).								*58.0 feet: Drillers Note - change in drilling*
65					65.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:35 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B017

Sheet 3 of 3

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	SS-16	17 16 20			Dense, wet, grayish brown to light to medium gray, well graded fine to coarse GRAVEL (GW-GC) with clay. 66.5								
					End of Boring at 66.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
70													
75													
80													
85													
90													
95													
100													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:35 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B018

Date(s) Drilled	10/08/2015 to 10/09/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	71.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	15.0 ft on 10/9/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	25 25 26	100		Very dense, dry, brown, clayey fine to coarse GRAVEL (GC)						4.0			
	SS	SS-2	42 34 18	100			3.5					4.0			
						Brown to black clayey SAND to lean CLAY (SC-CL).	5.0								
5	SS	SS-3	12 35 22	100		Very dense, dry, brown, clayey fine to coarse GRAVEL (GC), trace black ash at bottom.	6.5					4.0			
	SS	SS-4	4 4 10	100		Stiff, moist, dark gray, sandy SILT (ML) with Ash [Fill].						0.25			
10	ST	ST-5		85								1.5			*Pushed shelby tube from 10.0 to 12.0 feet*
15	SS	SS-6	WOH 2 3	100		Very soft to soft, moist, black to dark gray, silty CLAY (CL-ML).	15.0					0.25			
20	SS	SS-7	WOH WOH 3	100								0.25			*Trace shells in Sample 7*
25	ST	ST-8		70								0.25			*Pushed shelby tube from 25.0 to 27.0 feet*
30							30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:42 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B018

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	WOH WOH 4	100		Very soft, moist to wet, dark gray and trace black, lean CLAY (CL).					0.25			
35	SS-10	WOH	100		35.0 Very soft, wet, dark gray, clayey SILT (CL-ML), trace shells.					0.25			
40	ST-11		100							0.5			*Pushed shelby tube from 40.0 to 42.0 feet*
45	SS-12	WOH WOH WOH	100							0.25			
50	SS-13	WOH 3 4	33		50.0 Loose to medium dense, wet, dark gray, sandy SILT (SM).								
55	SS-14	4 6 12	67										
60	SS-15	WOH WOH WOH	100		60.0 Very soft, wet, dark gray, silty CLAY (CL-ML), trace shells.					0.25			
65					65.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:43 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B018

Sheet 3 of 3

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	SS-16	53 37 44	67		Very dense, wet, gray, silty fine to coarse GRAVEL (GM).								
70	SS-17	23 21 19	67		71.5 End of Boring at 71.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
75													
80													
85													
90													
95													
100													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:43 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B019

Sheet 1 of 2

Date(s) Drilled	09/24/2015 to 09/24/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	55.5 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					Barge.	0.0								
					Water.	1.5								
						4.0								
5	SS-1	1	33		Dark brown fine to coarse SAND and GRAVEL (SP-GP).	4.3								
					Soft to stiff, dark gray organic silty CLAY (OH).									
	ST-2		80								0.25			*Pushed shelby tube from 7.5 to 9.5 feet*
10	SS-3	WOR WOH 1	56								0.5			
	ST-4		85								1.5			*Pushed shelby tube from 12.5 to 14.5 feet*
						14.5								
15	SS-5	1 2 2	83		Stiff to medium, dark gray silty CLAY (CL), trace organics and shells.						1.0			
20	ST-6		100								0.75			*Pushed shelby tube from 20.0 to 22.0 feet*
25	ST-7		100								1.0			*Pushed shelby tube from 25.0 to 27.0 feet*
30														

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:50 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B019

Sheet 2 of 2

Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-8	1 2 2	100							1.25			
35	SS-9	1 1 2	100		36.0					1.0			
					Loose, dark gray clayey fine SAND (SC), trace silt.								
40	SS-10	6 7 6	78		40.0 Medium dense fine SAND (SP), trace silt.								
45	SS-11	5 3 3	78		45.0 Medium dense, dark gray silty CLAY (CL), trace shells and organics.					0.75			
50	SS-12	1 1 2	67							0.75			
55	SS-13	7 14 16	11		54.0 Medium dense, dark gray fine to coarse SAND and GRAVEL (SP-GP). 55.5 End of Boring at 55.5 ft								*Boring backfilled with bentonite and cement fluid*
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:50 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B020

Date(s) Drilled	10/01/2015 to 10/02/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 50 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS-1	19 17 13	56		Gravel (GP). 0.3 Lean CLAY (CL), trace fine to coarse gravel. 2.5								
	SS-2	6 8 7	67		Medium dense, moist, brown, clayey fine to coarse GRAVEL (GC). 5.0					0.0 1.0			
5	SS-3	6 8 7	83		Stiff, moist, sandy lean CLAY (CL), trace fine to coarse gravel.					1.5			
	SS-4	1 3 4	78							1.0			
10	ST-5		52										*Pushed shelby tube from 9.5 to 11.5 feet*
15	SS-6	5 3 7	6		Loose, brown well graded GRAVEL (GW). 15.0								*17.0 feet: Drillers Note - cobbles from 17.0 to 20.0 feet*
20	SS-7	30 48 50/5"	72		Dry, brown with some rust and black, well graded SAND (SW) with gravel [Fill]. 20.0								
25	SS-8	22 33 29	67		Very dense, dry, brown clayey GRAVEL (GC), little sand. 25.0								
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:56 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B020

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	27 19 22	78											
35	SS-10	19 27 20	78											
40	SS-11	15 16 41	56		End of Boring at 41.5 ft	41.5								*Less fines in Sample 11* *Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
45														
50														
55														
60														
65														

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:42:56 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B021

Sheet 1 of 2

Date(s) Drilled	10/01/2015 to 10/02/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	45.1 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	80/6"	17		Topsoil, lean CLAY (CL).								
					2.5								
	SS-2	6 5 4	44		Stiff, brown, sandy lean CLAY (CL), trace fine to coarse gravel.					<0.5			
5	ST-3									2.0			*Pushed shelby tube from 5.0 to 6.0 feet*
	SS-4	10 61	83		8.3								
					Very dense, dry, brown, silty GRAVEL (GM).								
10					10.0								
	SS-5	14 14 12	67		Medium dense, moist, brown, clayey GRAVEL (GC).								
15					15.0								
	SS-6	20 15 19	44		Stiff, moist, dark brown to gray and black, medium plastic cohesive lean CLAY (CL).					<0.5			
20					20.0								
	SS-7	9 12 9	100		Very stiff, moist, gray to black, sandy SILT (ML) with Ash [Fill].					1.0			
	ST-8		72										*Pushed shelby tube from 22.0 to 24.0 feet*
25	SS-9	6 20 32	100							<0.5			
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:01 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B021

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-10	11 20 24	94								0.5			*Less sand in Sample 10*
35	SS-11	4 8 10	100		Stiff, moist, black, lean CLAY (CL) with Ash, trace to little sand [Fill].	35.0					2.5			
40	SS-12	5 6 5	100		Medium dense, moist to wet, brown, silty SAND (SM).	40.0								
45	SS-13	50/2"	0		End of Boring at 45.1 ft	45.1								*45.0 feet: Drillers Note - hit rock Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
50														
55														
60														
65														

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:01 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B022

Sheet 1 of 1

Date(s) Drilled	09/23/2015 to 09/23/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Hollow-Stem Auger	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	21.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Drill Cuttings and Bentonite Chips	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	1 1 1	100		Very soft, moist, brown to dark gray, sandy SILT (ML).					0.0 0.5			*0.0 feet: Trace roots from 0.0 ot 0.5 feet*
	ST-2		71										*Pushed shelby tube from 2.5 to 4.5 feet*
5					5.0								
	SS-3	2 2 2	100		Soft, moist, dark gray, SILT (ML).					0.5			
					6.3								
	ST-4		100		Stiff, dry, dark gray, silty SAND (SM) with Ash [Fill].								*Pushed shelby tube from 7.5 to 9.5 feet*
10	SS-5	5 5 6	67							0.0 0.5			
15					15.0								
	SS-6	21 25 20	100		Dense, dry, dark brown to black, silty SAND (SM) with Ash [Fill].					0.0 0.75			
20					20.0								
	SS-7	3 4 5	100		Stiff, moist, brown, sandy lean CLAY (CL).					1.0 1.25			
					21.5								
					End of Boring at 21.5 ft								*Boring backfilled with 75 pounds of bentonite chips and soil cuttings*
25													
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:07 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B023

Sheet 1 of 3

Date(s) Drilled	09/22/2015 to 09/23/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	76.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	7 11 15	100		Dense, moist, brown, fine to medium sandy silty GRAVEL (GM) [Fill]								
					2.0								
	SS-2	8 15 18	100		Stiff to hard, moist, sandy silty CALY (CL) with medium to coarse gravel [Fill]. Grades with medium brown sand in occasional lenses. Grades with zones of high plastic clay.					4.5			
5	SS-3	10 27 18	100							3.5 4.25			
	SS-4	7 17 20	100							4.5			
					9.5								
10	SS-5	13 12 10	83		Medium dense, moist, brown clayey silty fine to medium SAND (SM) [Fill].					4.5			
					11.0								
					Hard, moist, brown, silty sandy CLAY (CL) with fine to medium gravel [Fill].								
					13.0								
					Medium dense, moist, brown fine to medium GRAVEL with sand and clay lenses [Fill].								
15	SS-6	22 32 52	83										
					18.0								
					Moist, dark gray to black, silt to fine gravel sized fly / bottom ASH [Fill].								
20	SS-7	51 39 26	94										
					23.0								
					Moist to wet, dark gray, silt sized fly ash with some sand to small gravel sized FLY ASH particles [Fill].								
25	SS-8	4 6 5	83							0.0 0.25			
	ST-9		63										
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:10 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B023

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-10	15 11 11	100							0.25 0.5			
					33.0								
					Medium dense to dense, moist, dark gray to black, silty sand to small gravel sized bottom ASH [Fill].								
35	SS-11	20 36 53	100							0.5 3.5			
					40.0								
40	SS-12	14 11 12	100		Medium dense, moist to wet, dark gray to black, silty SAND (SM), trace gravel and ash [Fill].					0.5 1.3			
					44.0								
45	SS-13	7 4 14	33		Very stiff, wet, brown, sandy lean CLAY (CL) with fine to coarse gravel.					0.5			
					50.0								
50	SS-14	34 52	83		Very dense, wet, brown, clayey fine to coarse angular GRAVEL (GC) with sand.								
55	SS-15	18 11 8	78										
60	SS-16	11 7 8	17										
65					65.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:10 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B023

Sheet 3 of 3

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	SS-17	6 4 5	67		Loose, wet, brown, silty fine to coarse GRAVEL (GM).								
70					70.0								
	SS-18	19 19 13	67		Dense, wet, brown, silty fine to coarse GRAVEL (GM) with fine sand.								*70.6 feet: Sand seam from 70.6 to 71.0 feet*
75					75.0								
	SS-19	18 17 9	33		Medium dense, wet, silty fine to coarse GRAVEL (GM).								
					76.5								
					End of Boring at 76.5 ft								*Boring backfilled with 94 pounds of Portland Type I Cement*
80													
85													
90													
95													
100													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:10 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B024

Date(s) Drilled	09/22/2015 to 09/22/2015	Logged By	Andrew Wilding	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	62.7 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0								0.0								
	SS	1	14 15 15	100		Dense, moist, brown fine to medium silty GRAVEL [Fill].										
	SS	2	19 23 18	100												
								4.5								
5	SS	3	5 7 15	100		Stiff, moist, brown silty CLAY with some medium gravel and sand [Fill].		5.8					3.5			
						Medium dense, moist, brown, silty medium SAND, trace organics [Fill].		7.0								
	SS	4	4 15 23	78		Medium stiff, moist, brown, silty SAND, with some small to medium gravel [Fill].							2.25 3.0			
								9.5								
10	SS	5	10 12 16	78		Medium stiff, moist, dark gray, clayey SILT with medium to coarse sand, some gravel (presumably fly ash) and seams of brown silty clay [Fill].							4.0 4.5			
								13.0								
						Dense, moist, dark gray to black fine to coarse sand sized bottom ASH with some fine gravel [Fill].										
15	SS	6	13 20 29	94												
						Grades with fine gravel.										
20	SS	7	75/0.3'	38												
								22.0								
						Very soft, moist to wet, dark gray silt to fine sand sized FLY ASH [Fill].										
25	SS	4	3 2 3	100												
	ST	9		57												*Pushed shebly tube from 27.0 to 29.0 feet* *Shelby tube refusal at 29.2*
30																

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:18 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B024

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-10	1 3 2	100		Grades with thin, hard cemented layers.								
35	SS-11	5 9 12	100							0.5			
					39.0 Medium dense, wet, sandy silty fine to coarse GRAVEL (GM).								
40	SS-12	55/6"	50										
45	SS-13	22 27 21	78										
50	SS-14	15 18 15	50		Grades with ~1" silty clay layers and zones of silty clay matrix (silty clay, brownish gray, soft to medium stiff, moist).								
55	SS-15	55/0.2'	0										
					58.0 Medium dense, moist, silty SAND (SM) with trace to fine medium gravel.								
60	SS-16	20 22 13	78										
					62.0 Wet, sandy fine to medium, rounded GRAVEL (GP). 62.7								
	SS-17	80/0.1'	17		End of Boring at 62.7 ft								*Boring backfilled with Portland Type I cement*
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:18 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B025

Sheet 1 of 2

Date(s) Drilled	10/01/2015 to 10/01/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	56.5 ft
Drill Rig Type	Mobile 50 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS-1	23 19 22	56		Medium dense, dry, brown, silty SAND (SM) with gravel [Road Fill].		0.0								
							2.5								
	SS-2	5 7 9	72		Stiff, dry, brown, lean CLAY (CL).							3.0			
5	SS-3	14 26 19	78		Dense, dry, silty GRAVEL (GM) with sand [Fill].		5.0								
							7.5								
	SS-4	2 2 2	89		Soft, gray with some black SILT (ML) to very fine silty SAND (SM).							<0.5			
10	SS-5	2 3 4	33									0.5			*Pushed shelby tube from 10.5 to 14.0 feet*
	ST-6		100									1.0			
15	SS-7	2 3 2	56									<0.5			
							20.0								
20	SS-8	9 5 3	56		Stiff, moist to wet, gray with some black layering, sandy SILT (ML).							<0.5			
25	ST-9		100												*Pushed shelby tube from 25.0 to 27.0 feet*
	SS-10	4 4 5	56									1.0			
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:23 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B025

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-11	3 4 5	67							<0.5			
35	SS-12	5 7 7	72							1.0			
40	SS-13	6 12 11	61							1.1			
45	SS-14	6 7 8	83							1.0			
50	SS-15	7 8 10	89							0.5 1.5			
55	SS-16	10 12 13	94		55.0 Very stiff, moist to wet, black, gray and some dark brown, sandy SILT (ML). 56.5 End of Boring at 56.5 ft					3.5 4.0			*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:23 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B026

Sheet 1 of 1

Date(s) Drilled	09/23/2015 to 09/23/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	12.0 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0						Barge.	0.0								
						Water.	1.5								
							4.0								
5	SS-1		4 5 7	56		Dark brown fine to coarse SAND and GRAVEL (SP-GP).	4.5								
						Dark gray to brown gravelley CLAY (GC), trace sand.									
	SS-2		8 4 9												
10							11.5								
						End of Boring at 12 ft									*11.5 feet: Drillers Note - hard drilling from 11.5 to 12.0 feet* *12.0 feet: Possible boulder or obstruction* *Boring backfilled with bentonite grout*
15															
20															
25															
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:29 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B026A

Sheet 1 of 1

Date(s) Drilled	09/23/2015 to 09/23/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	26.5 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					Blind drill - see HEN-B026. 0.0								*Blind drilled to 10.0 feet*
10	SS-1	7 6 7	11		10.0 Brown gravelly CLAY (GC), trace sand.								
	SS-2	25 42 13	0										
	SS-3	6 7 5	33										*Large rock in Sample 3*
15													
	SS-4	5 5 9	11										
20	SS-5	7 8 6	11		20.0 Brown GRAVEL (GP) with sand and clay.								
25	SS-6	8 9 6	33		25.0 Brown fine to coarse SAND (SP) and GRAVEL (GP), trace silt and clay. 26.5 End of Boring at 26.5 ft								*Boring backfilled with bentonite grout*
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:31 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B027

Date(s) Drilled	09/22/2015 to 09/22/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	31.5 ft
Drill Rig Type	Diedrich D-26 Barge Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					Barge. 0.0								
					1.5 Water.								
5					7.0								
	SS-1	2 3 3 WOH	78		Dark brown SAND (SP) and GRAVEL (GP). 7.5 Dark gray, silty CLAY (CL), trace sand.					1.5			
10	ST-2		72		12.0					2.5			*Pushed shelby tube from 10.0 to 12.0 feet*
	SS-3	3 4 7	61		Dark gray to brown, silty CLAY (CL) with some gravel and sand.					1.5 2.0			
15	SS-4	4 5 7	22							1.75			
20	SS-5	3 5 4	33		20.0 Brown gravelly CLAY (GP) with some sand.								
25	SS-6	7 8 12	22		25.0 Brown to gray clayey SILT (ML) with some sand and gravel.								
					28.0 Fine to coarse SAND (SP) and GRAVEL (GP).								*28.0 feet: Cave in*
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:34 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B027

Sheet 2 of 2

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION: Elevation (feet)	MATERIAL DESCRIPTION: Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-7	8 9 8	56											
						31.5								
					End of Boring at 31.5 ft									*Boring backfilled with bentonite grout*
35														
40														
45														
50														
55														
60														
65														

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:34 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B029

Date(s) Drilled	10/01/2015 to 10/01/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	24 28 34	100		Very dense, dry, brown, silty GRAVEL (GM) [Road Fill].								
					2.5								
	SS-2	10 6 11	100		Stiff to very stiff, dry, lean CLAY (CL).					4.5			
5	ST-3		100							4.5			*Pushed shelby tube from 5.0 to 7.0 feet*
	SS-4	12 14 17	100							4.0			
10	ST-5		100							2.5			*Pushed shelby tube from 10.0 to 12.0 feet*
					15.0								
15	SS-6	4 6 8	83		Stiff, dark brown with trace rust, lean CLAY (CL), trace fine to coarse gravel.					1.5			
					20.2								
20	SS-7	6 12 20	78		Dense, dry, brown, clayey GRAVEL (GC).					1.5			
25	SS-8	17 17 43	56										
30													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:40 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B029

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	29 50/5"	22										*Less fines in Sample 9*
35	SS-10	20 25 28	61										
40	SS-11	16 14 15	6										
					41.5 End of Boring at 41.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:40 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B030

Sheet 1 of 1

Date(s) Drilled	09/29/2015 to 09/30/2015	Logged By	Norm Seiler	Checked By	AJW
Drilling Method	Hollow-Stem Auger	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	11.0 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	9.0 ft on 9/29/2015		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS-1		22 17 37	83		Brownish gray sand, gravel, and clay [Fill].									
							2.5								
	SS-2		15 17 15	67		Brown fine to coarse sand and gravel with some clay [Fill].									
5	SS-3		18 20 30	83											
							7.5								
	SS-4		4 5 6	100		Dark gray with trace gravel, sand, and clay, with ASH [Fill].									
							10.0								*9.0 feet: Wet*
10	ST-5			33		Black ASH with gravel [Fill].									*Pushed shelby tube from 10.0 to 11.0 feet*
							11.0								*10.0 feet: Switch to mud rotary*
						End of Boring at 11 ft									*Boring backfilled with Portland Type I cement*
15															
20															
25															
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:45 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B032

Sheet 1 of 2

Date(s) Drilled	09/30/2015 to 09/30/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	32 29 20	67		Very dense, dry, brown, fine to coarse well graded GRAVEL (GW) with silt and sand [Fill].	1.0					4.5			
	SS	SS-2	6 18 17	100		Hard, dry, black, lean CLAY (CL), trace fine to medium gravel.						3.5			
5	ST	ST-3		79								4.5			*Pushed shelby tube from 5.0 to 7.0 feet*
	SS	SS-4	8 12 16	100								3.5			
10	SS	SS-5	8 16 20	44								0.5			*10.0 feet: Coarse gravel*
15	SS	SS-6	19 39 43	72		Very dense, moist, brown and black, clayey fine to coarse GRAVEL (GC).	15.0								
20	SS	SS-7	18 36 50/3"	61											
25	SS	SS-8	98 35 50/4"	78											*24.5: Drillers Note - boulder from 24.5 to 25.2 feet*
30							30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:48 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B032

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	18 11 30	100		Hard, moist, brown, fine to coarse gravelly lean CLAY (CL).					3.0 4.5			
35	SS-10	41 28 40	67		35.0 Very dense, moist, brown and black, clayey fine to coarse GRAVEL (GC).								
40	SS-11	12 18 50/4"	72		41.5 End of Boring at 41.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:48 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B034

Sheet 1 of 2

Date(s) Drilled	09/30/2015 to 10/01/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0					0.0								
	SS-1	25 19 21	100		Very dense, dry, brown, silty SAND (SM) [Fill]. 0.5 Hard, dry, black, gravelly lean CLAY (CL) [Fill].					1.5 2.5			
	SS-2	7 8 11	100							3.5 4.5			
5					5.0								
	SS-3	17 28 32	100		Dense, dry, brown, silty SAND (SM). 5.5 Very dense, brown to gray, silty fine to coarse GRAVEL (GM) with sand.								
	SS-4	11 18 32	100										
10					10.0								
	SS-5	27 35 18	56		Very dense, moist, brown, clayey GRAVEL (GC).								
15	SS-6	21 24 25	44										
20					20.0								
	SS-7	10 11 9	44		Medium dense, dry, silty fine to coarse GRAVEL (GM).								
25	SS-8	11 13 16	6										
30					30.0								

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:53 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B034

Sheet 2 of 2

Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	14 14 12	22		Medium dense, moist to wet, brown, well graded GRAVEL (GW).								
35	SS-10	9 11 10	67										
40	SS-11	10 8 9	17		41.5 End of Boring at 41.5 ft								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:53 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B037

Sheet 1 of 2

Date(s) Drilled	09/23/2015 to 09/24/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	41.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Portland Cement and Grout	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0	SS	SS-1	12 15 21	100		Dense, dry, brown, silty SAND (SM) with fine to coarse gravel [Road Fill].	0.0								
							2.0								
	SS	SS-2	12 17 20	100		Dense, dry, poorly graded SAND (SP), trace fine to medium gravel [Fill].									
5	SS	SS-3	12 19 26	100		Dense, dry, brown, silty SAND (SM) with fine to coarse gravel [Fill].	5.0								
	SS	SS-4	10 8 12	94		Very stiff, dark gray to black, lean CLAY (CL), trace fine to coarse gravel [Fill].	8.0								
10	SS	SS-5	12 33 31	100		Dry to moist, dark brown, clayey fine to coarse GRAVEL (GC) with sand.	10.0								*11.3 feet: Rusty in color* *13.0 feet: 100% water loss*
15	SS	SS-6	10 43 40	67		Very dense, moist, light brown, fine to coarse clayey GRAVEL (GC) with sand.	15.0								
20	SS	SS-7	10 14 22	94											
25	SS	SS-8	19 21 16	56											
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:59 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B037

Sheet 2 of 2

Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
30	SS-9	21 14 19	83		30.5 Hard, moist, dark greenish gray, fine to coarse, rounded to angular gravelly lean CLAY (CL).					1.25			
35	SS-10	7 12 18	83		35.0 Very stiff, moist, brown, clayey fine to coarse GRAVEL (GC).								
40	SS-11	13 20 21	67		41.5 End of Boring at 41.5 ft								*Boring backfilled with Portland Type I Cement*
45													
50													
55													
60													
65													

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:43:59 AM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois

Project Number: 60439752

Log of Boring HEN-B038

Sheet 1 of 1

Date(s) Drilled	09/23/2015 to 09/23/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Hollow-Stem Auger	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Borehole Depth	21.5 ft
Drill Rig Type	Diedrich D-120 Rubber Tired ATV	Drilling Contractor	Strata Earth Services	Surface Elevation	ft
Borehole Backfill	Drill Cuttings and Bentonite Chips	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Hammer Data	Automatic, 140 lbs, 30" drop
		Groundwater Level(s)	ft on		

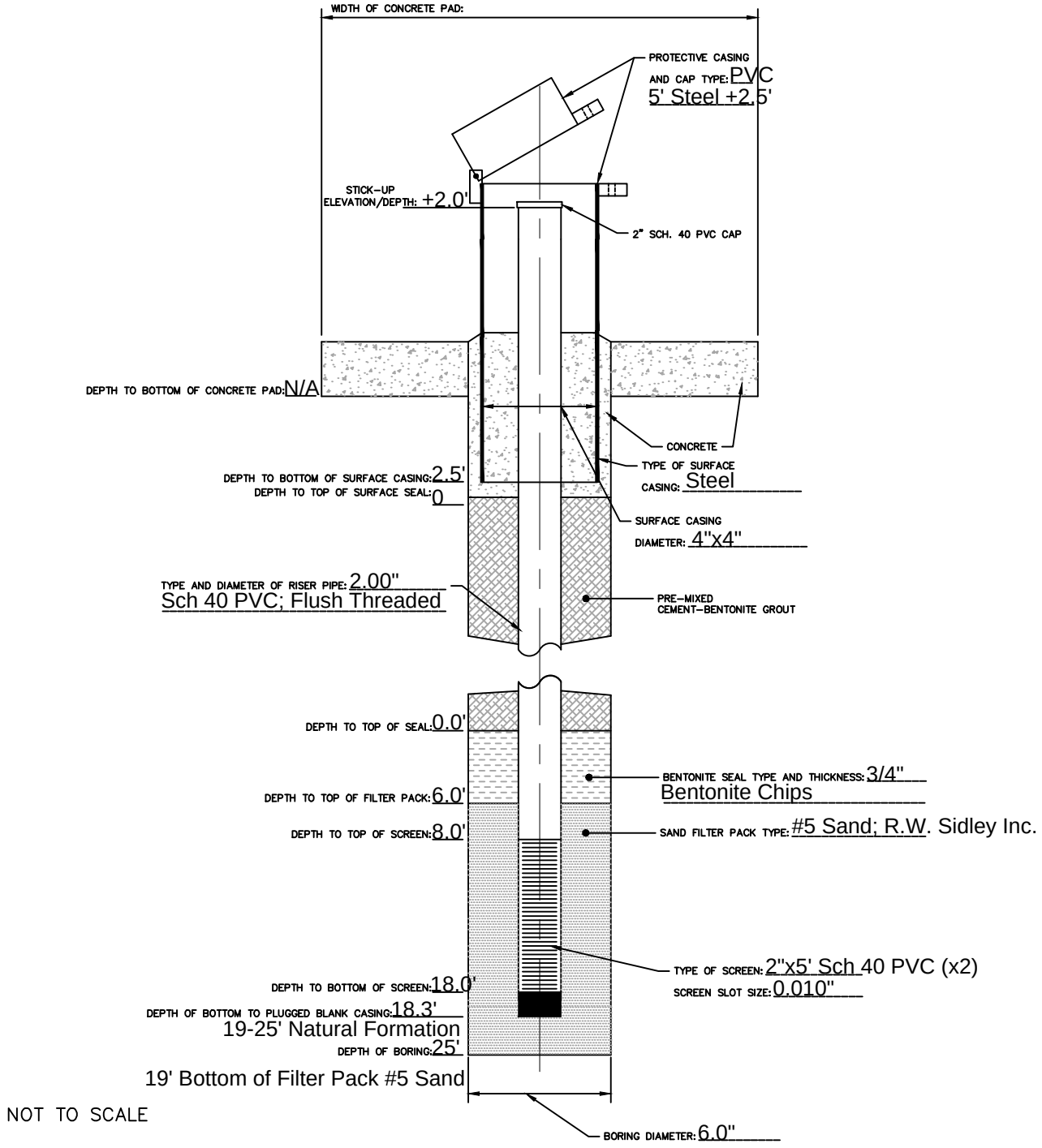
Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
0							0.0								
	SS-1		12 18 22	89		Dense, dry, dark brown, well graded GRAVEL with CLAY (GW-GC) [Road fill]									
							3.0								
	SS-2		16 30 50/5.5"	97		Very dense, dry, gray, well graded fine to coarse GRAVEL (GW) [Fill].									
5	SS-3		37 50/5"	50											
	SS-4		5 6 31	94			8.1								
						Stiff, moist, black and brown, lean CLAY (CL), trace sand and fine gravel [Fill].	8.6								
						Very dense, dry, brown, well graded GRAVEL (GW) [Fill].									
10	SS-5		6 10 12	100			10.5								
						Very stiff, dry, greenish gray, lean CLAY (CL) [Fill].						6.0			
15							15.0								
	SS-6		15 15 24	100		Dense, moist, brown, clayey GRAVEL (GC) with sand [Fill].									
20	SS-7		7 17 13	94			21.5								
						End of Boring at 21.5 ft									*Boring backfilled with 75 pounds of bentonite chips and soil cuttings*
25															
30															

Report: GEO_SOIL; File K:\PROJECTS\60439752_DYNEGY CCR HENNEPIN\400-TECHNICAL\BORING LOGS\60439752_HENNEPINDYNEGYBORINGLOGS.GPJ; 12/18/2015 9:44:04 AM

APPENDIX B

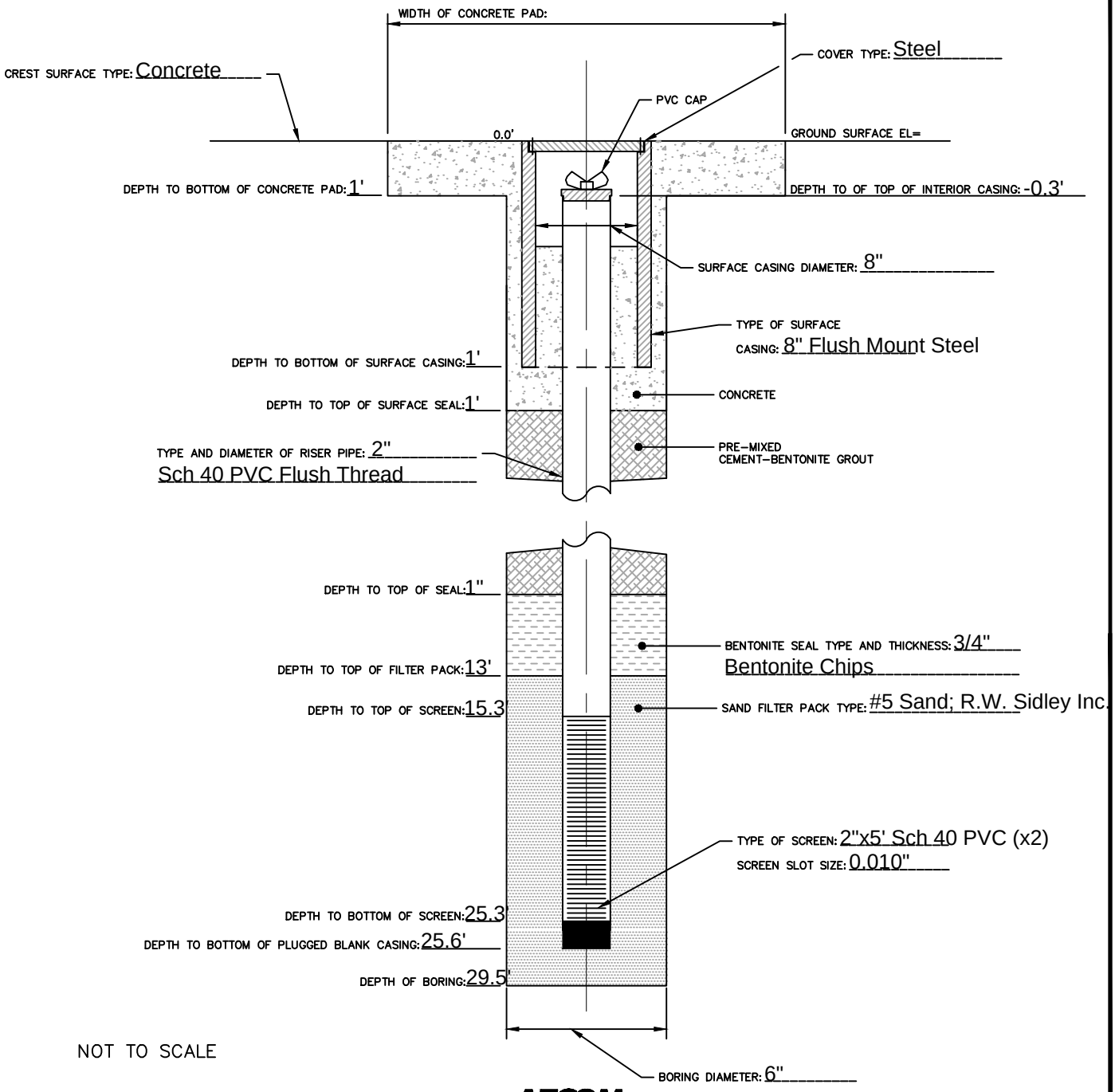
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location	P001	Date Installed	10/15/15	Time	9:10 A.M.
Installed By	Scott Komen	Observed By	R. Weseljak	Total Depth	25'
Method of Installation	6" Solid Flight Auger	Drilling Contractor	Strata	Surface Elevation	
Screened Interval	8-18'	Completion Zone	Silts and Clays		
Remarks		Groundwater Level(s)	13.33' T.O.C.		



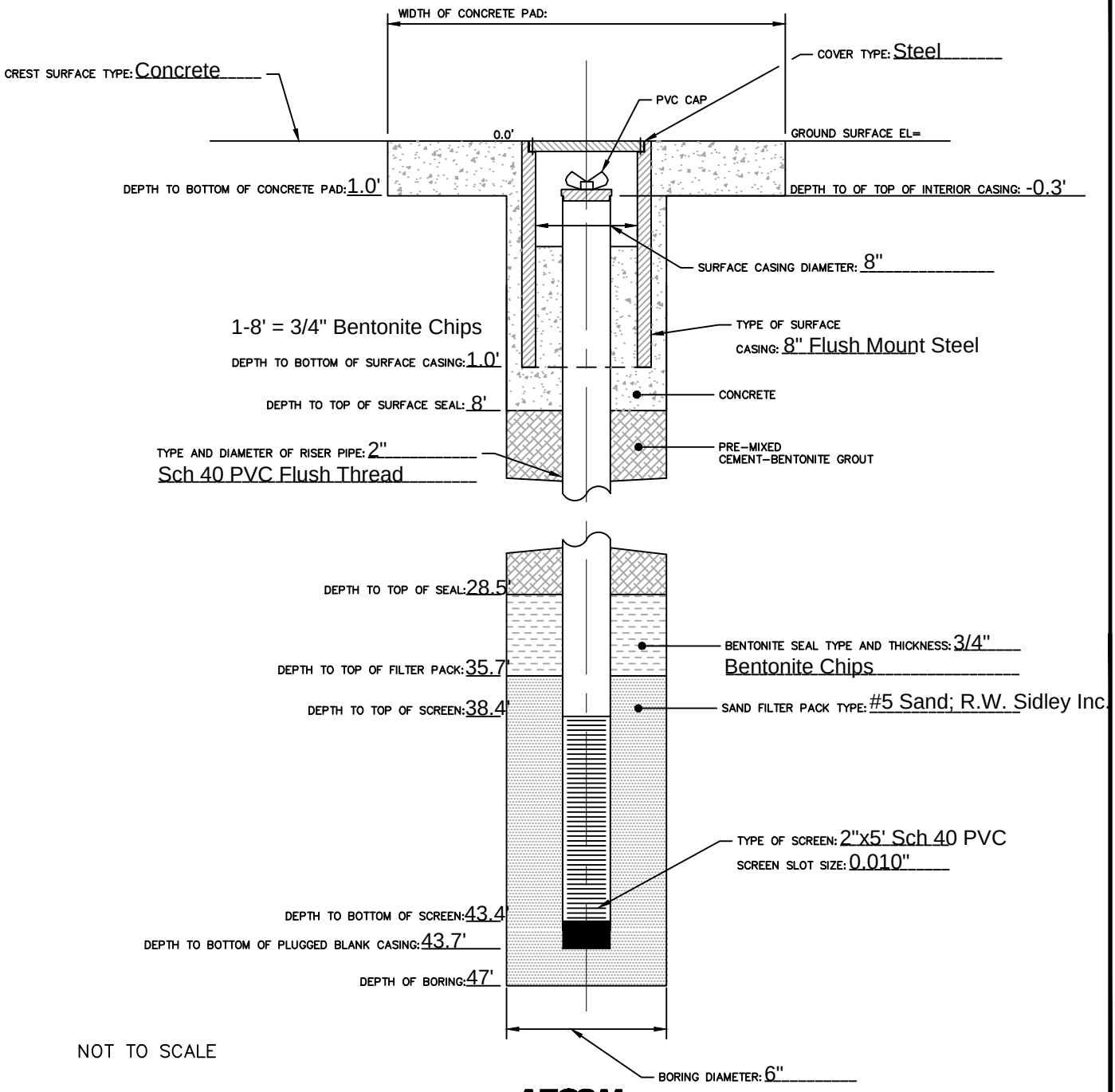
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location: P002	Date Installed: 10/15/15	Time: 11:10 A.M.
Installed By: Scott Komen	Observed By: R. Weseljak	Total Depth: 29.5'
Method of Installation: 6" Solid Flight Auger	Drilling Contractor: Strata	Surface Elevation:
Screened Interval: 15.3-25.3'	Completion Zone: Sands	
Remarks:	Groundwater Level(s): 15.90' T.O.C.	



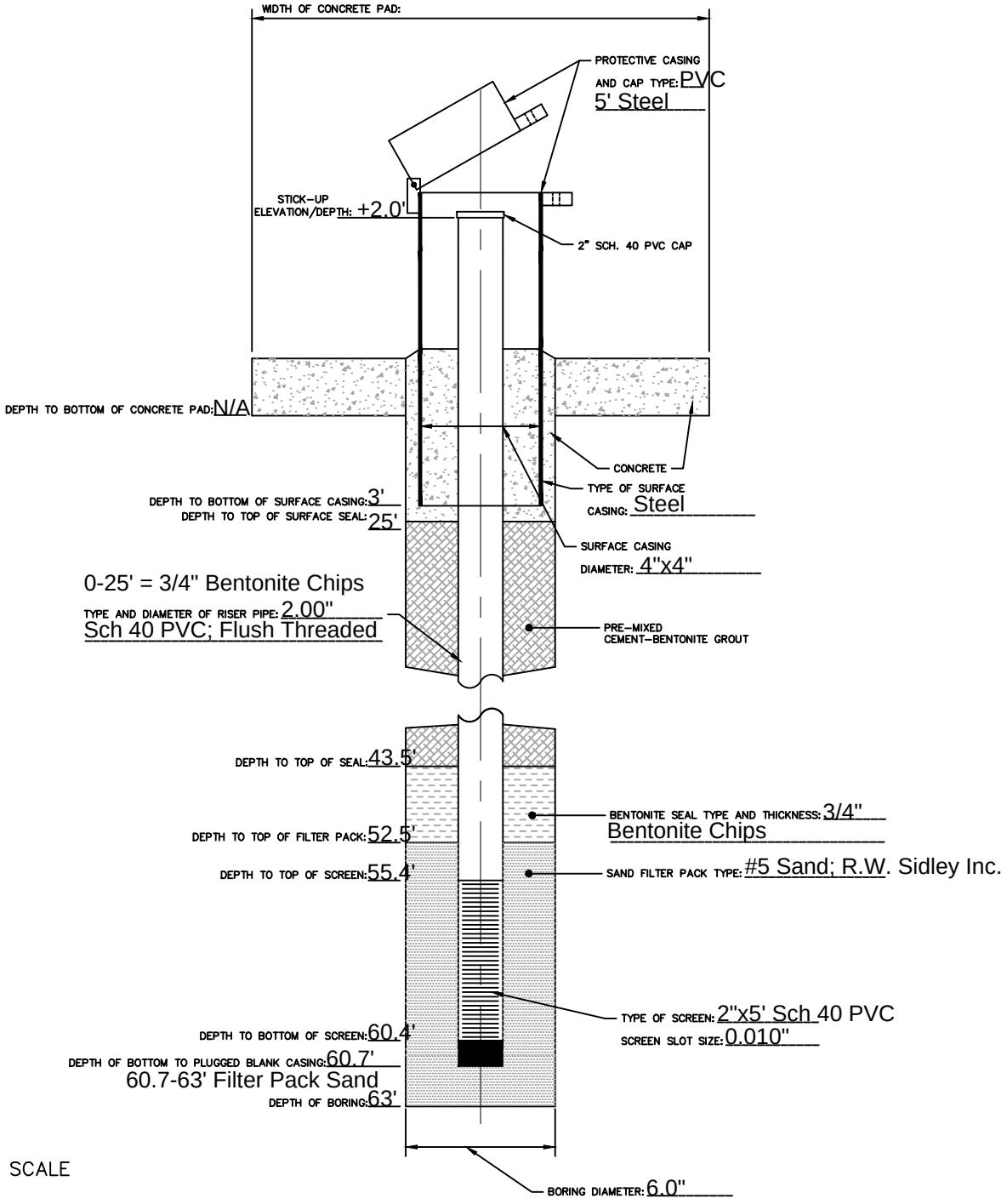
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location: P003	Date Installed: 10/14/15	Time: 9:45 A.M.
Installed By: Scott Komen	Observed By: R. Weseljak	Total Depth: 47'
Method of Installation: 6" Mud Rotary/ 6" Casing	Drilling Contractor: Strata	Surface Elevation:
Screened Interval: 38.4'-43.4'	Completion Zone: Gravels	
Remarks:	Groundwater Level(s): 17.15' T.O.C.	



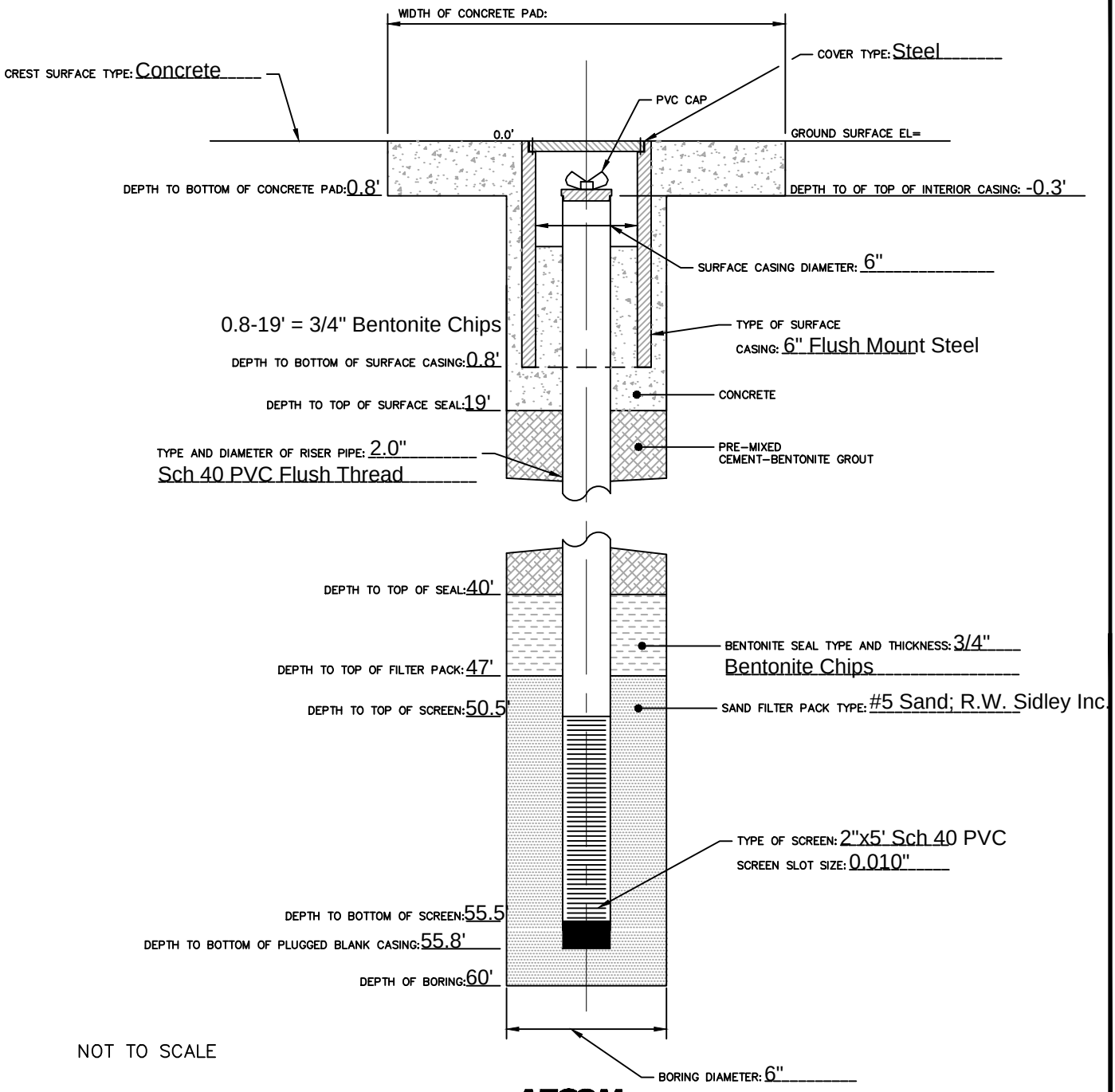
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location	P004	Date Installed	10/16/15-10/19/15	Time	8:00 A.M.
Installed By	Scott Komen	Observed By	R. Weseljak	Total Depth	63'
Method of Installation	6" Mud Rotary with 6' Casing	Drilling Contractor	Strata	Surface Elevation	
Screened Interval	55.4-60.4'	Completion Zone	Gravels		
Remarks		Groundwater Level(s)	48.65' T.O.C.		



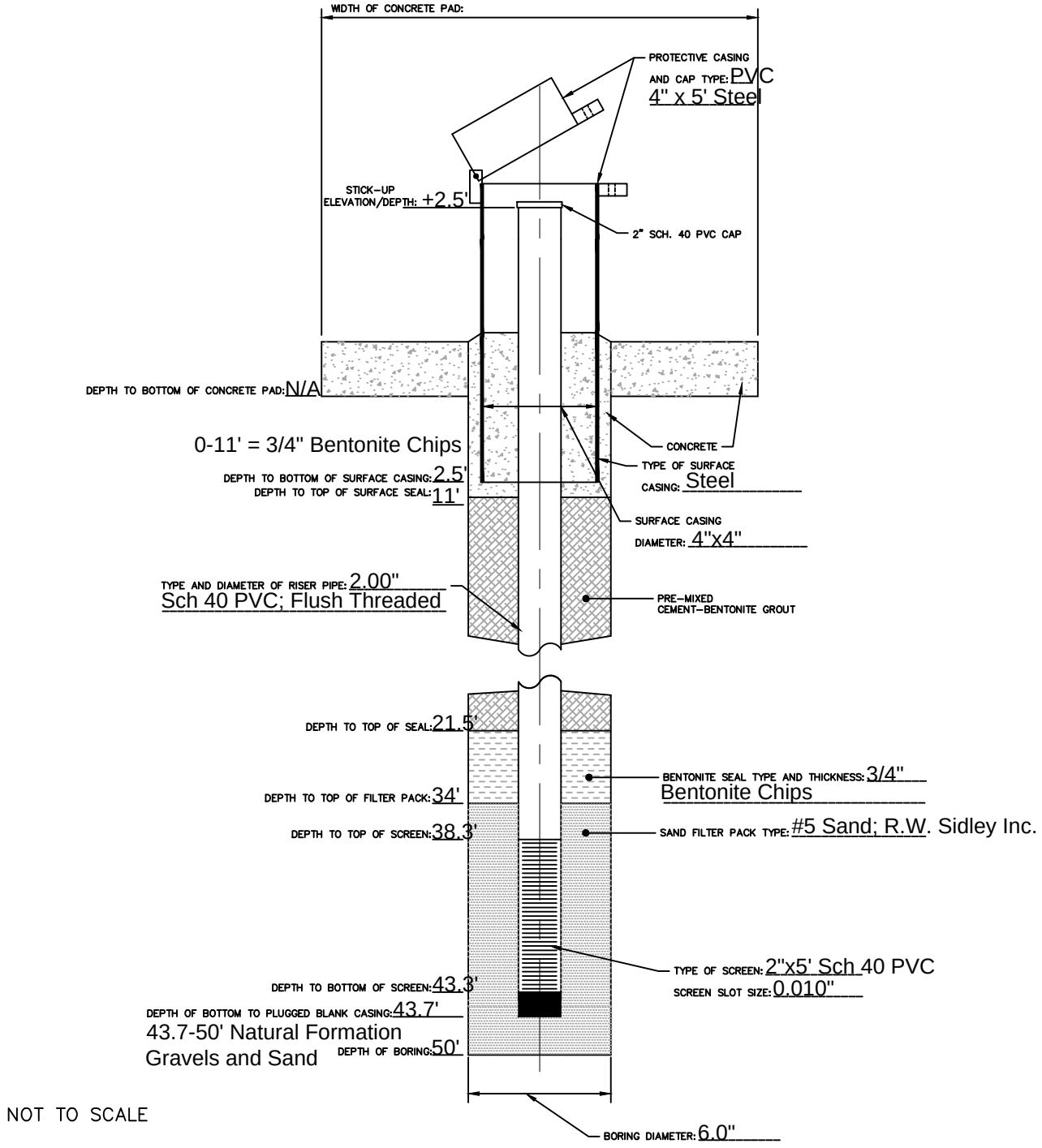
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location: P005	Date Installed: 10/20/15	Time: 4:30 P.M.
Installed By: Scott Komen	Observed By: R. Weseljak	Total Depth: 60'
Method of Installation: 6" Tricone Mud Rotary	Drilling Contractor: Strata	Surface Elevation:
Screened Interval: 50.5-55.5'	Completion Zone: Gravels and Sands	
Remarks:	Groundwater Level(s): 45.80' T.O.C.	



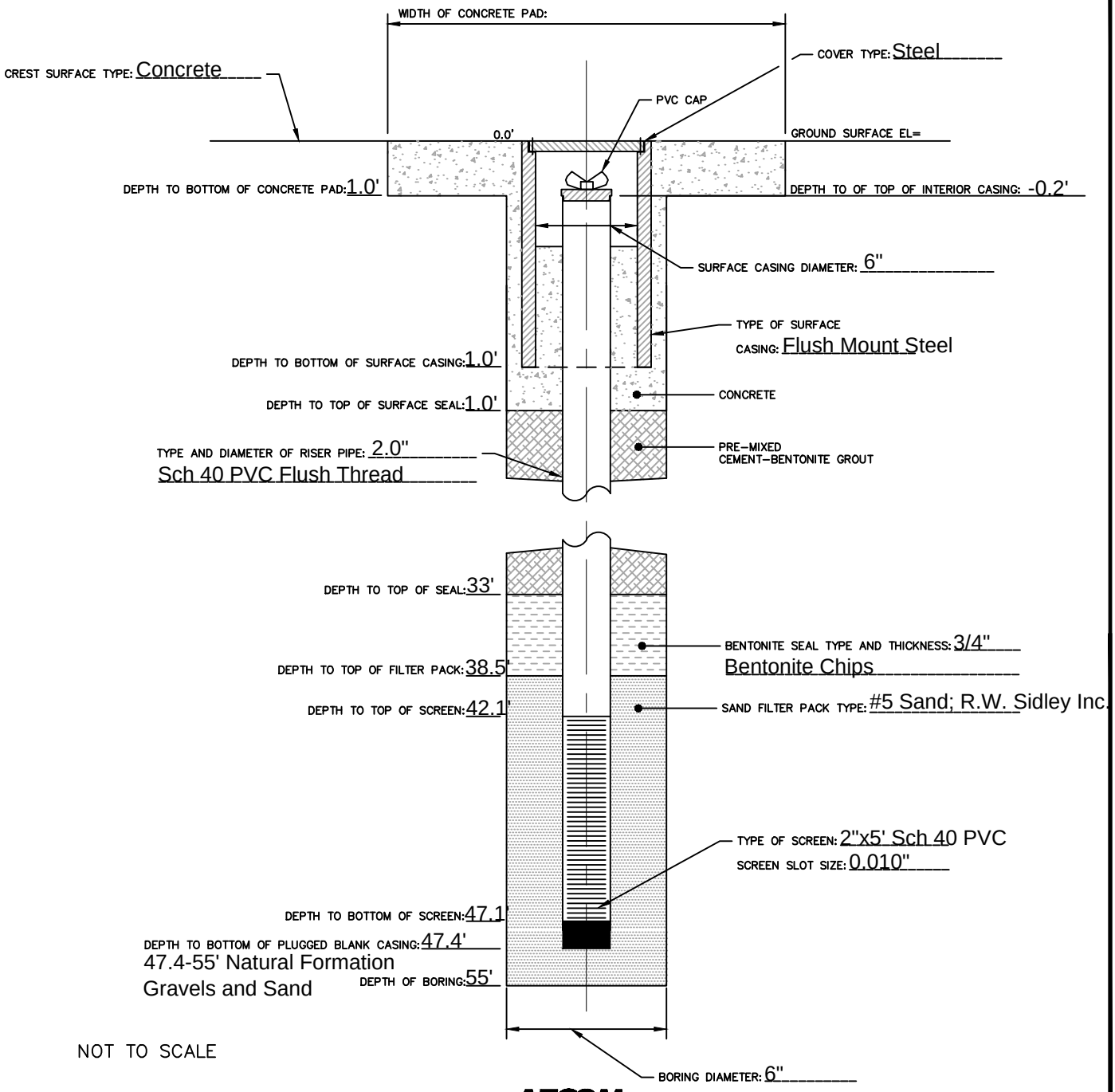
Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location	P006	Date Installed	10/20/15	Time	11:20 A.M.
Installed By	Scott Komen	Observed By	R. Weseljak	Total Depth	50'
Method of Installation	6" Tricone Mud Rotary	Drilling Contractor	Strata	Surface Elevation	
Screened Interval	38.3-43.3'	Completion Zone	Gravel		
Remarks		Groundwater Level(s)	45.74' T.O.C.		



Project: Dynegy Project Location: Hennepin, IL Project Number: 60439752	Log of Piezometer Sheet 1 of 1

Piezometer Location: P007	Date Installed: 10/21/15	Time: 5:00 P.M.
Installed By: Scott Komen	Observed By: R. Weseljak	Total Depth: 55'
Method of Installation: 6" Tricone Mud Rotary	Drilling Contractor: Strata	Surface Elevation:
Screened Interval: 42.1-47.1'	Completion Zone: Gravels	
Remarks:	Groundwater Level(s): 44.65' T.O.C.	



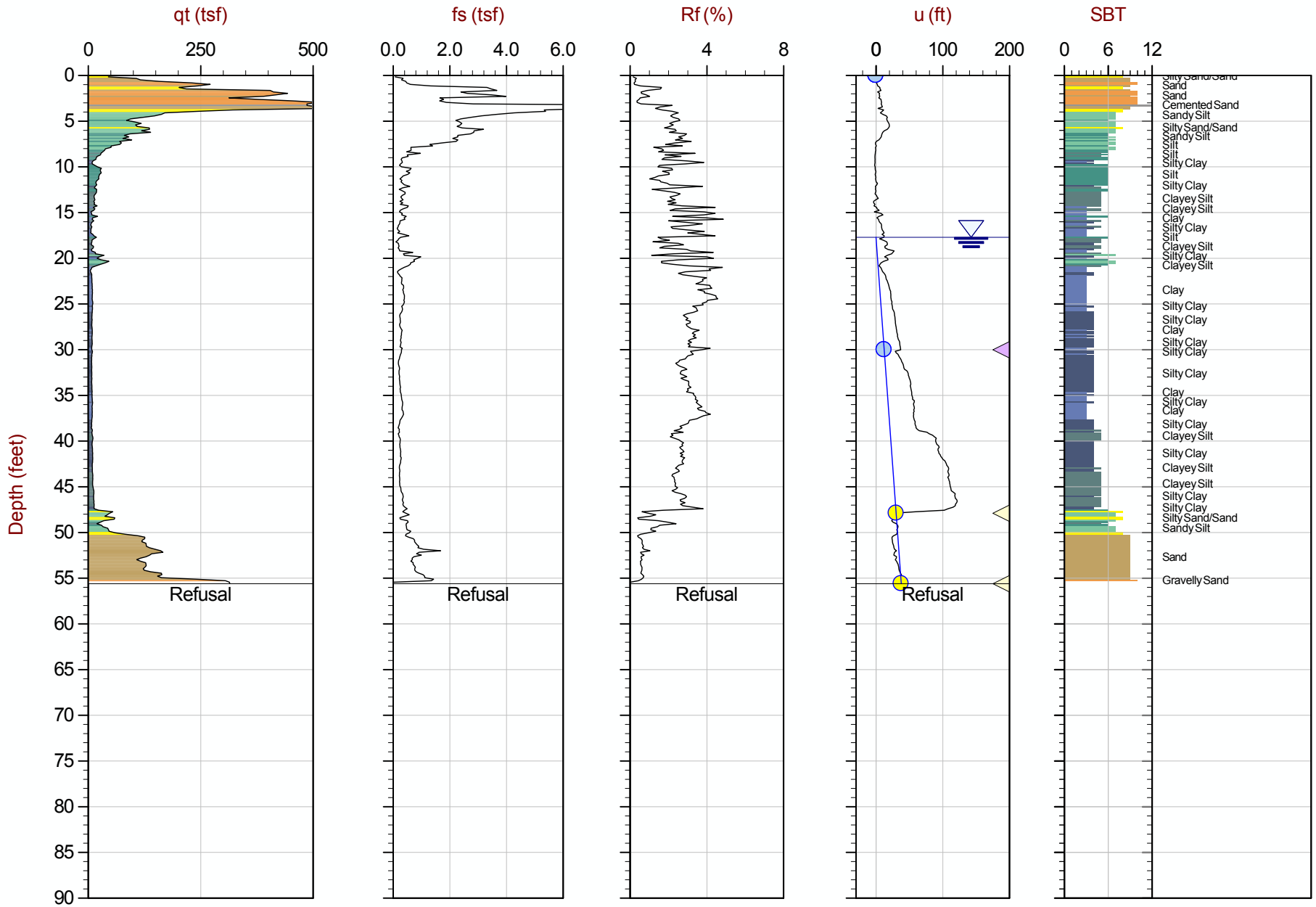
APPENDIX C

CONETEC

AECOM

Job No: 15-53081
Date: 09:10:15 08:58
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C002
Cone: 301:T1500F15U500



Max Depth: 16.950 m / 55.61 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP02.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574662m E: 305168m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

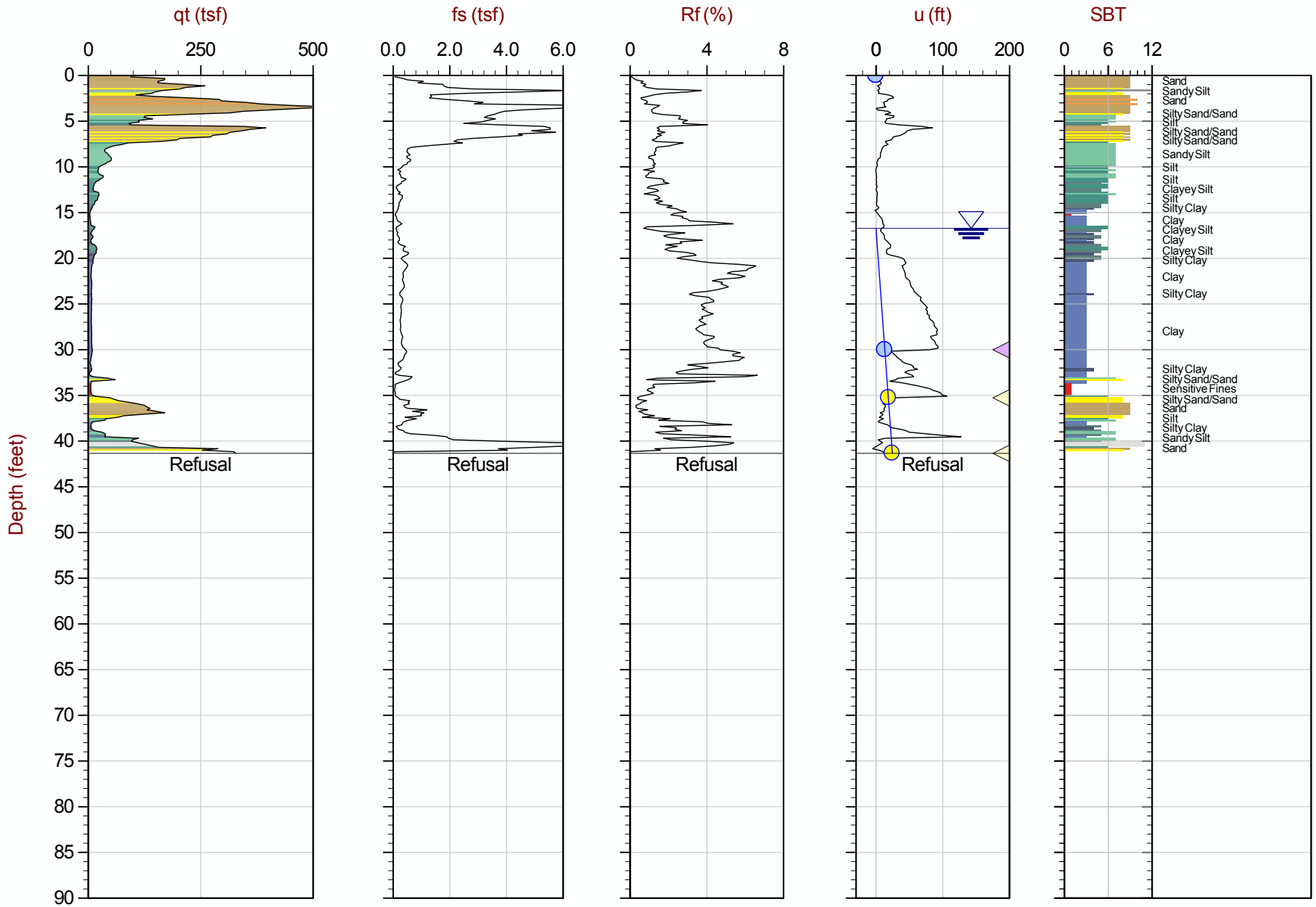
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:03:15 12:09
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C004
Cone: 301:T1500F15U500



Max Depth: 12.600 m / 41.34 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP04.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574765m E: 305345m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

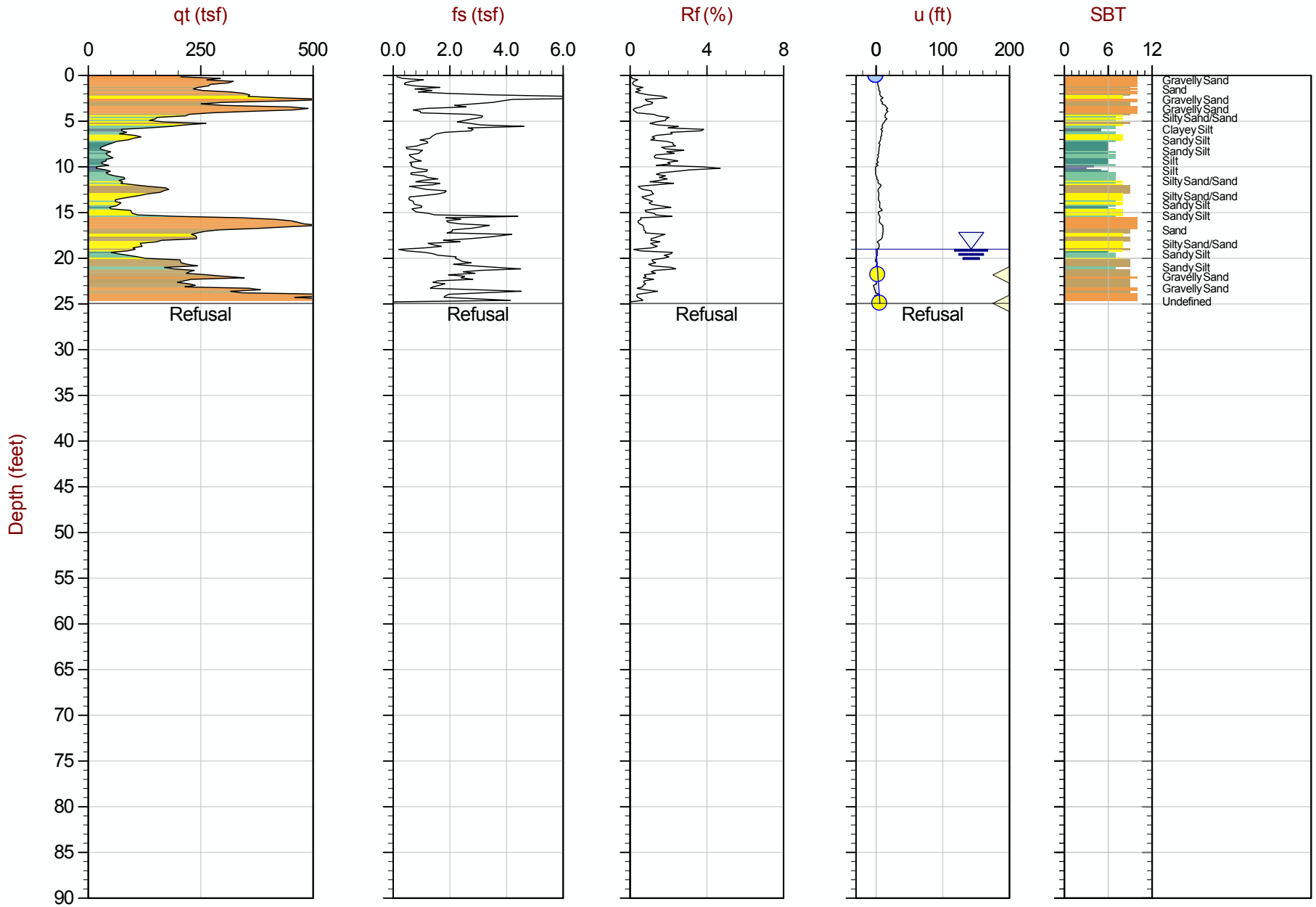
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:03:15 09:08
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C005
Cone: 301:T1500F15U500



Max Depth: 7.600 m / 24.93 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP05.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574883m E: 305653m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

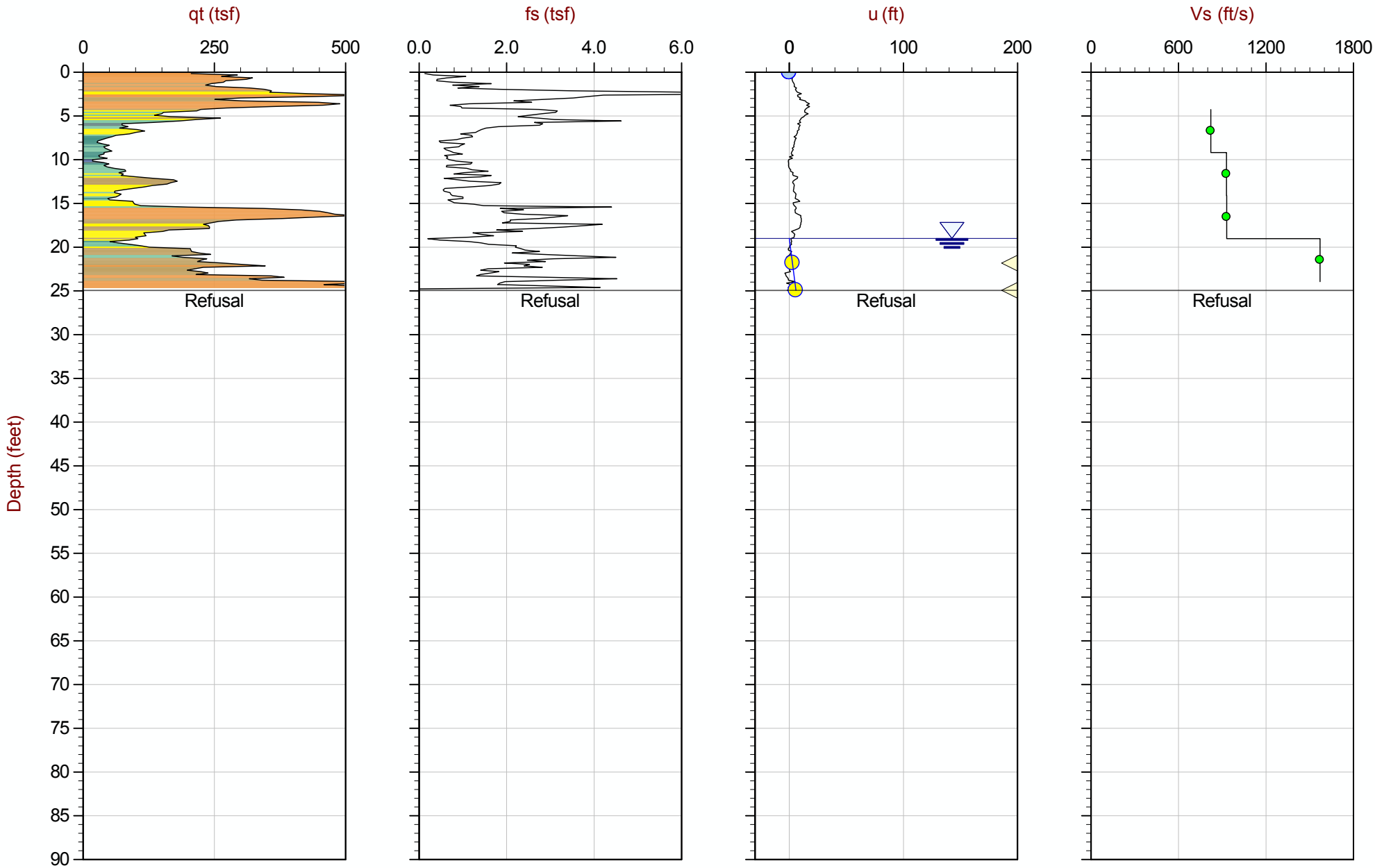
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:03:15 09:08
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C005
Cone: 301:T1500F15U500



Max Depth: 7.600 m / 24.93 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP05.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574883m E: 305653m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

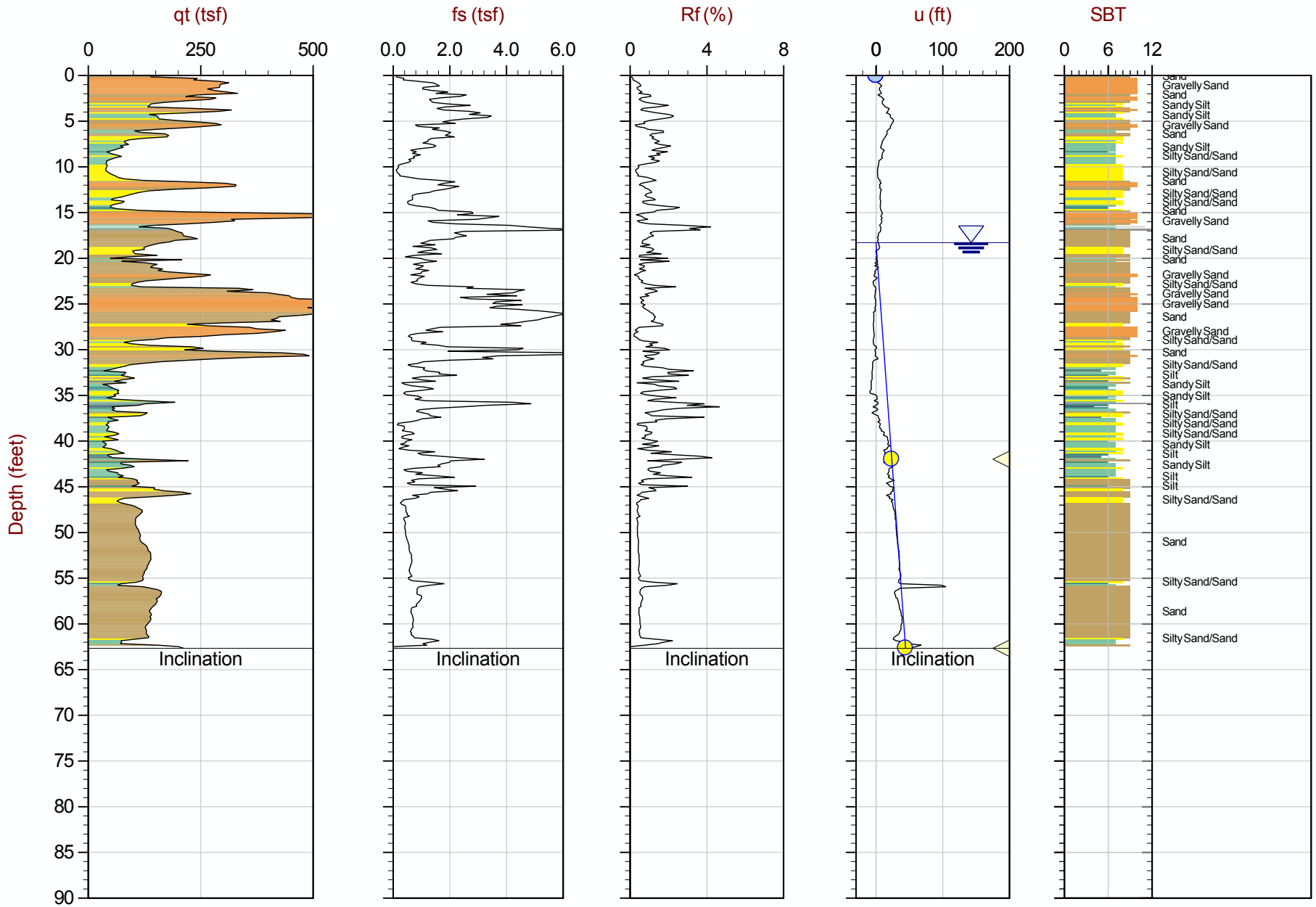
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:03:15 10:10
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C005A
Cone: 301:T1500F15U500



Max Depth: 19.100 m / 62.66 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP05A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574883m E: 305655m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

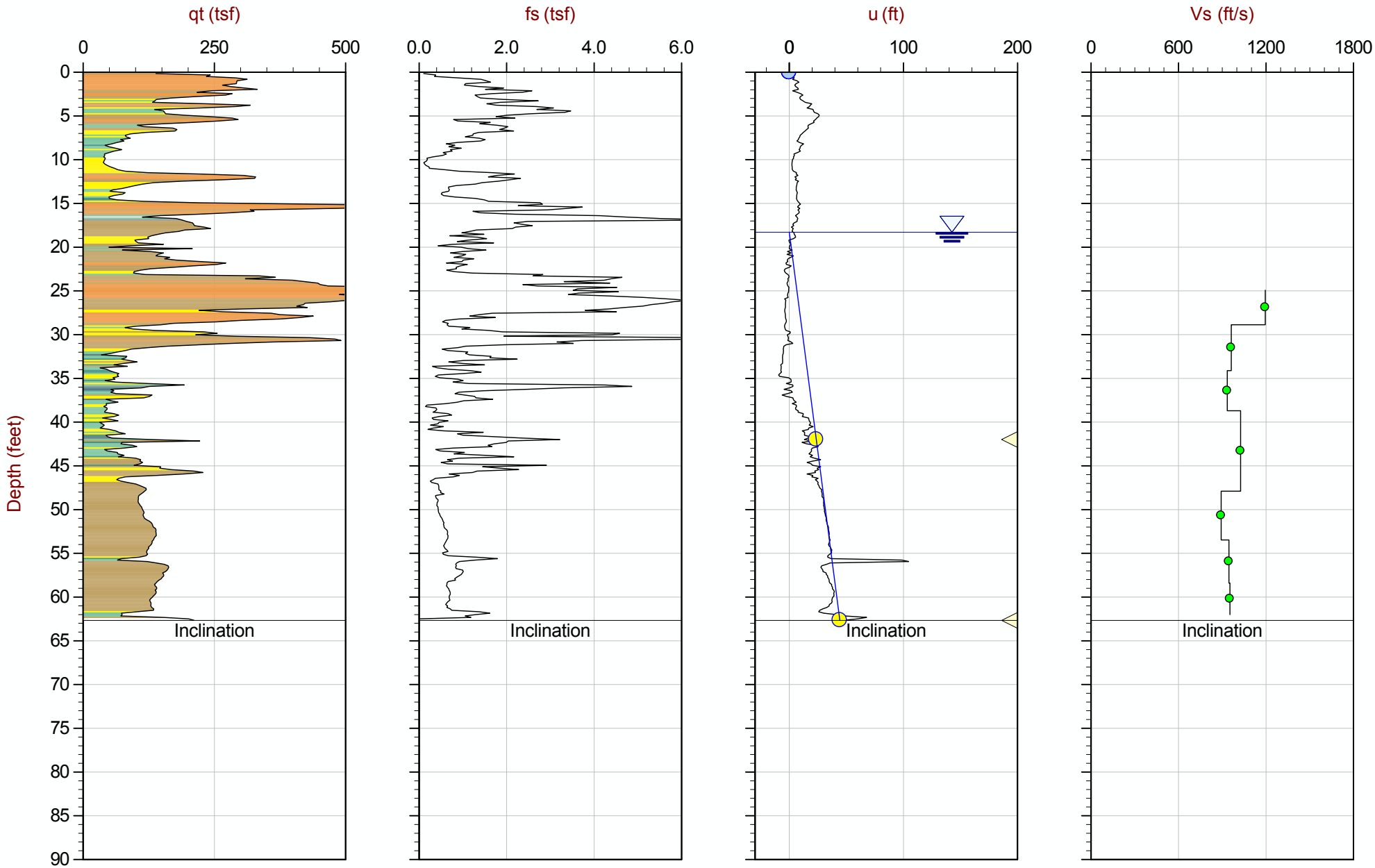
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:03:15 10:10
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C005A
Cone: 301:T1500F15U500



Max Depth: 19.100 m / 62.66 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP05A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574883m E: 305655m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

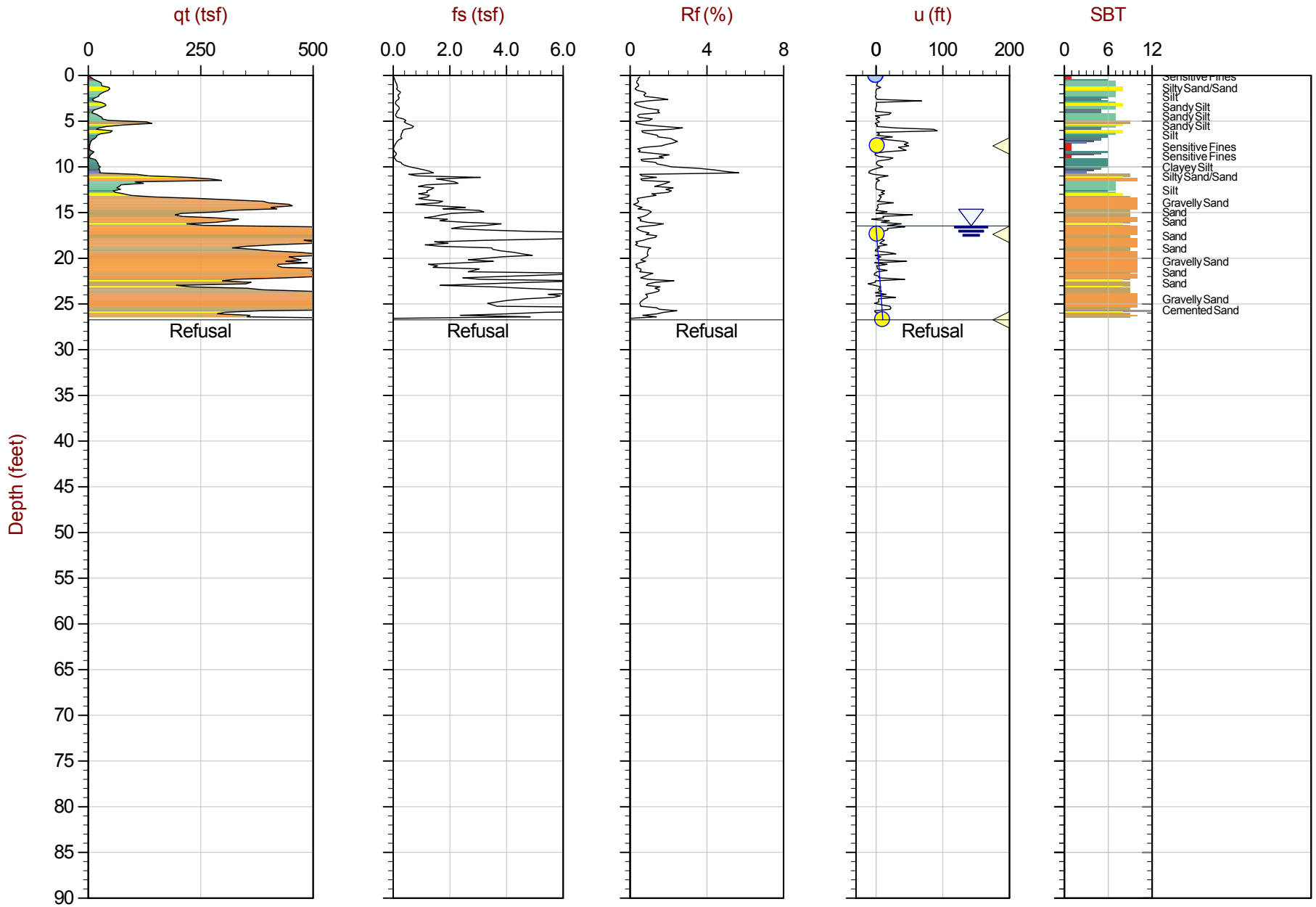
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:03:15 13:48
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C006
Cone: 374:T1500F15U500



Max Depth: 8.150 m / 26.74 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP06.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574762m E: 305708m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

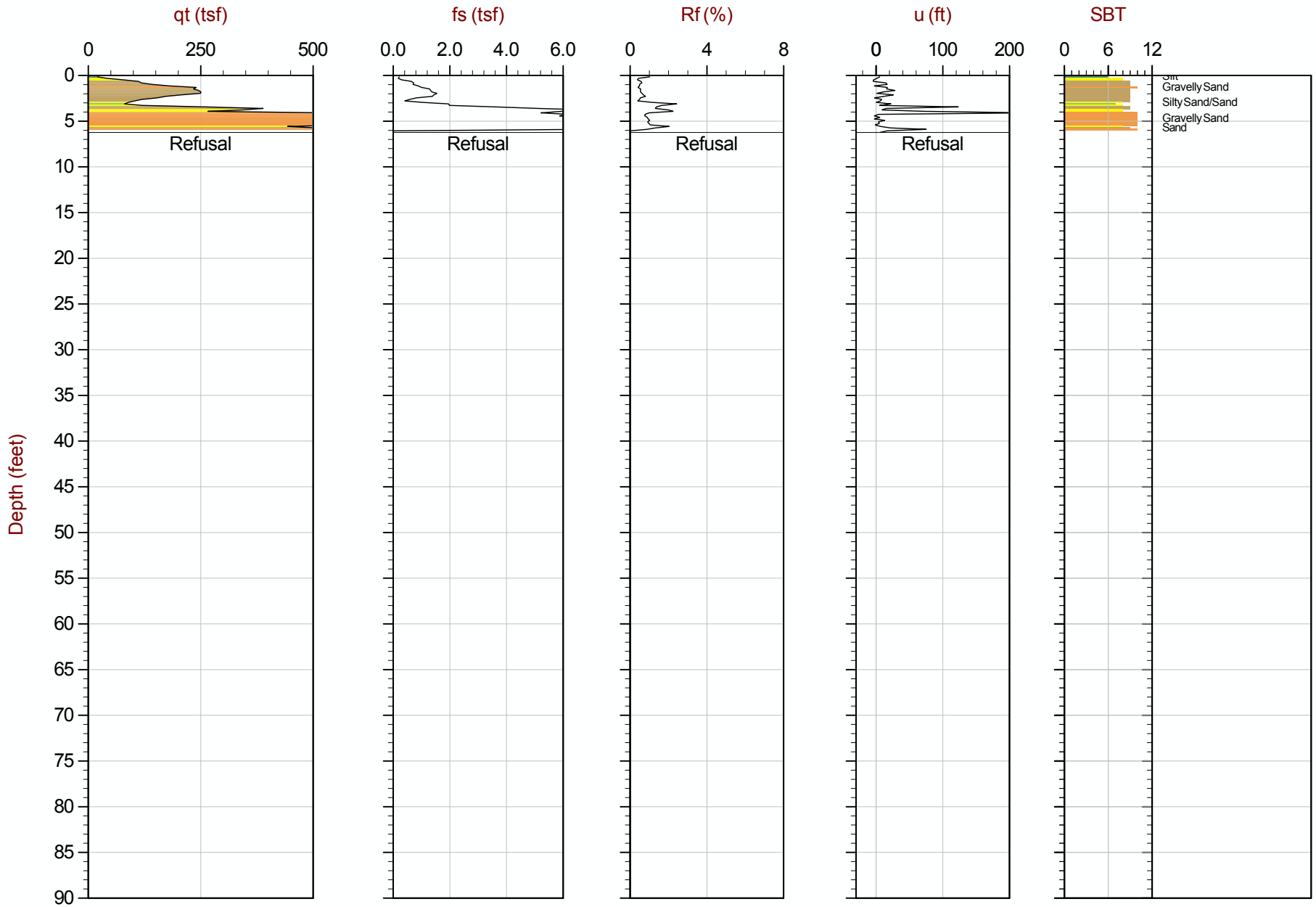
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:09:15 09:10
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C007
Cone: 374:T1500F15U500



Max Depth: 1.900 m / 6.23 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP07.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574759m E: 305719m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

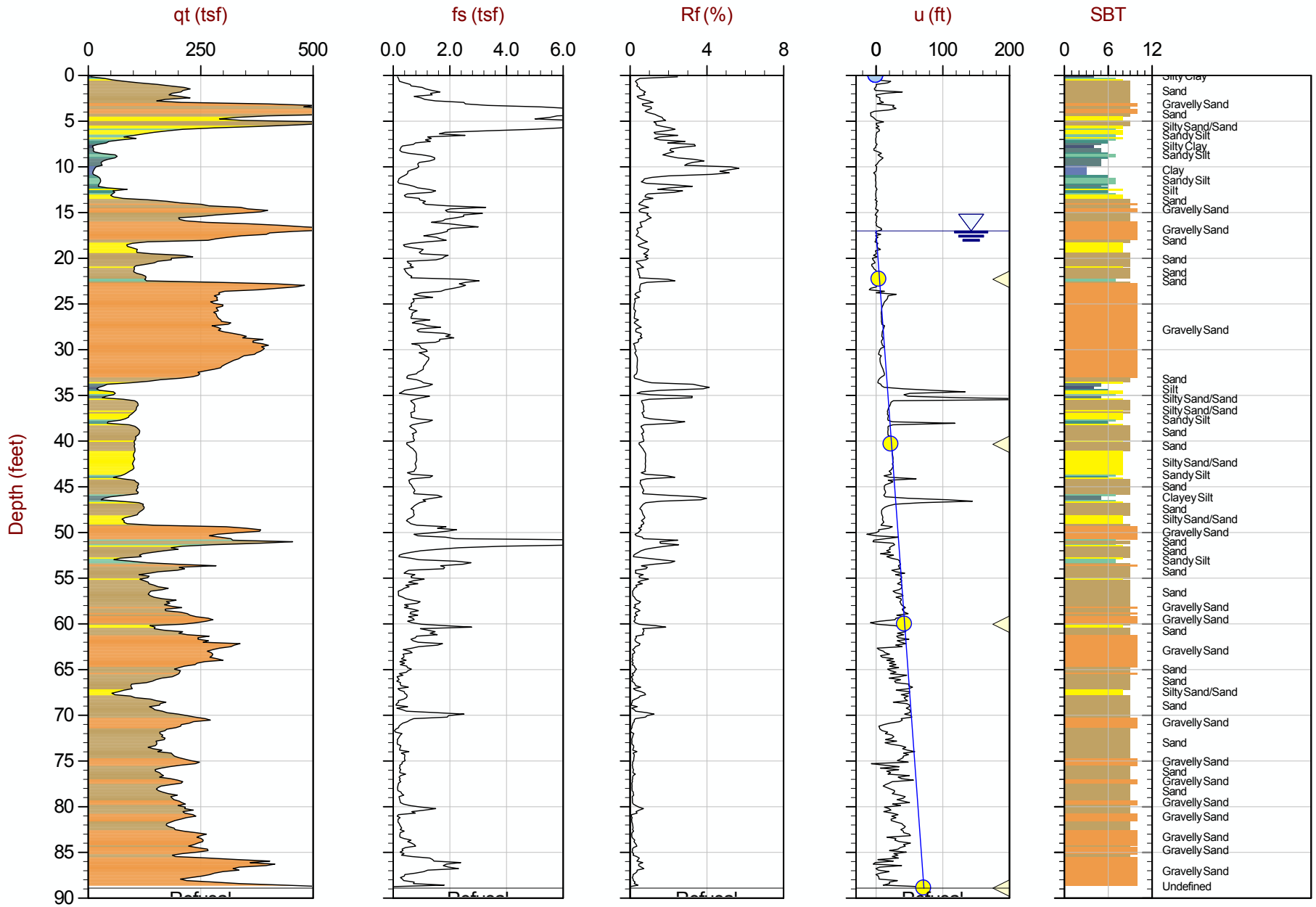
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:09:15 09:54
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C007B
Cone: 374:T1500F15U500



Max Depth: 27.100 m / 88.91 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP07B.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574758m E: 305719m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

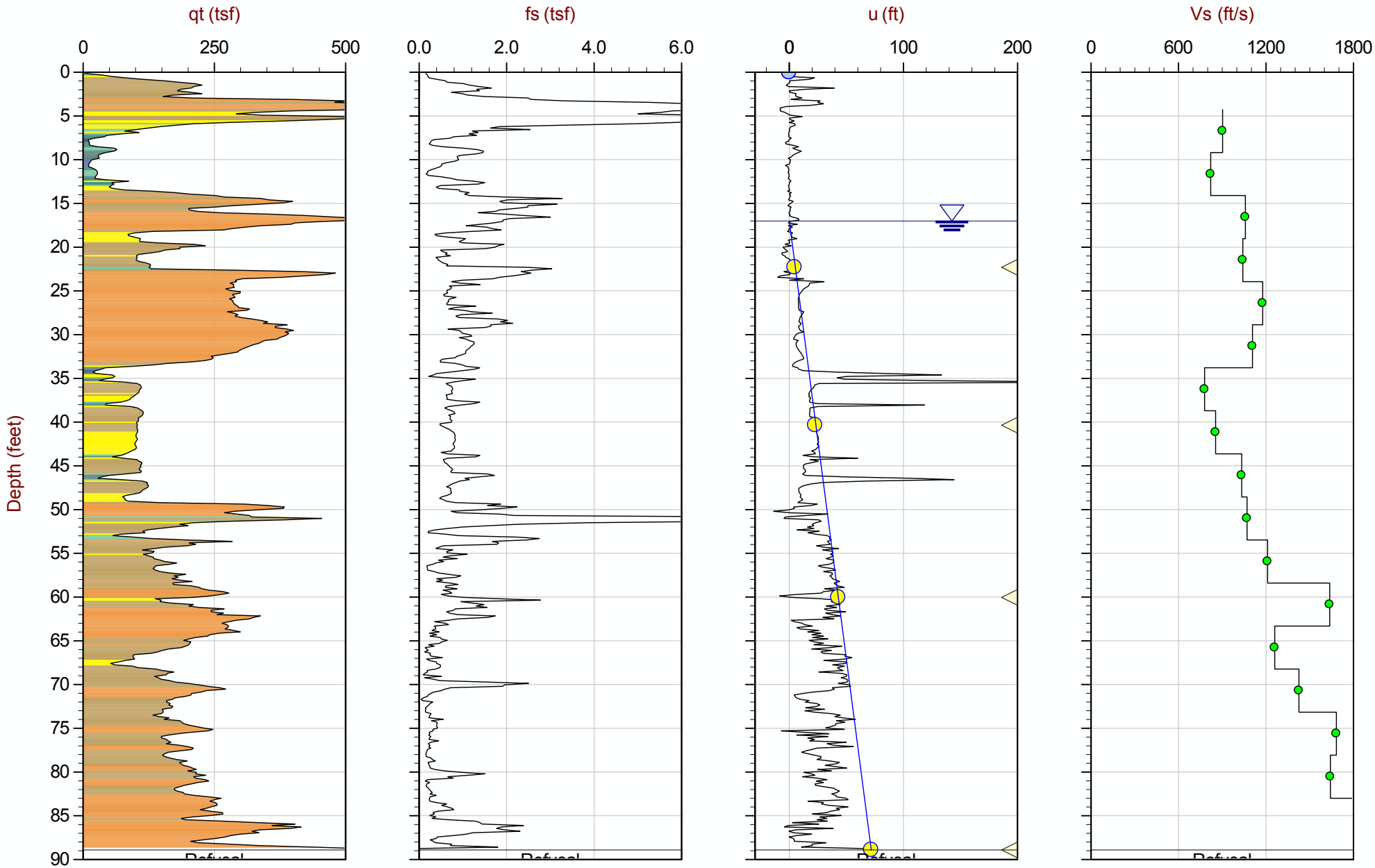
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:09:15 09:54
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C007B
Cone: 374:T1500F15U500



Max Depth: 27.100 m / 88.91 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP07B.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574758m E: 305719m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

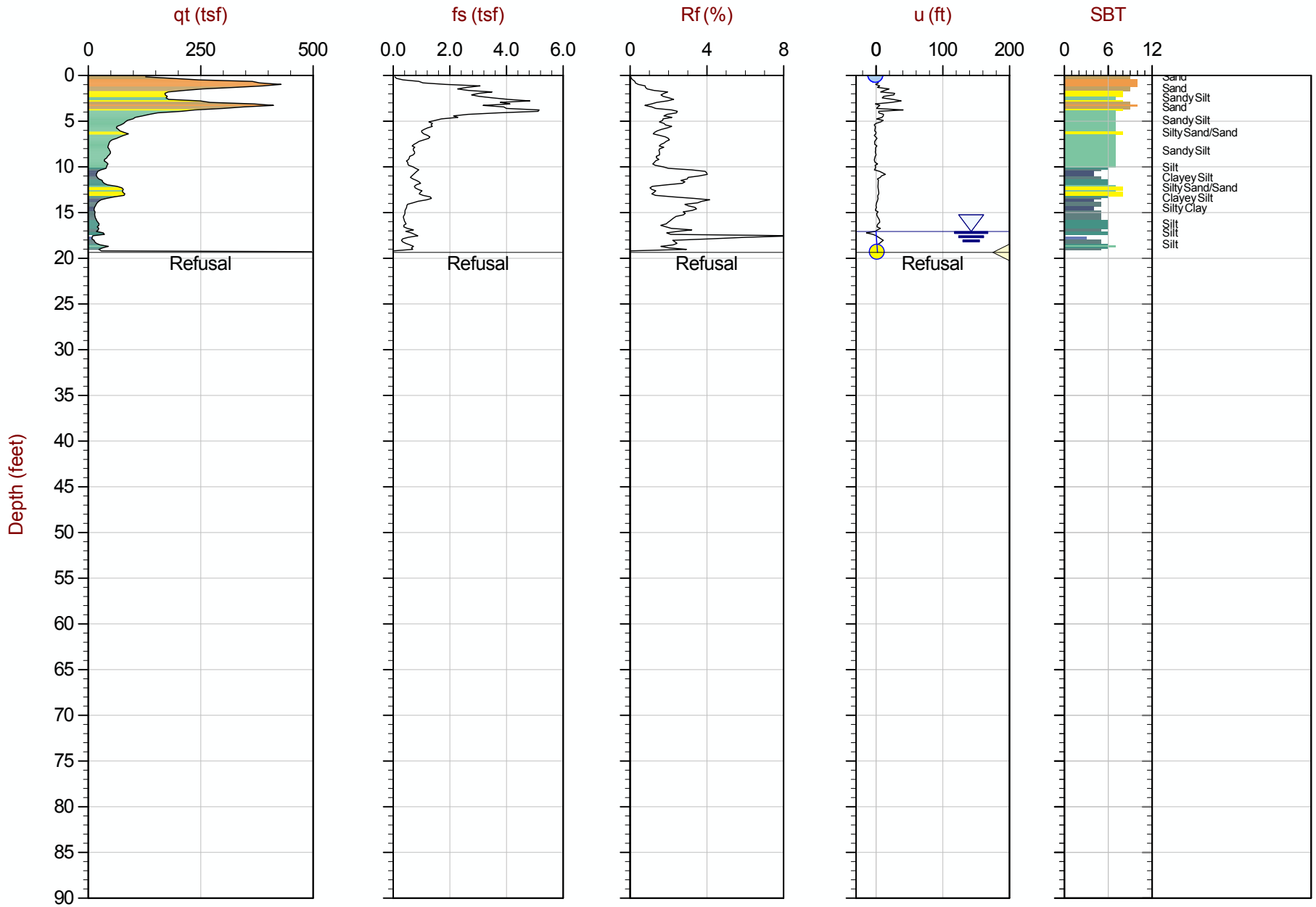
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:11:15 09:31
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C008
Cone: 374:T1500F15U500



Max Depth: 5.900 m / 19.36 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP08.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574579m E: 305555m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

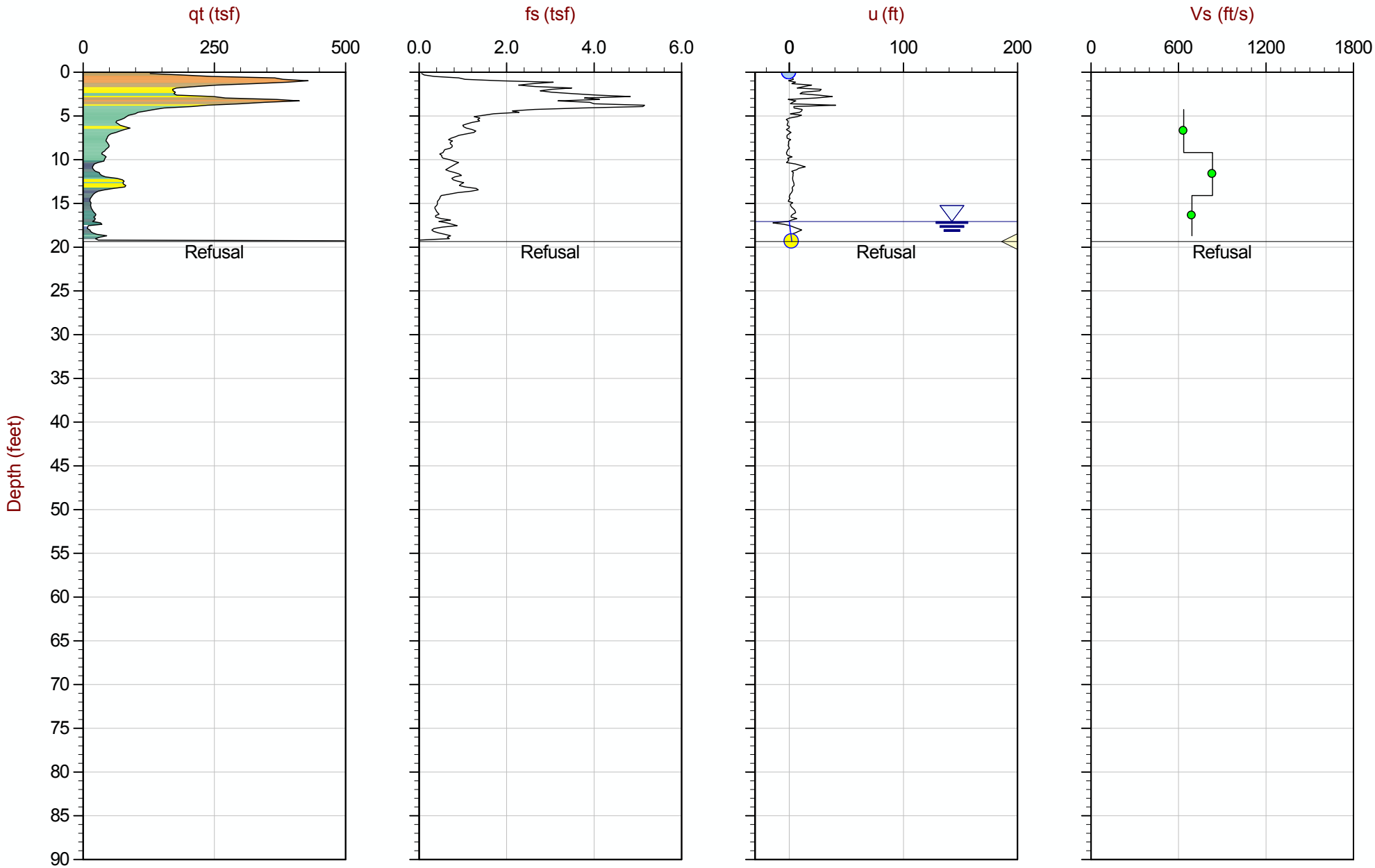
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:11:15 09:31
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C008
Cone: 374:T1500F15U500



Max Depth: 5.900 m / 19.36 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP08.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574579m E: 305555m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

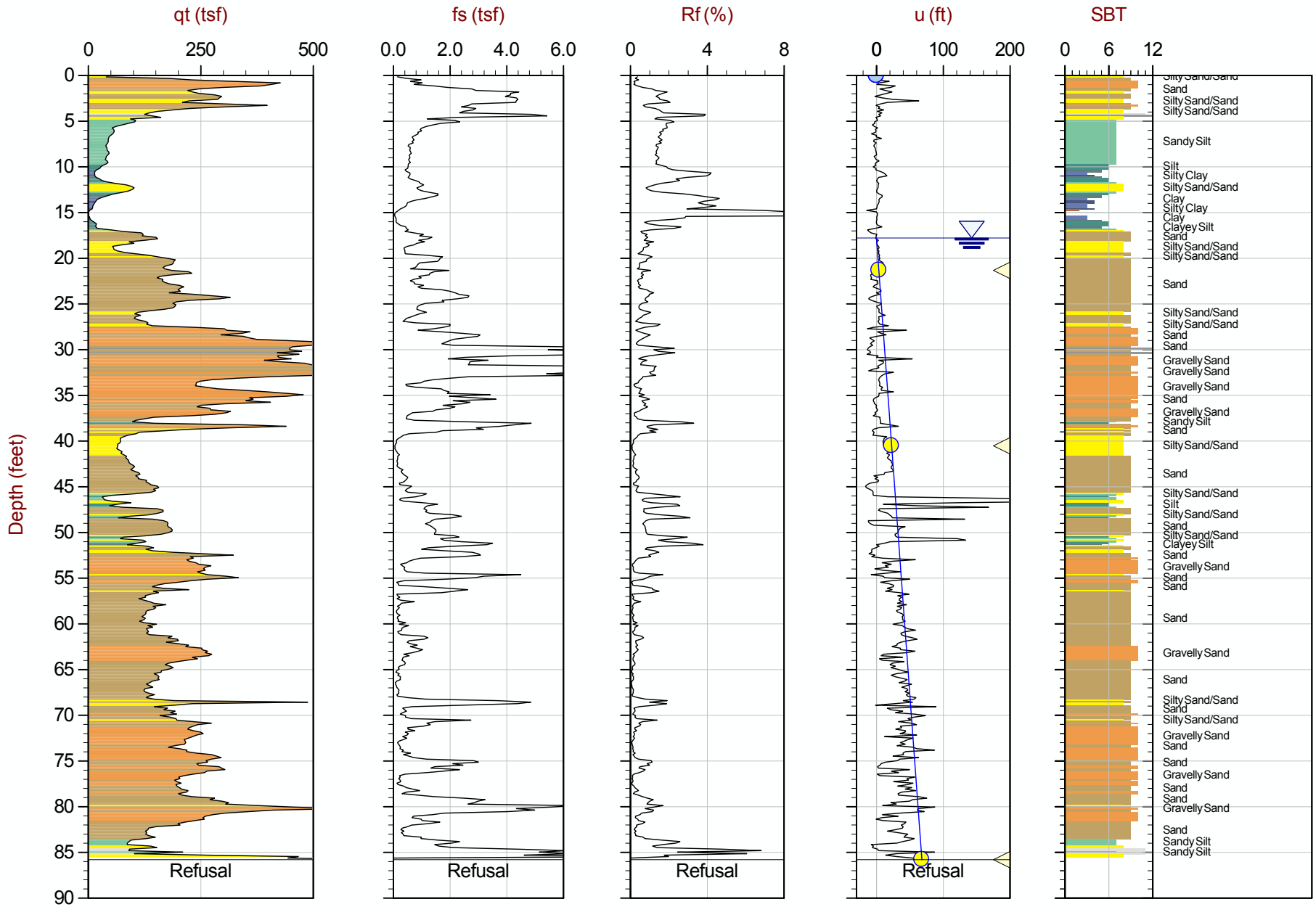
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:11:15 10:25
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C008B
Cone: 374:T1500F15U500



Max Depth: 26.150 m / 85.79 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP08B.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574578m E: 305559m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

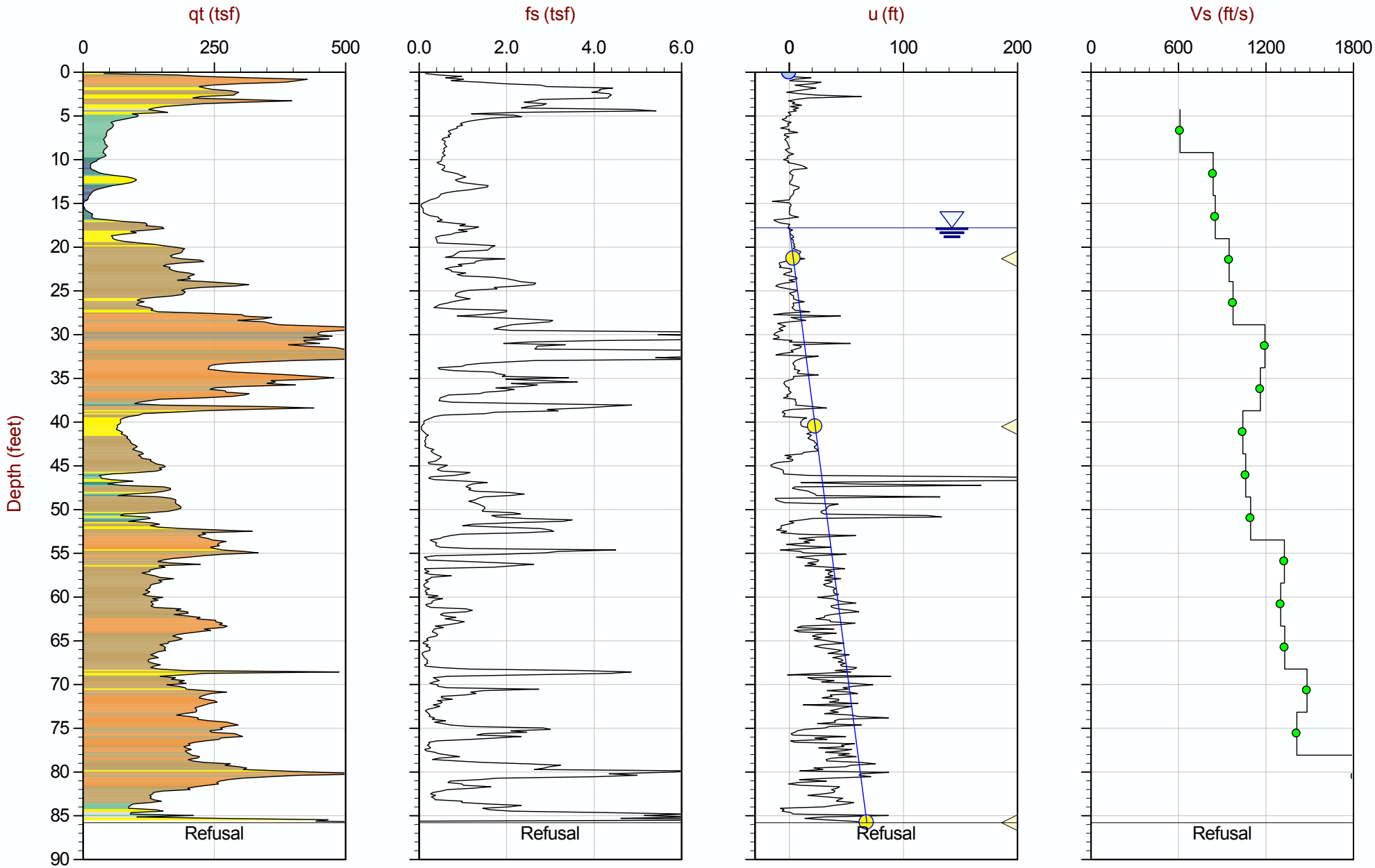
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:11:15 10:25
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C008B
Cone: 374:T1500F15U500



Max Depth: 26.150 m / 85.79 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP08B.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574578m E: 305559m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

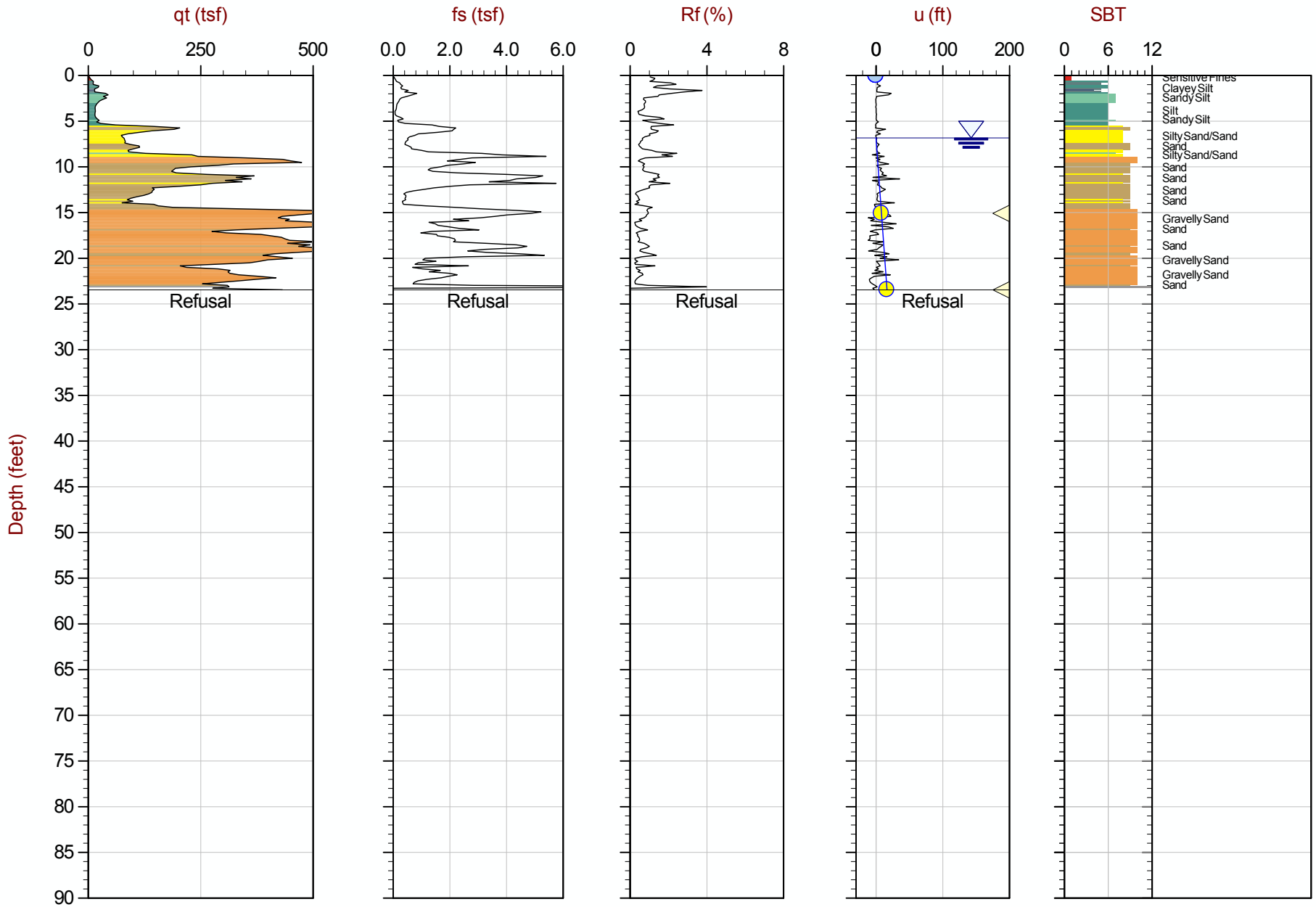
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:10:15 14:28
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C009
Cone: 374:T1500F15U500



Max Depth: 7.150 m / 23.46 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP09.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574570m E: 305552m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

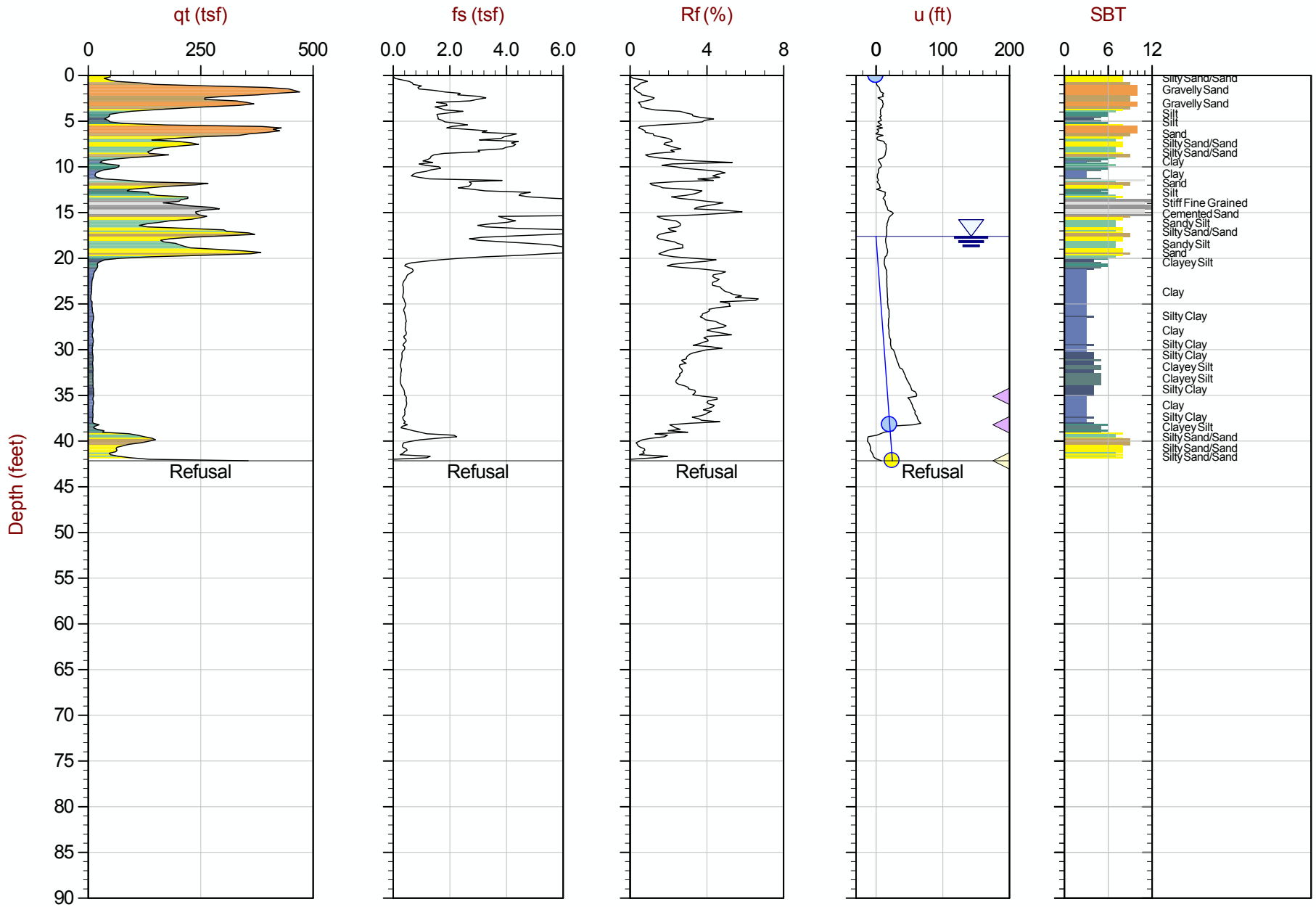
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:11:15 09:08
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C010
Cone: 301:T1500F15U500



Max Depth: 12.850 m / 42.16 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP10.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574593m E: 305262m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

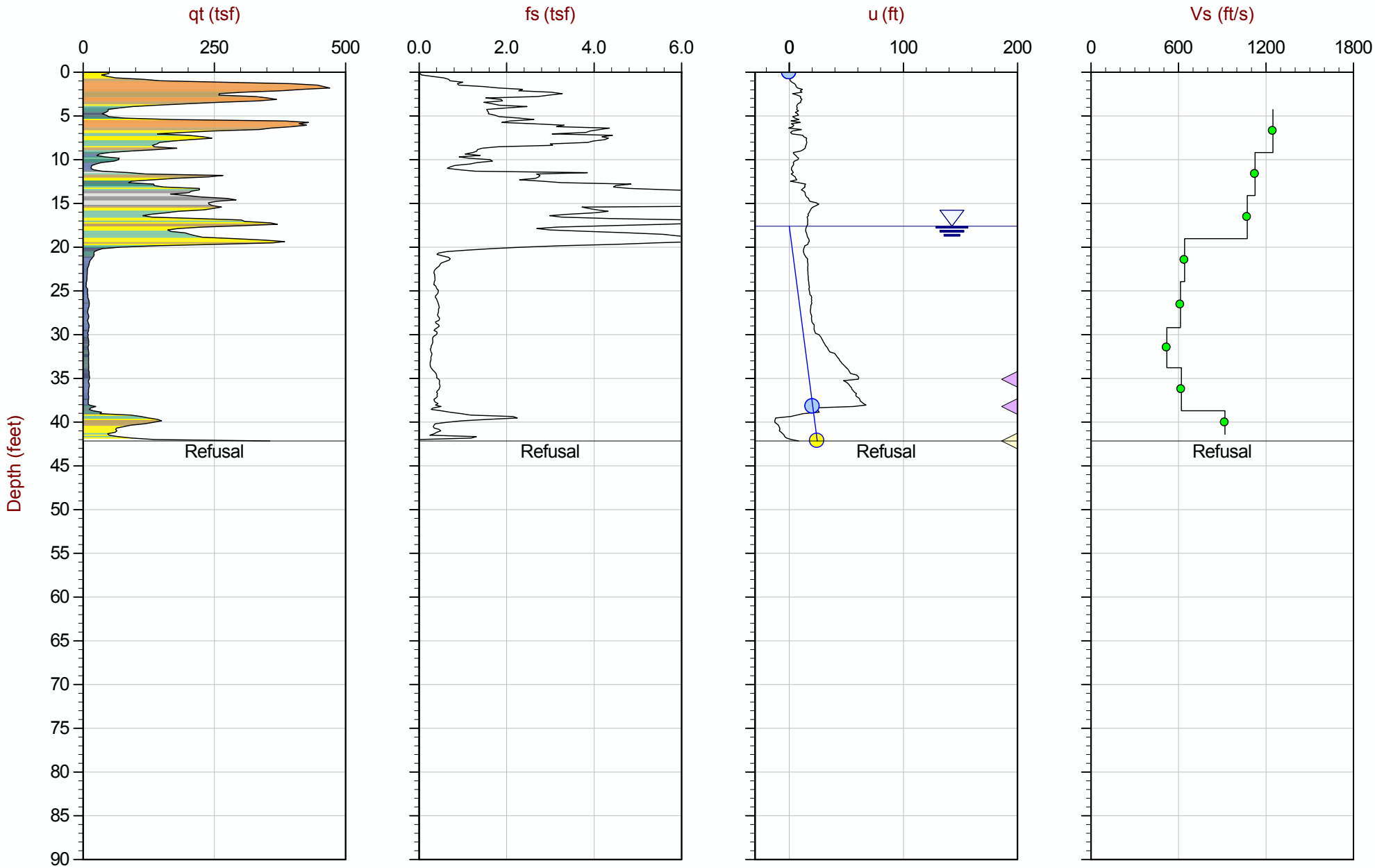
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:11:15 09:08
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C010
Cone: 301:T1500F15U500



Max Depth: 12.850 m / 42.16 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP10.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574593m E: 305262m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

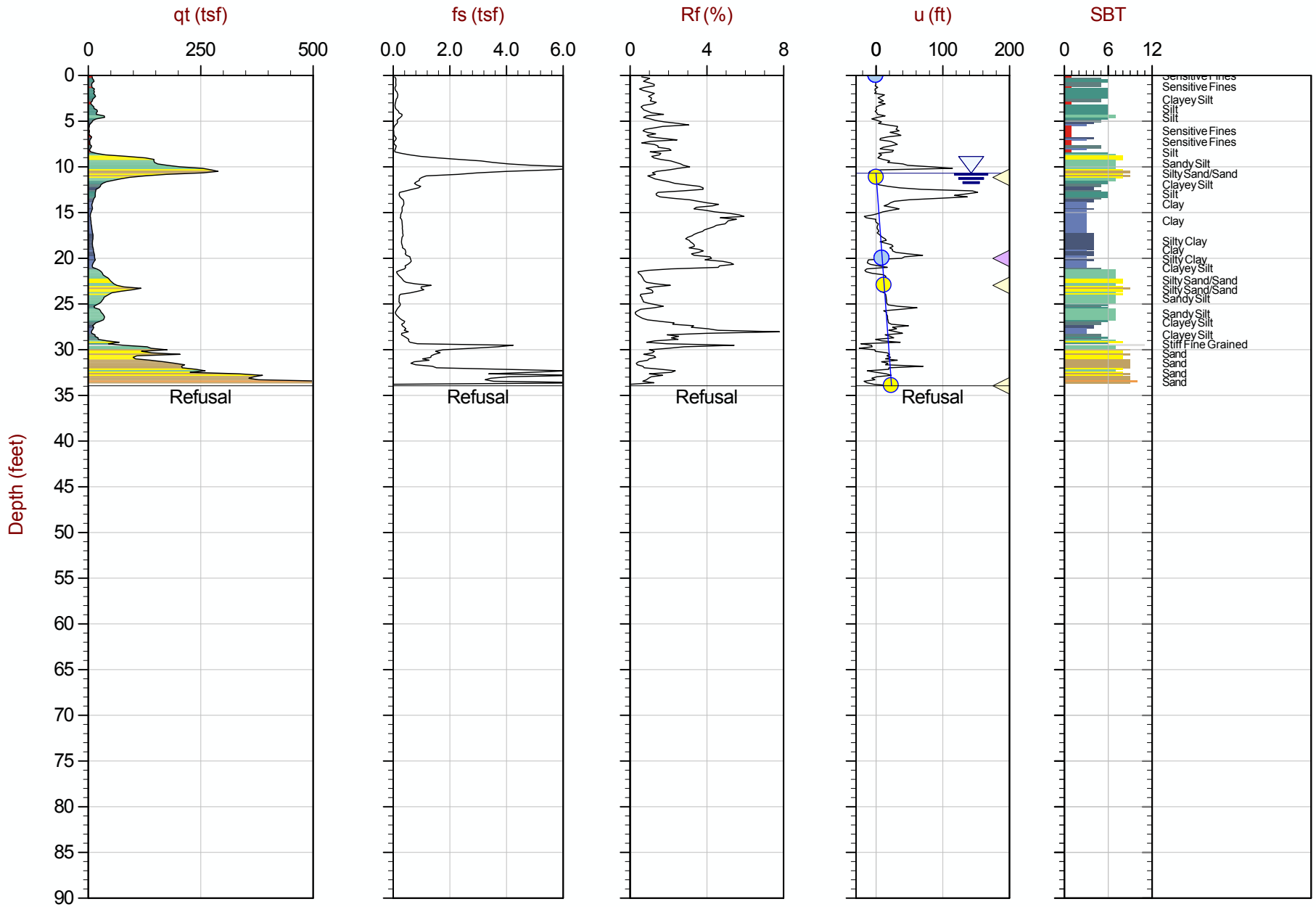
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:10:15 09:34
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C012
Cone: 374:T1500F15U500



Max Depth: 10.350 m / 33.96 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP12.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574689m E: 305353m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

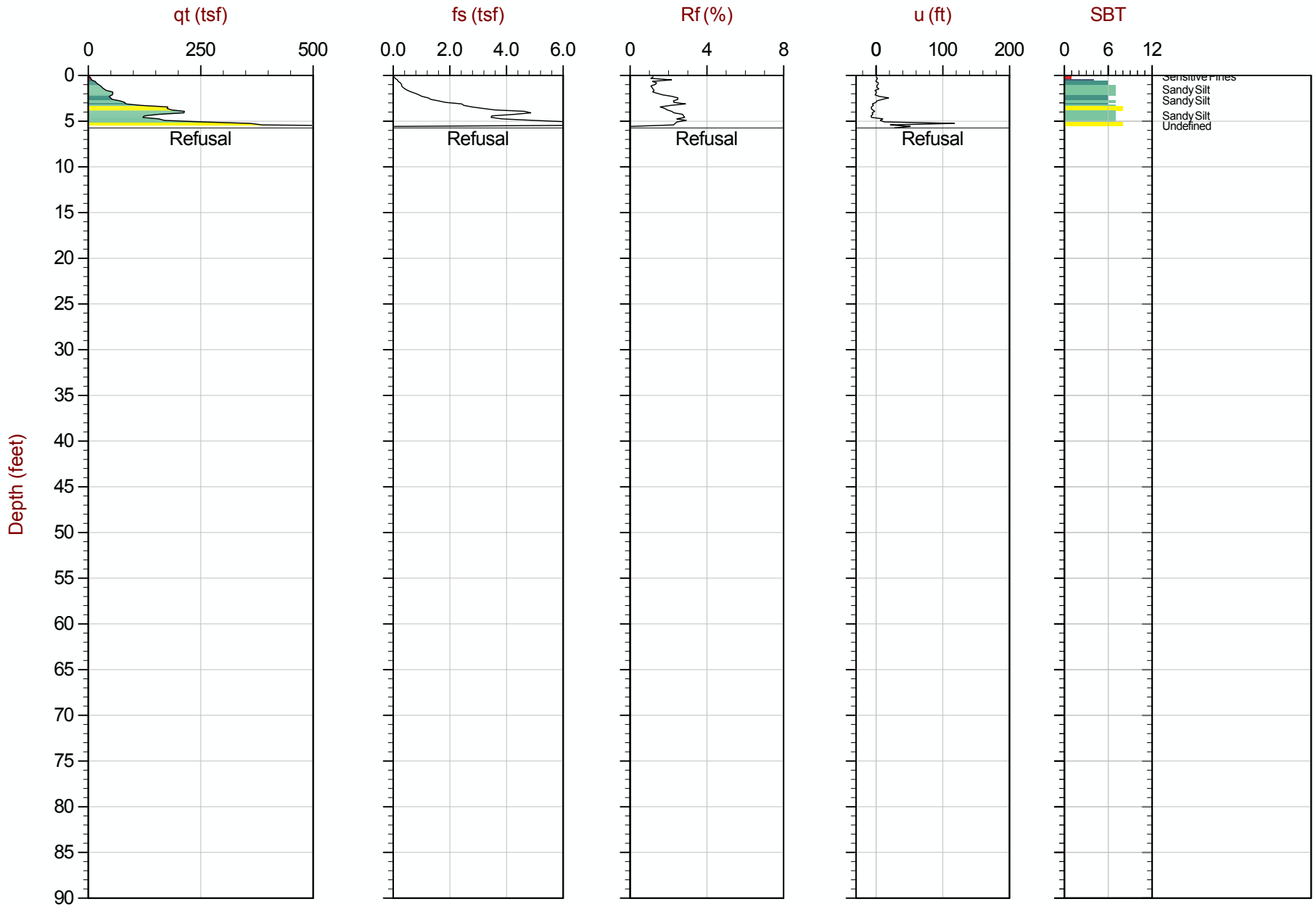
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:09:15 14:37
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C013
Cone: 374:T1500F15U500



Max Depth: 1.750 m / 5.74 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP13.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574687m E: 305500m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

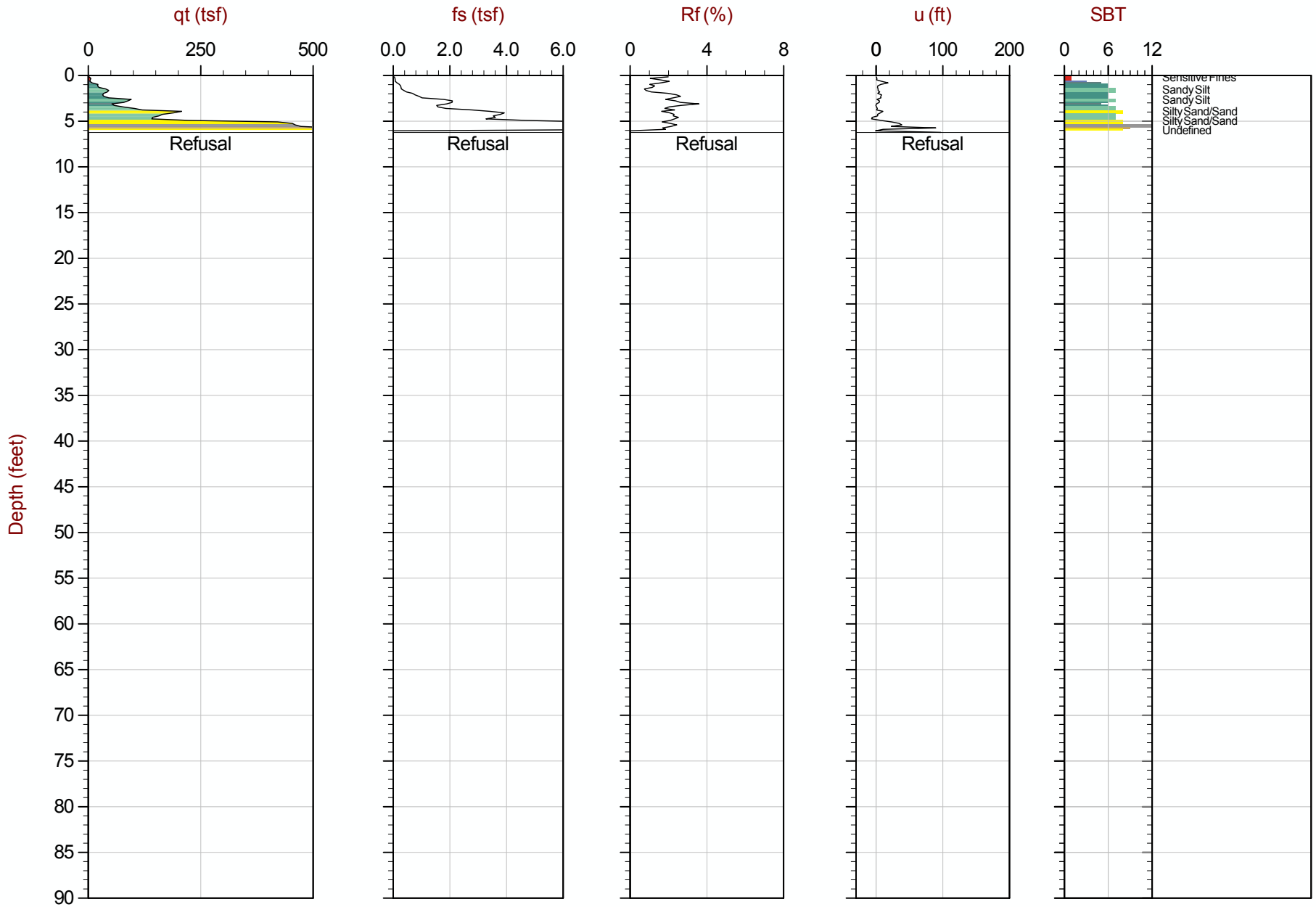
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:09:15 15:40
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C013B
Cone: 374:T1500F15U500



Max Depth: 1.900 m / 6.23 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP13B.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574690m E: 305498m

100

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

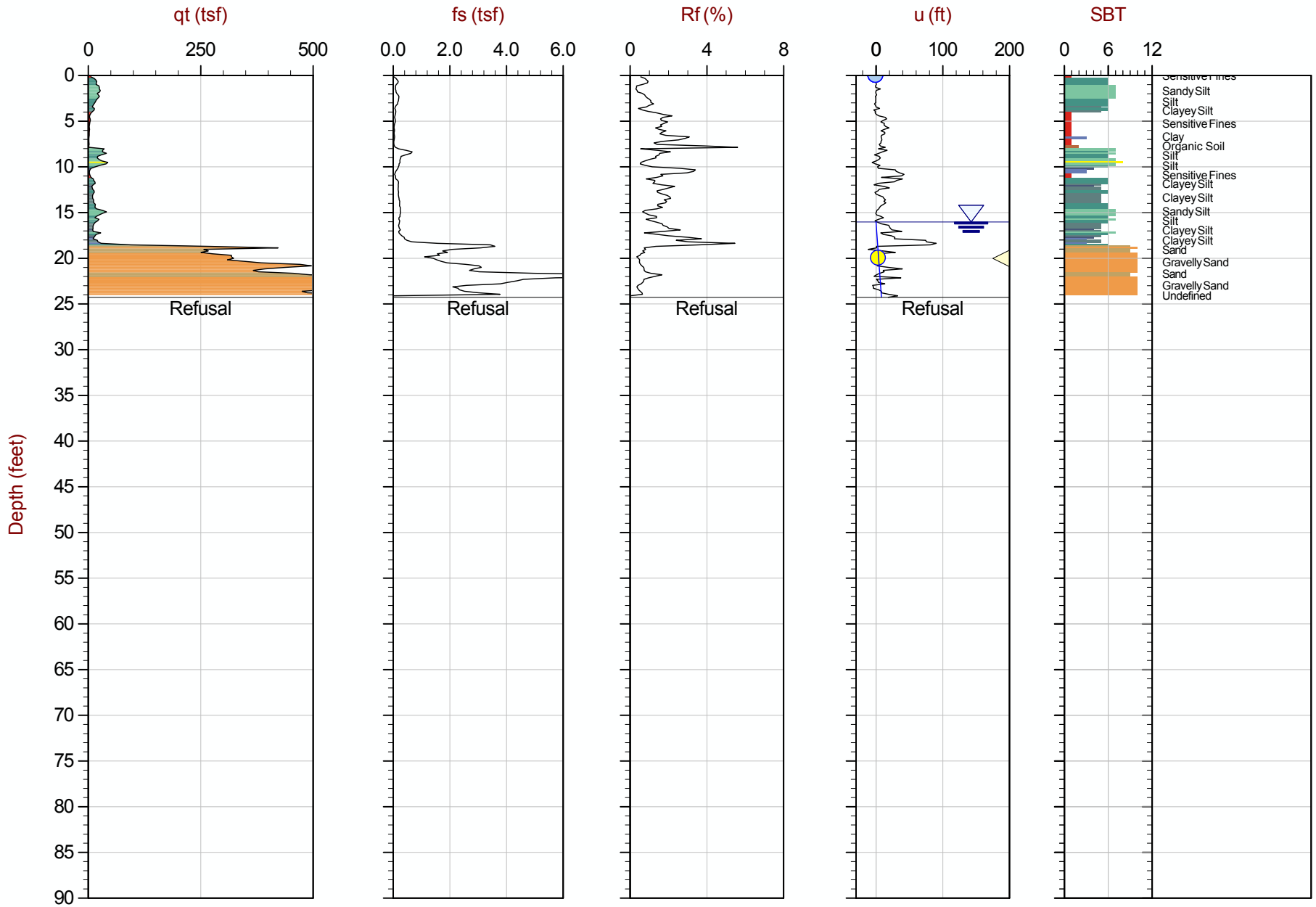
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:09:15 13:22
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C014
Cone: 374:T1500F15U500



Max Depth: 7.400 m / 24.28 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP14.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574716m E: 305618m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

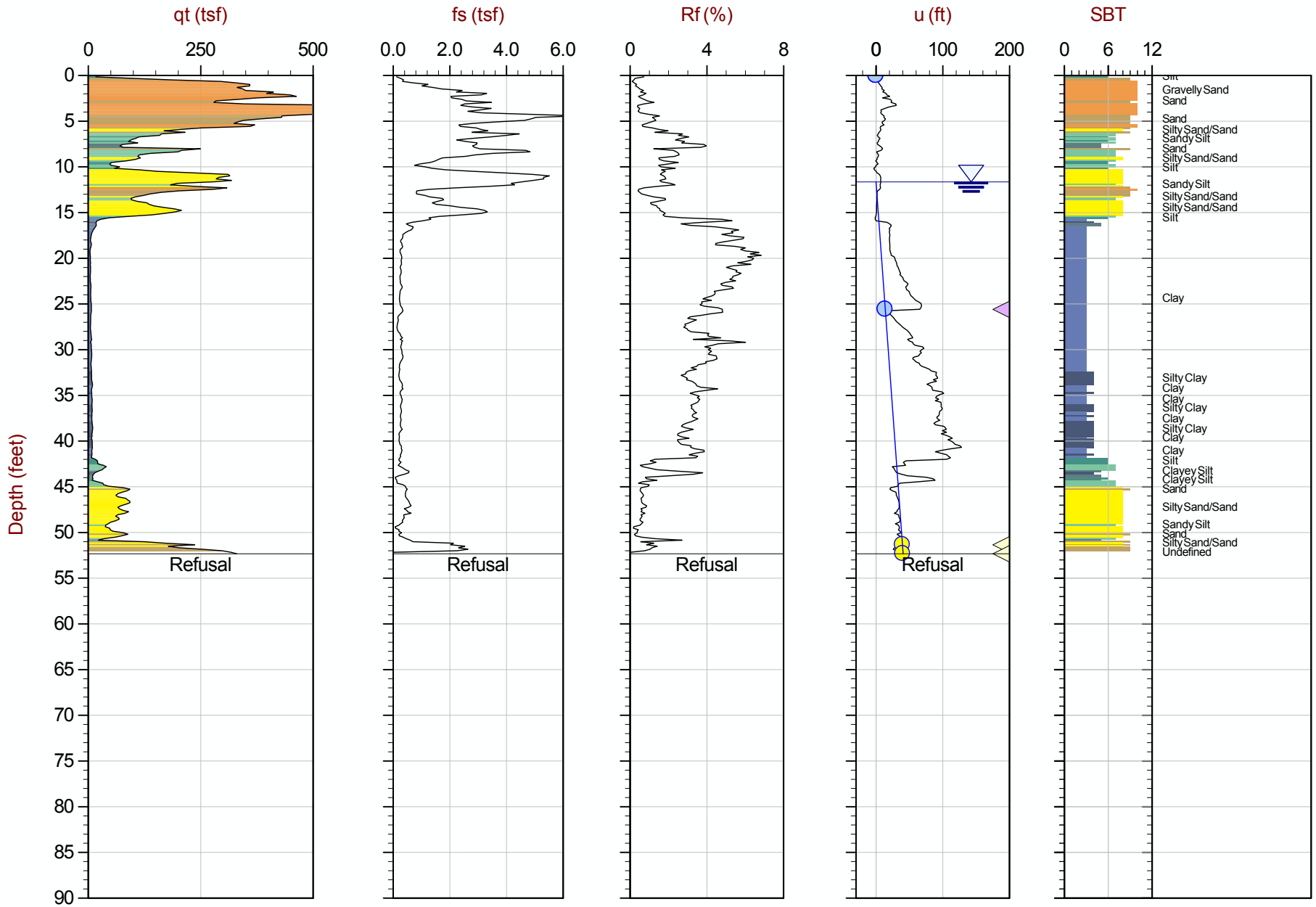
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:10:15 14:10
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C015
Cone: 301:T1500F15U500



Max Depth: 15.950 m / 52.33 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP15.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574590m E: 305103m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

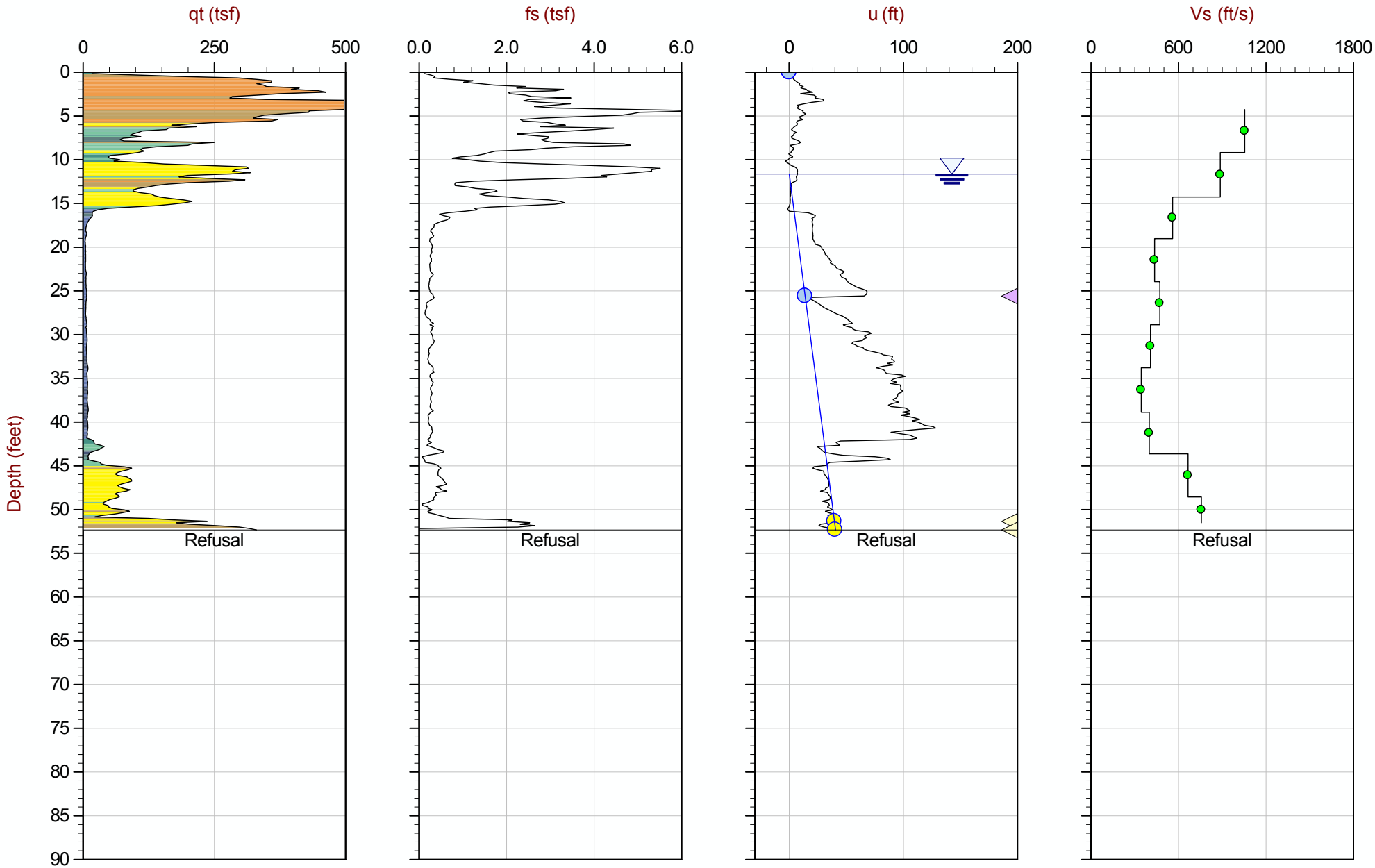
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:10:15 14:10
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C015
Cone: 301:T1500F15U500



Max Depth: 15.950 m / 52.33 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP15.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574590m E: 305103m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

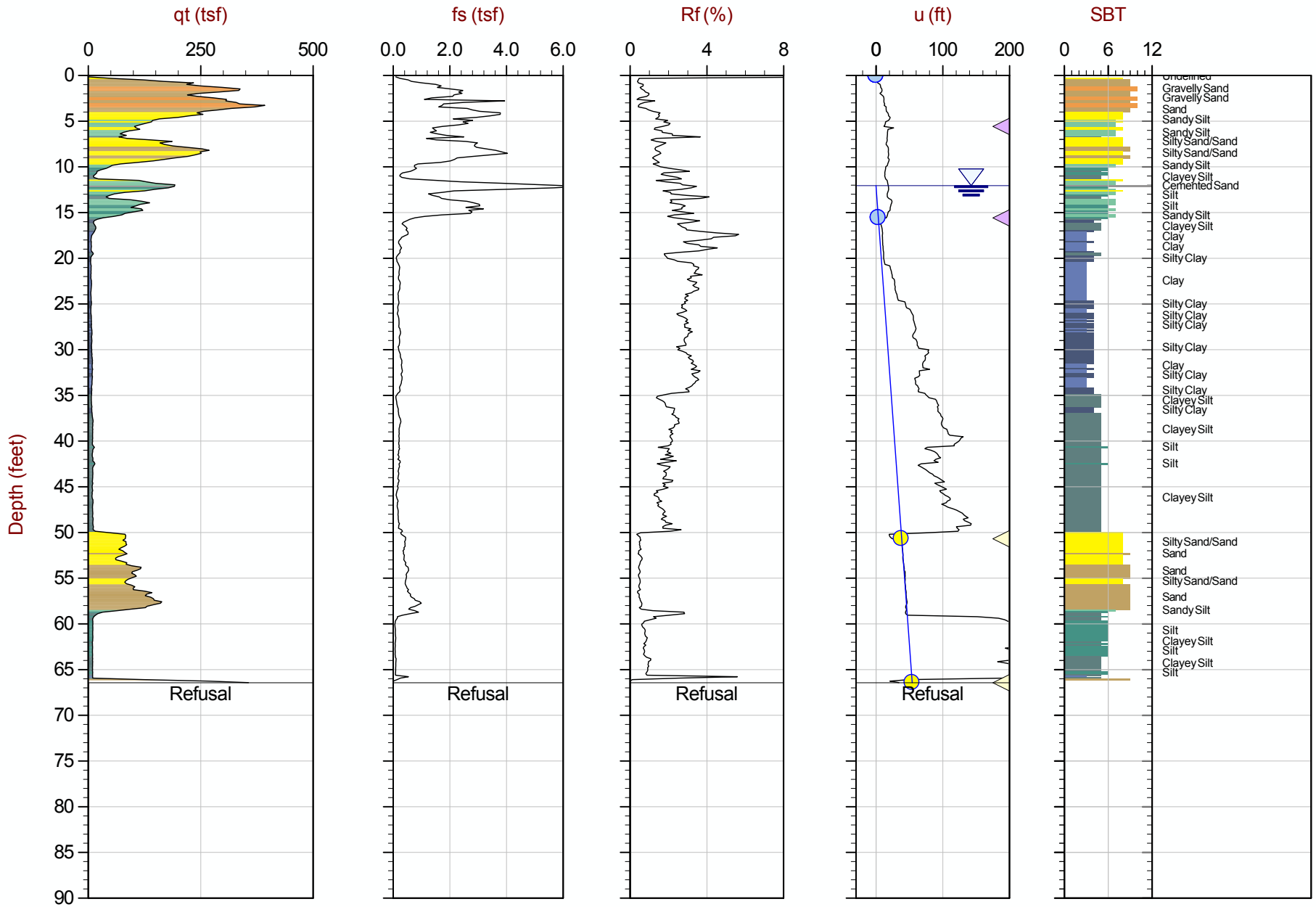
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:09:15 13:54
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C017
Cone: 301:T1500F15U500



Max Depth: 20.250 m / 66.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP17.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574661m E: 305021m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

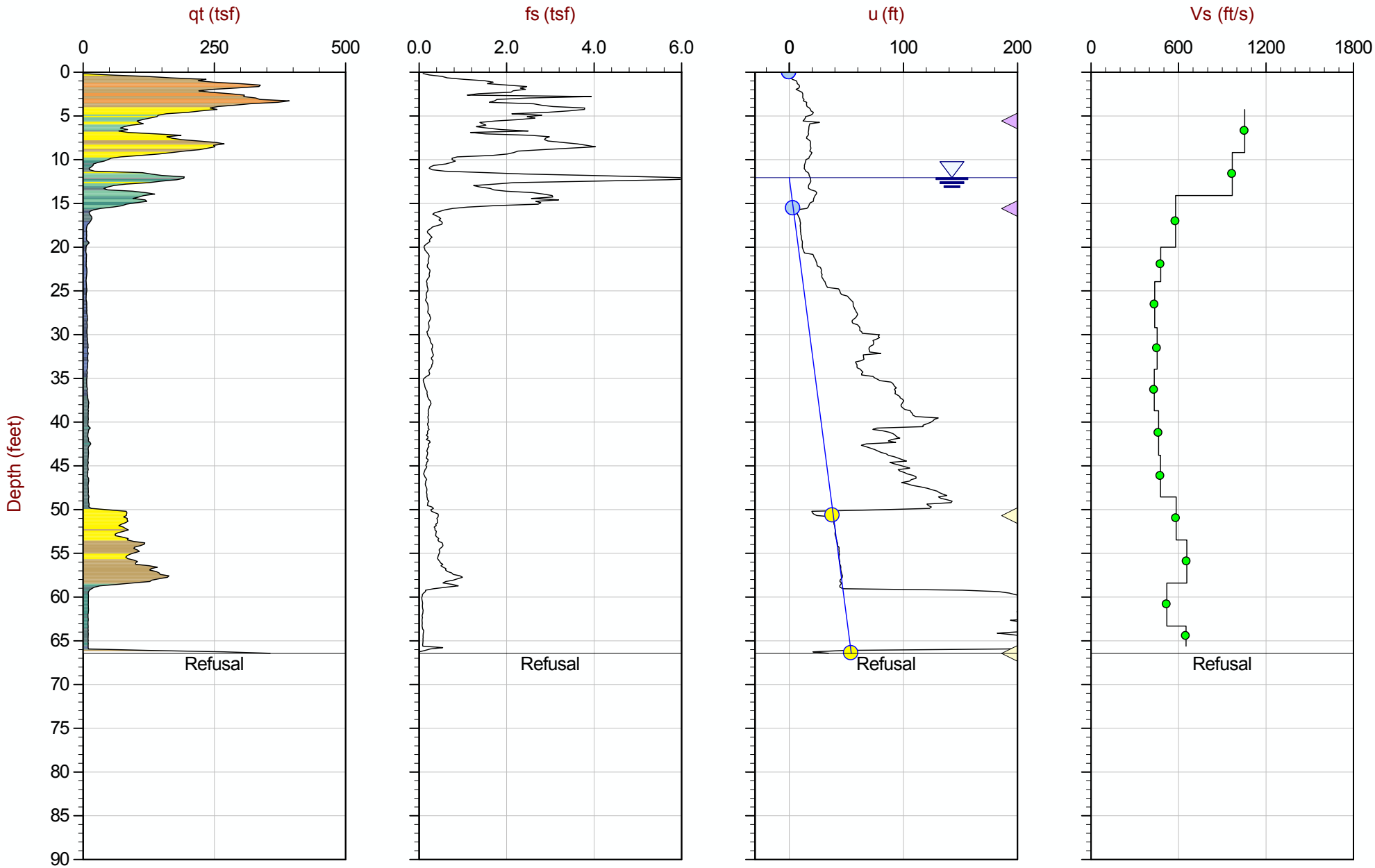
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:09:15 13:54
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C017
Cone: 301:T1500F15U500



Max Depth: 20.250 m / 66.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP17.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574661m E: 305021m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

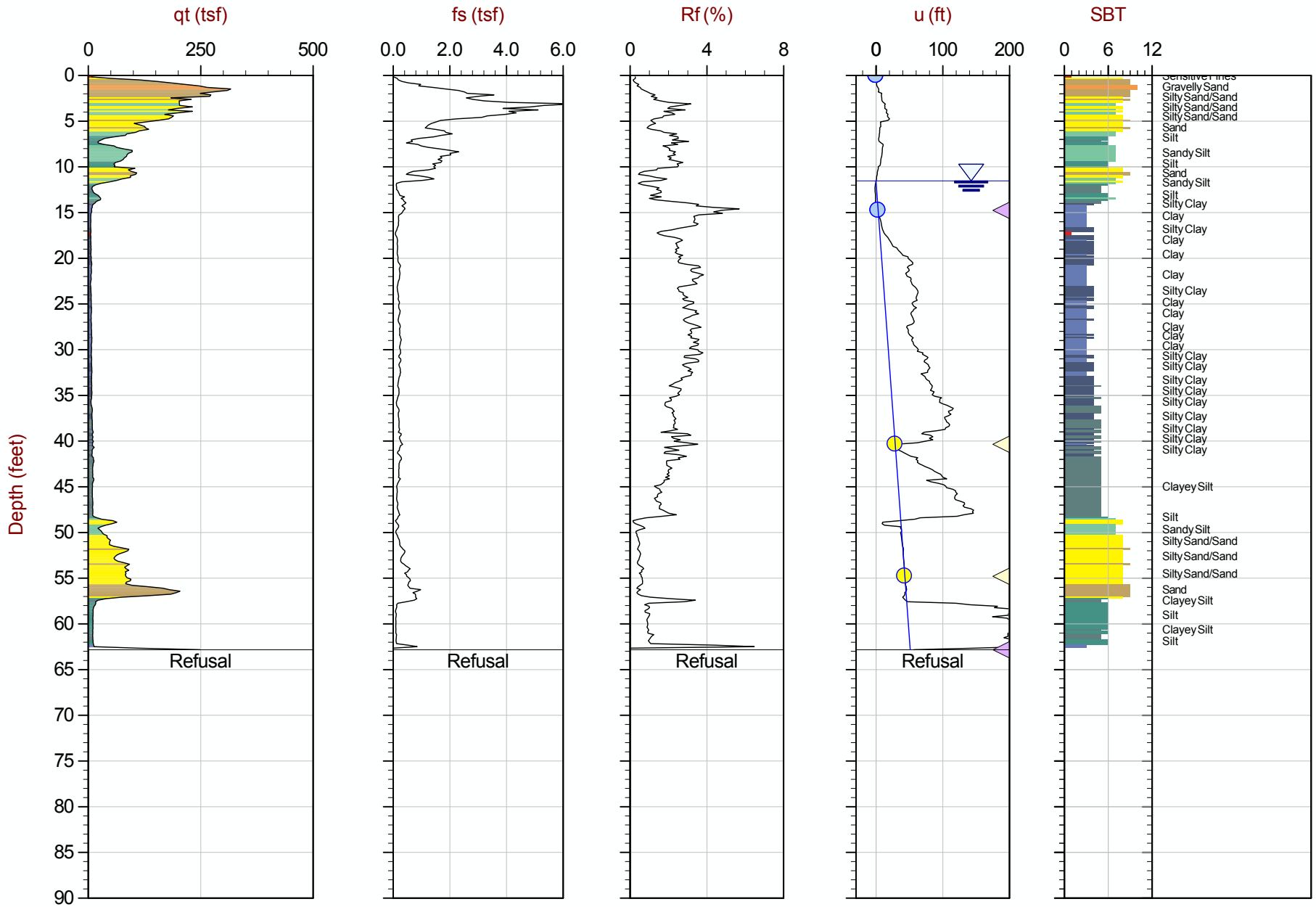
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:09:15 09:45
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C019
Cone: 301:T1500F15U500



Max Depth: 19.150 m / 62.83 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP19.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574729m E: 305083m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

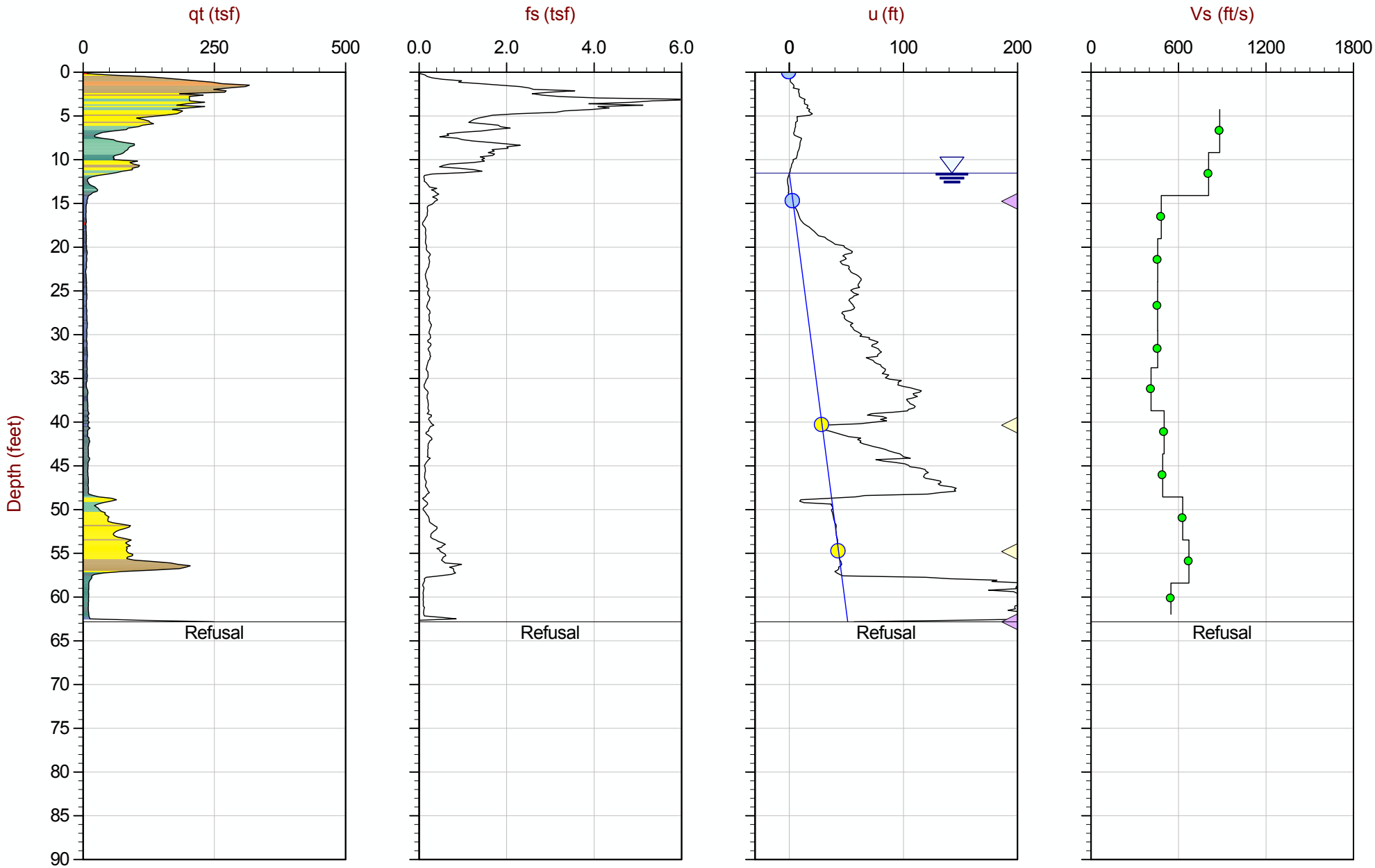
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:09:15 09:45
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C019
Cone: 301:T1500F15U500



Max Depth: 19.150 m / 62.83 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP19.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574729m E: 305083m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

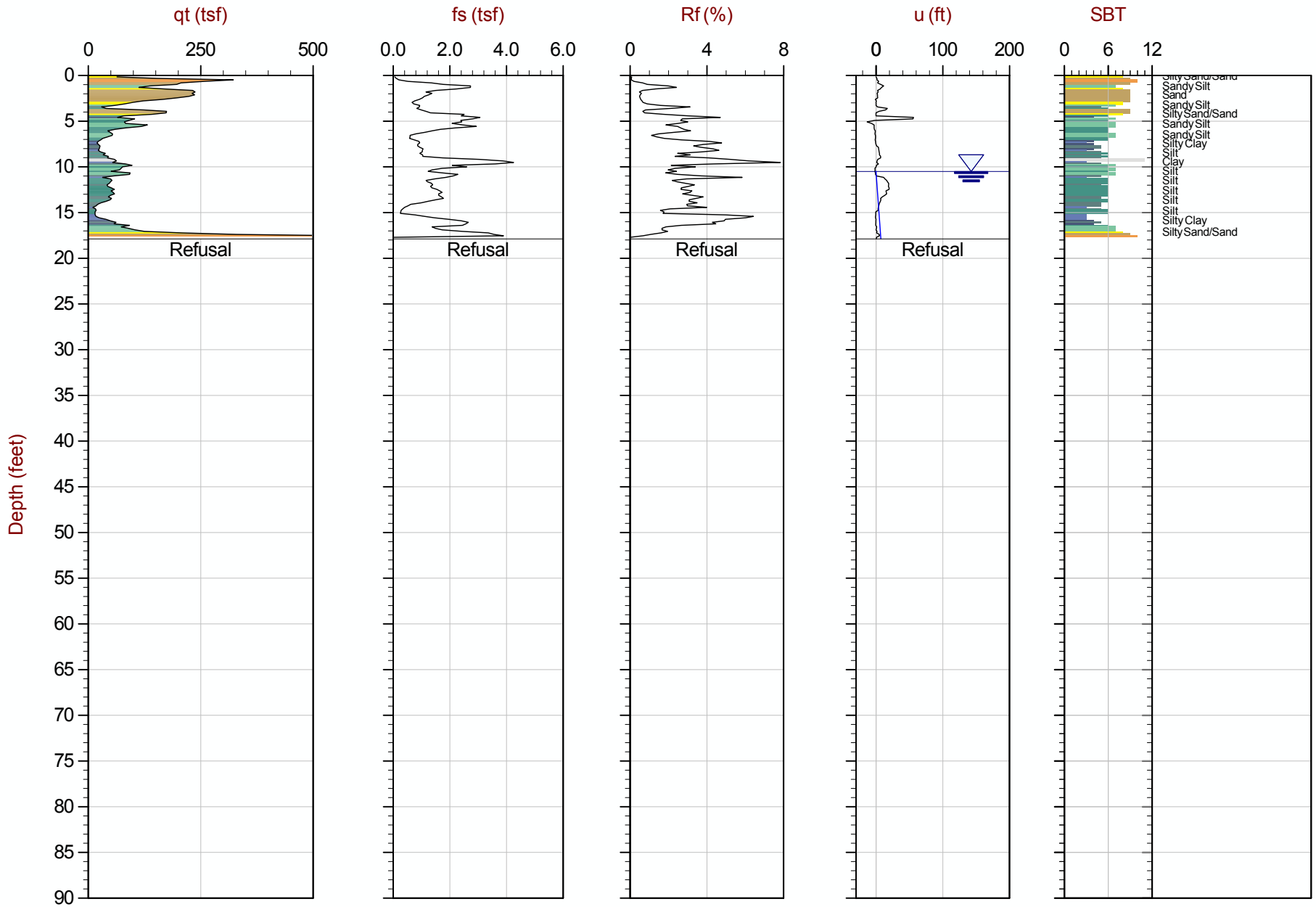
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:01:15 15:21
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C020
Cone: 340:T1500F15U500



Max Depth: 5.450 m / 17.88 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP20.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574944m E: 306822m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

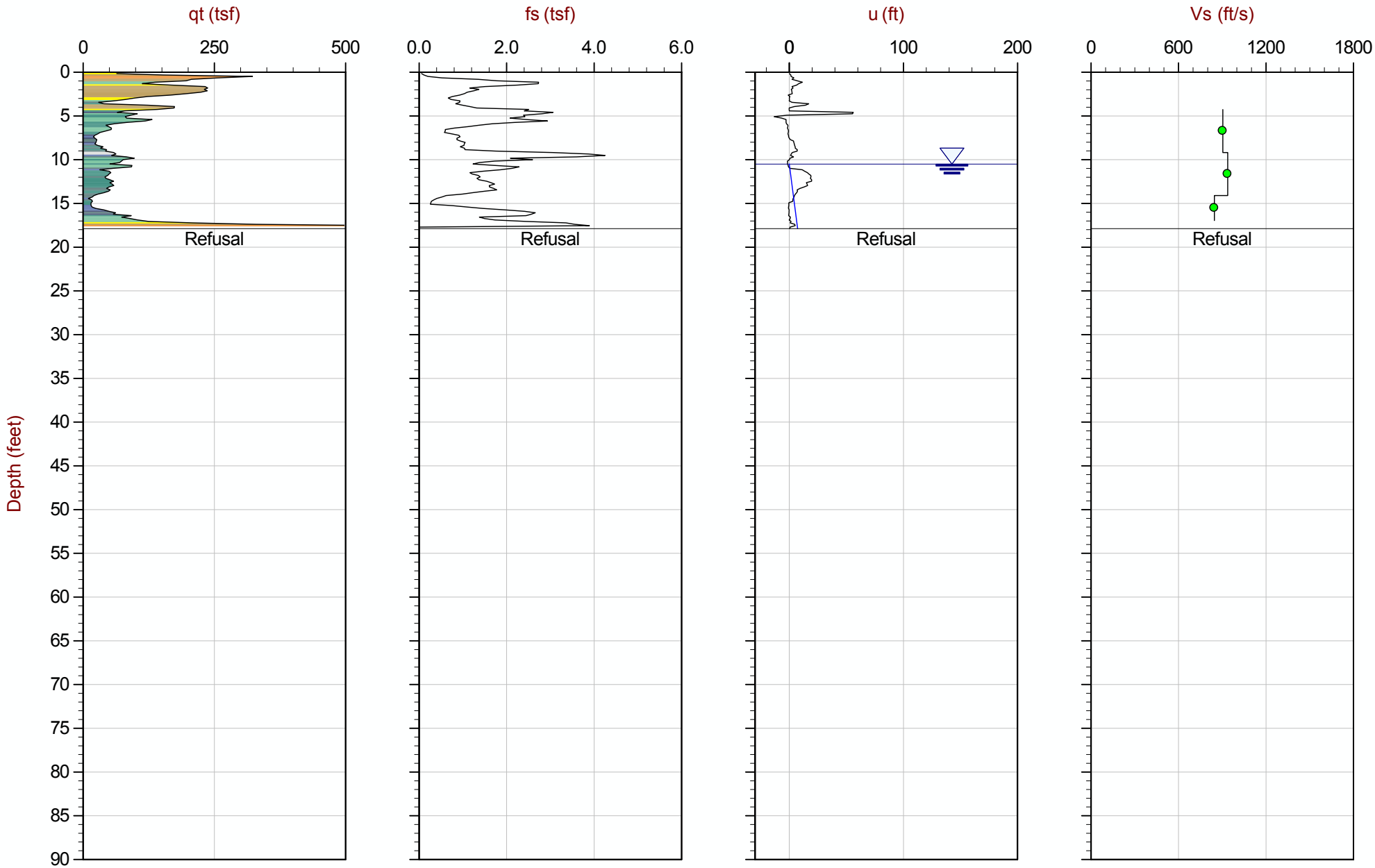
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:01:15 15:21
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C020
Cone: 340:T1500F15U500



Max Depth: 5.450 m / 17.88 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP20.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574944m E: 306822m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

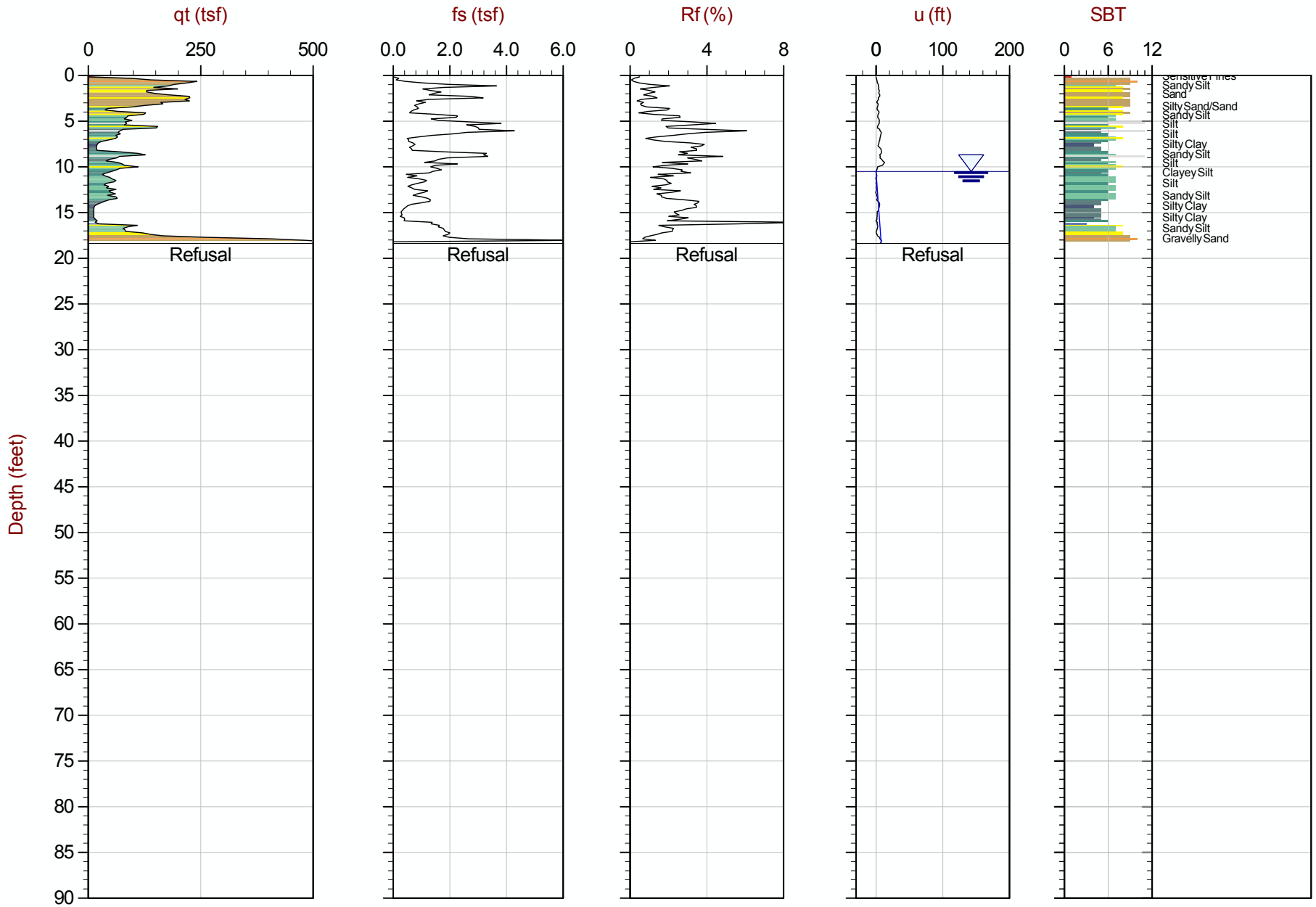
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:01:15 16:04
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C020A
Cone: 340:T1500F15U500



Max Depth: 5.600 m / 18.37 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP20A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574942m E: 306820m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

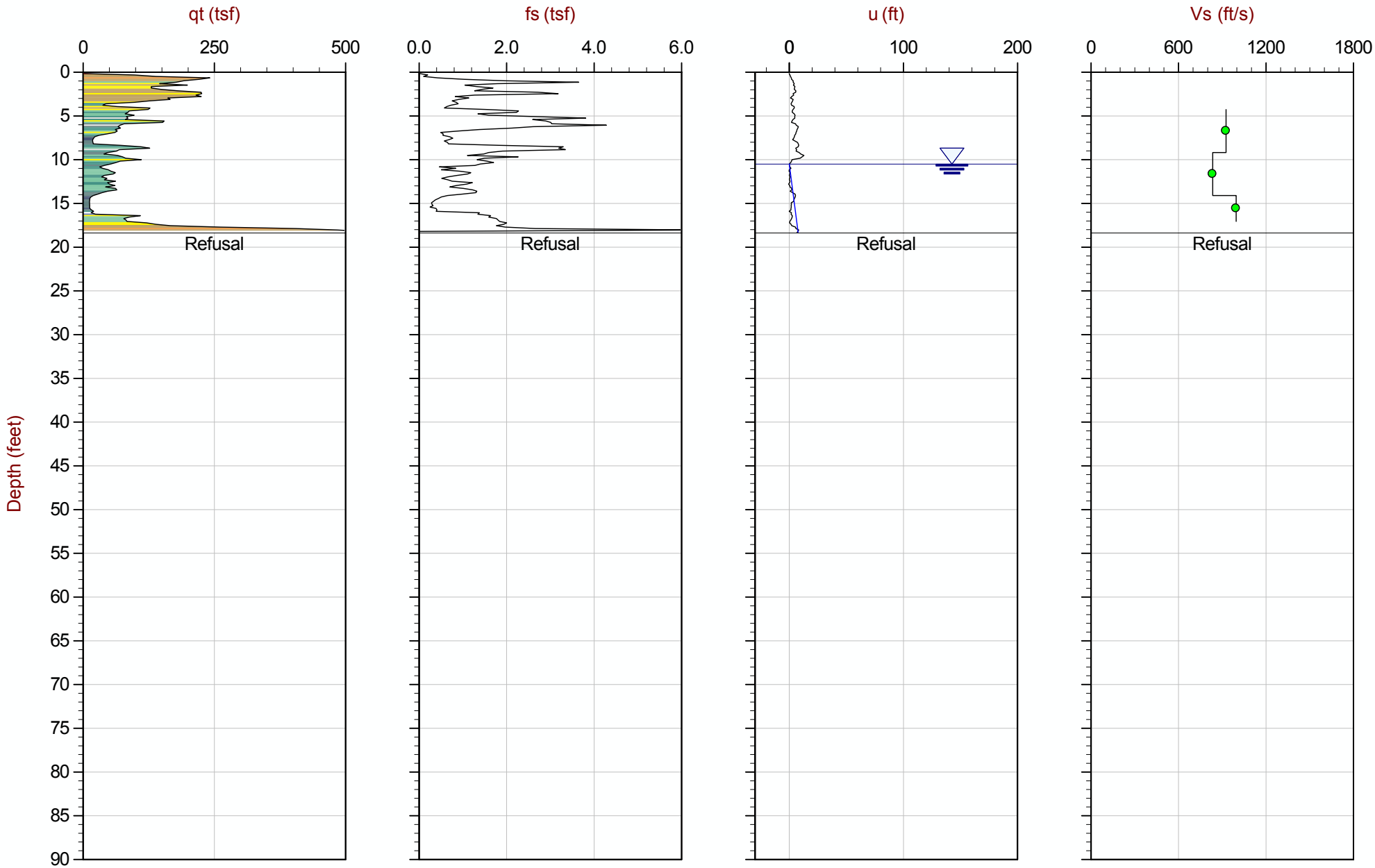
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:01:15 16:04
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C020A
Cone: 340:T1500F15U500



Max Depth: 5.600 m / 18.37 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP20A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574942m E: 306820m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

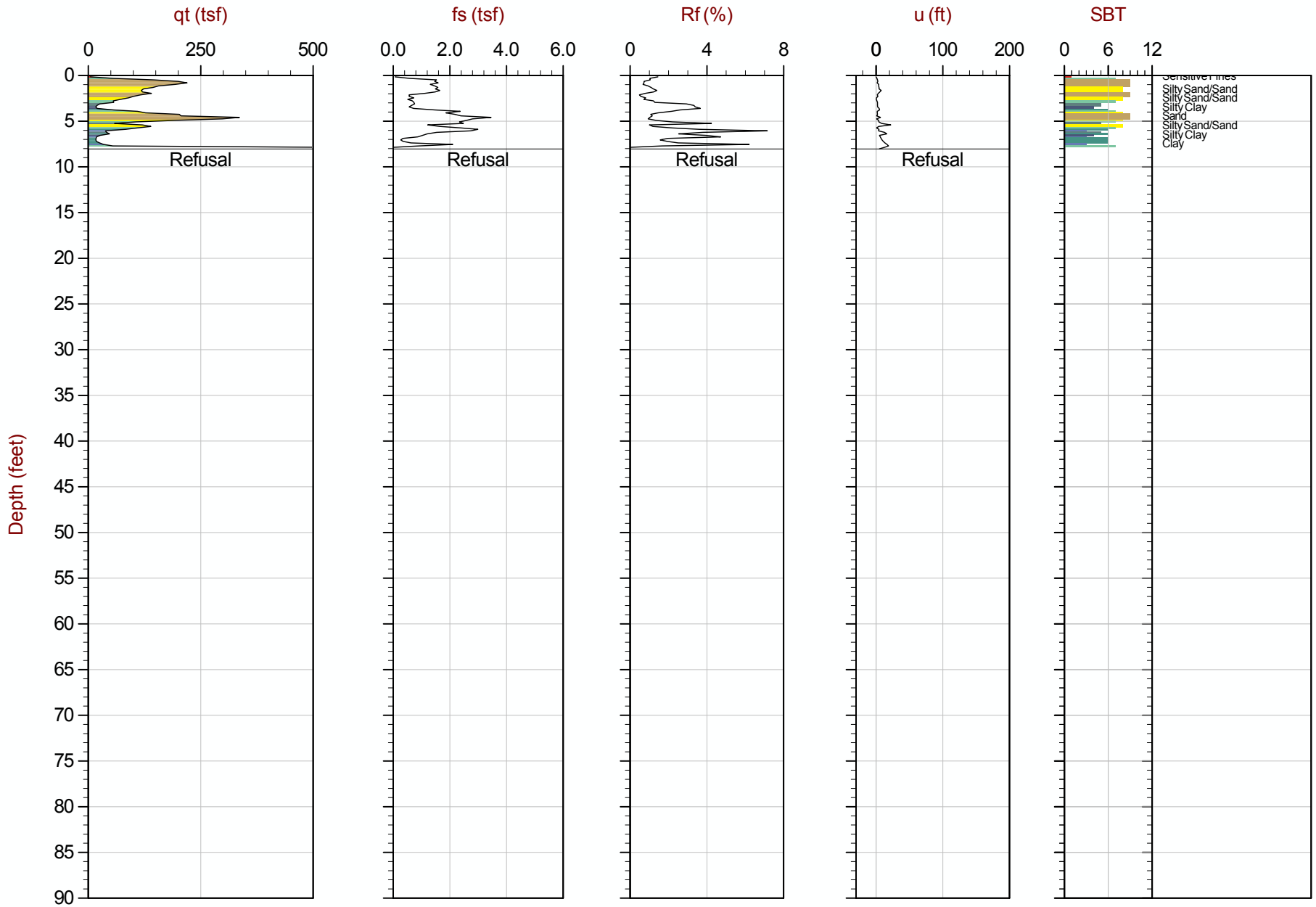
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:01:15 12:42
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C021
Cone: 340:T1500F15U500



Max Depth: 2.450 m / 8.04 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP21.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574913m E: 306616m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

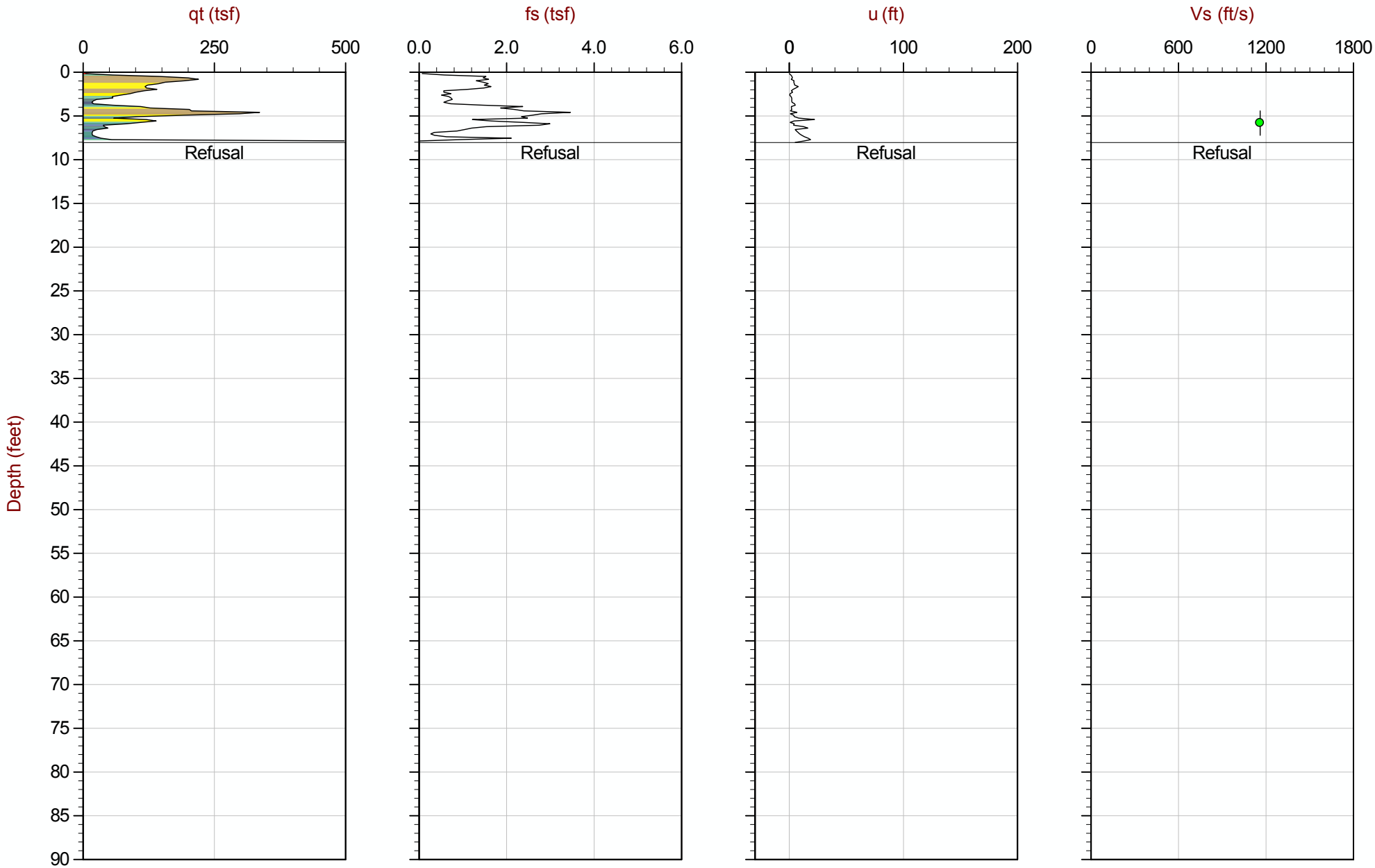
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:01:15 12:42
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C021
Cone: 340:T1500F15U500



Max Depth: 2.450 m / 8.04 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP21.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574913m E: 306616m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

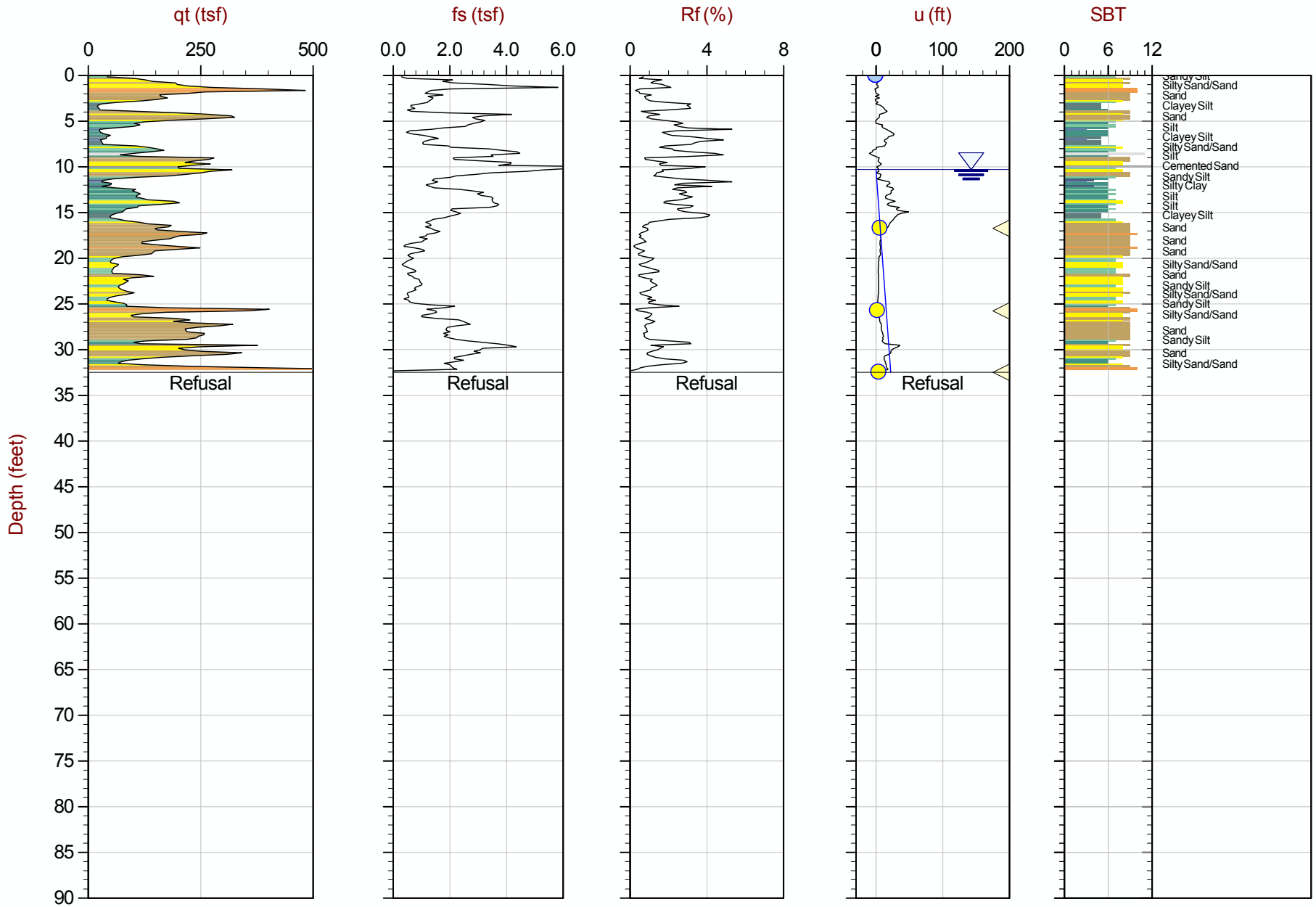
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:01:15 13:06
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C021A
Cone: 340:T1500F15U500



Max Depth: 9.900 m / 32.48 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP21A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574913m E: 306613m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

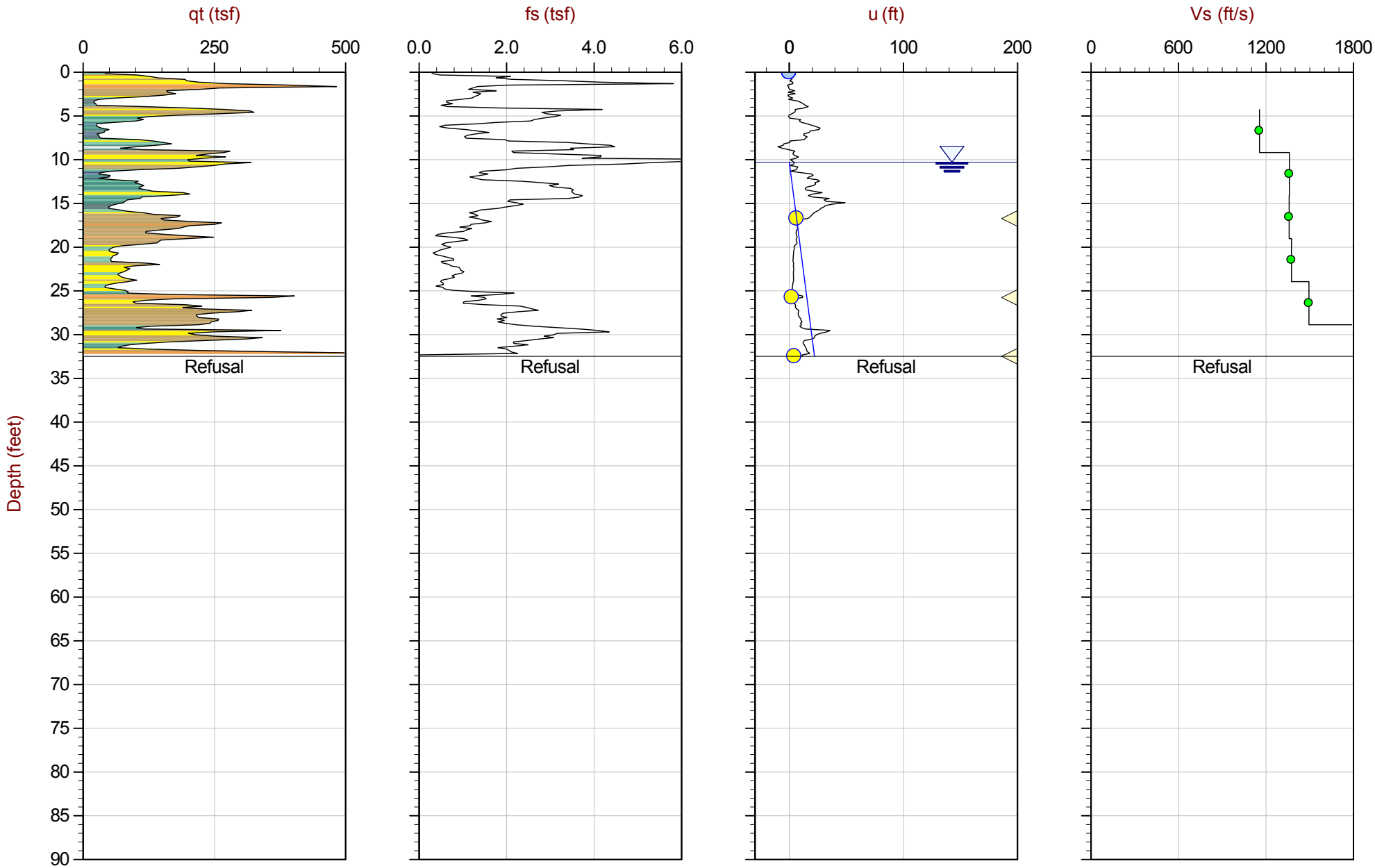
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:01:15 13:06
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C021A
Cone: 340:T1500F15U500



Max Depth: 9.900 m / 32.48 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP21A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574913m E: 306613m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

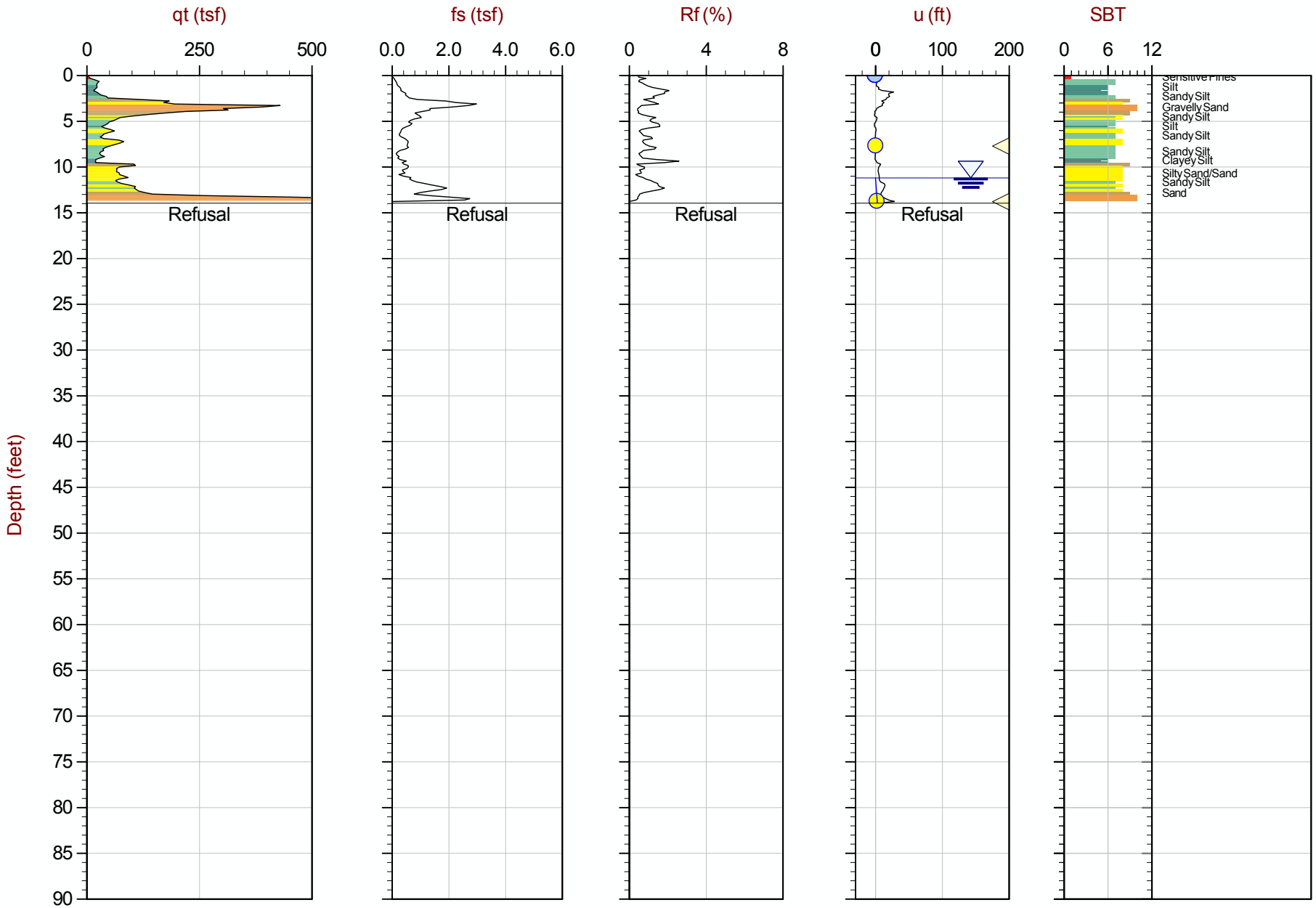
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:01:15 13:08
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C022
Cone: 374:T1500F15U500



Max Depth: 4.250 m / 13.94 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP22.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574885m E: 306596m

Hydrostatic Line ○ Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

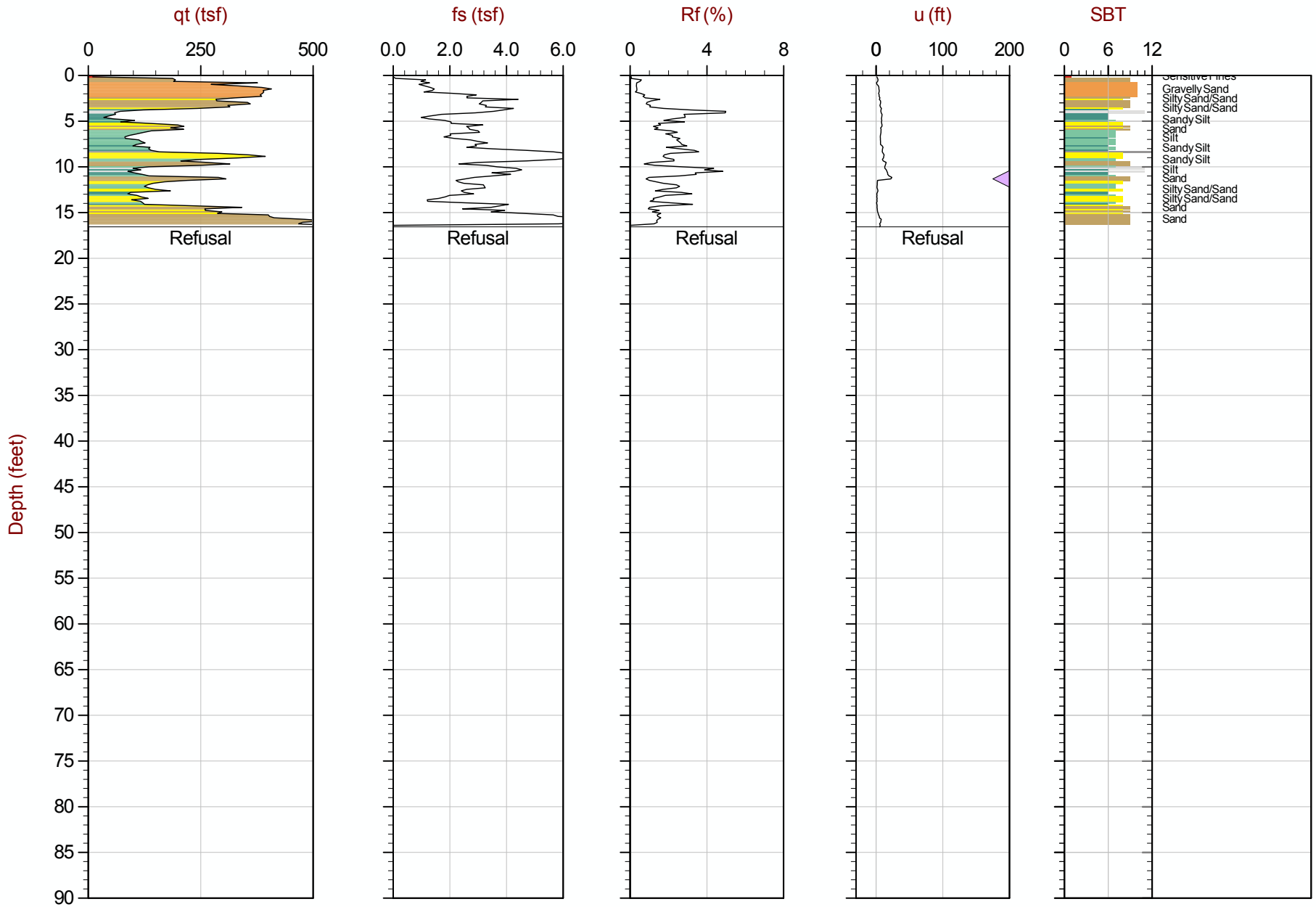
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 12:42
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C023
Cone: 340:T1500F15U500



Max Depth: 5.050 m / 16.57 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP23.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575033m E: 306617m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

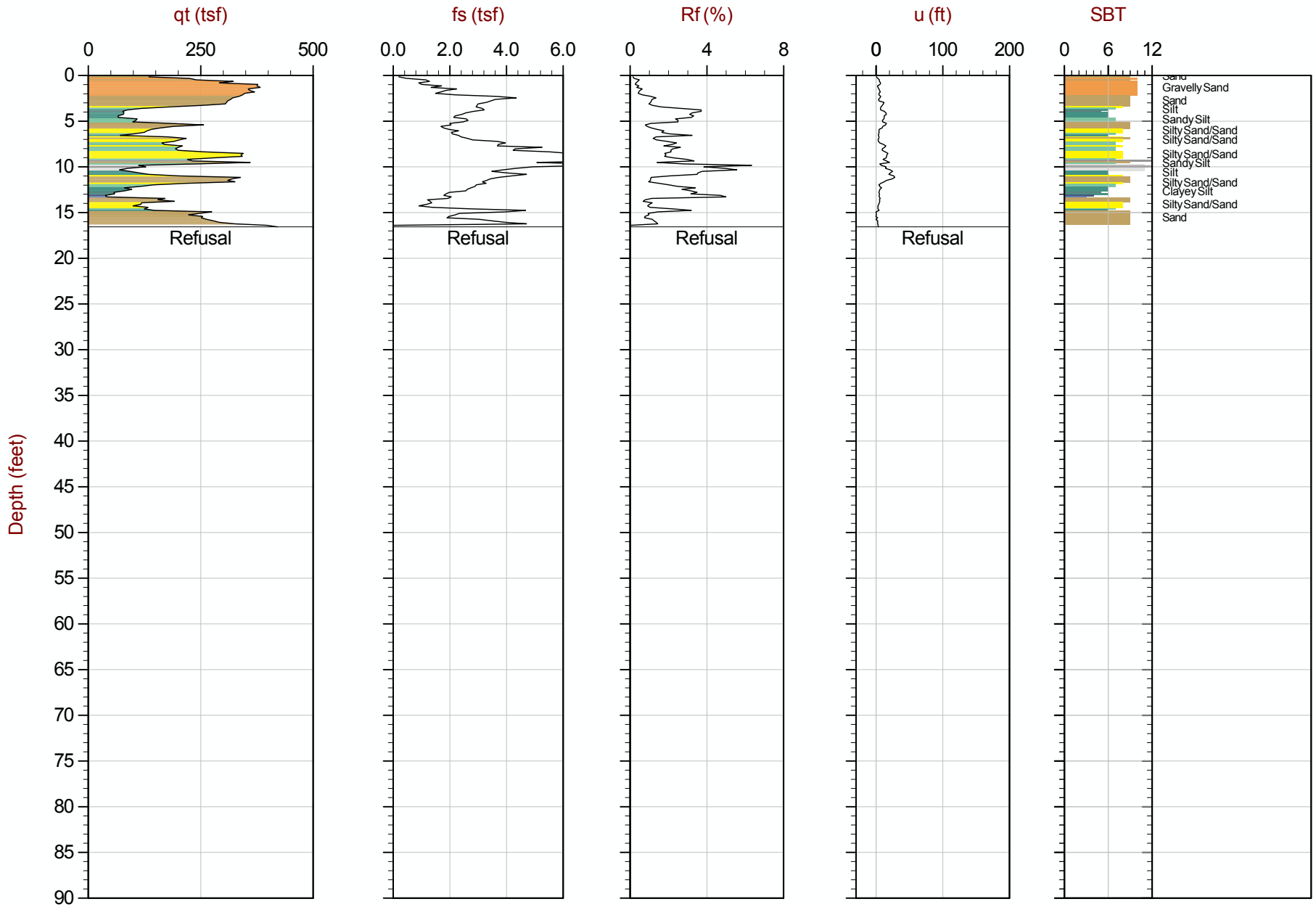
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 13:43
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C023A
Cone: 340:T1500F15U500



Max Depth: 5.050 m / 16.57 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP23A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575033m E: 306619m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

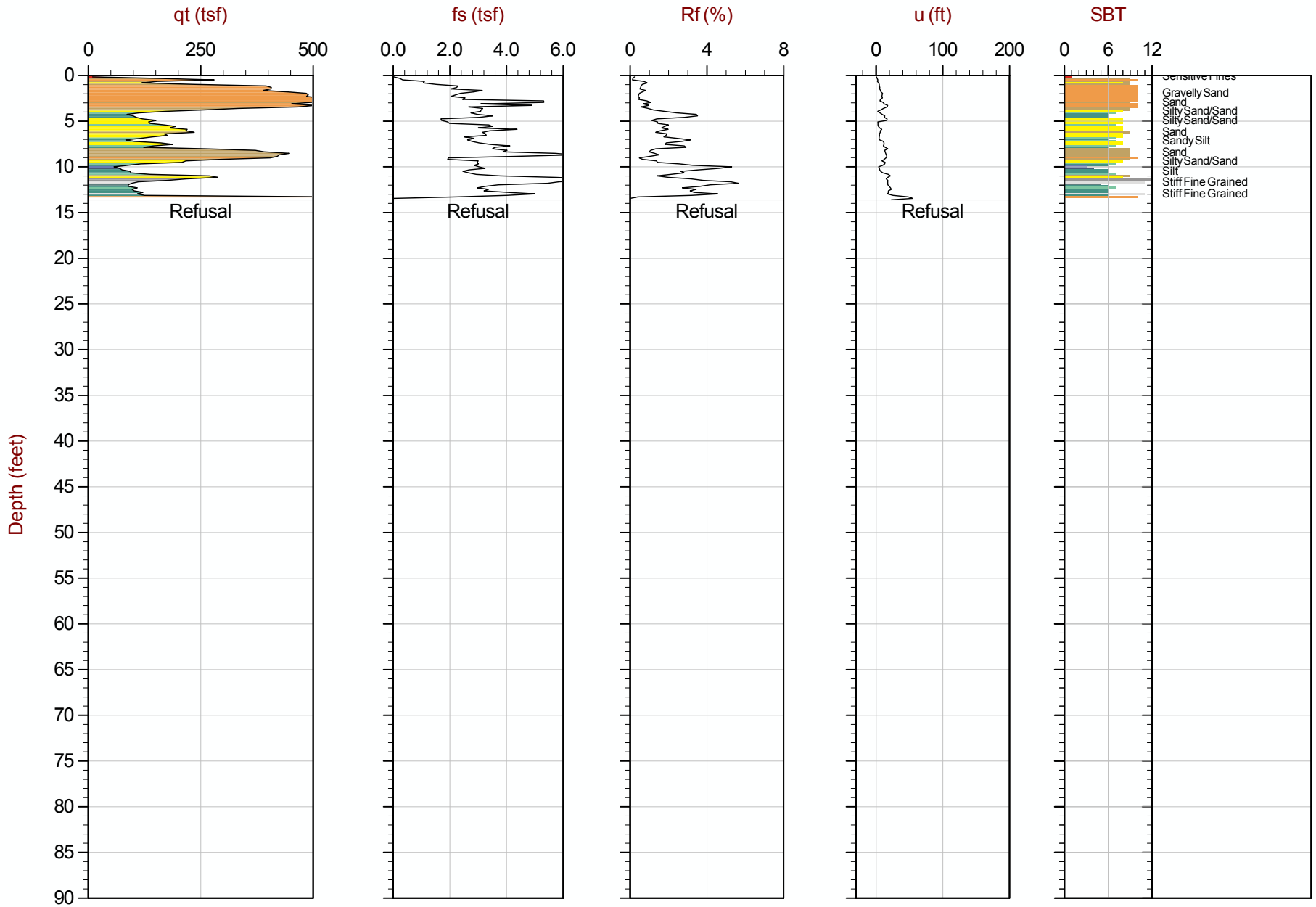
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 11:13
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C024
Cone: 340:T1500F15U500



Max Depth: 4.150 m / 13.62 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP24.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575150m E: 306819m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

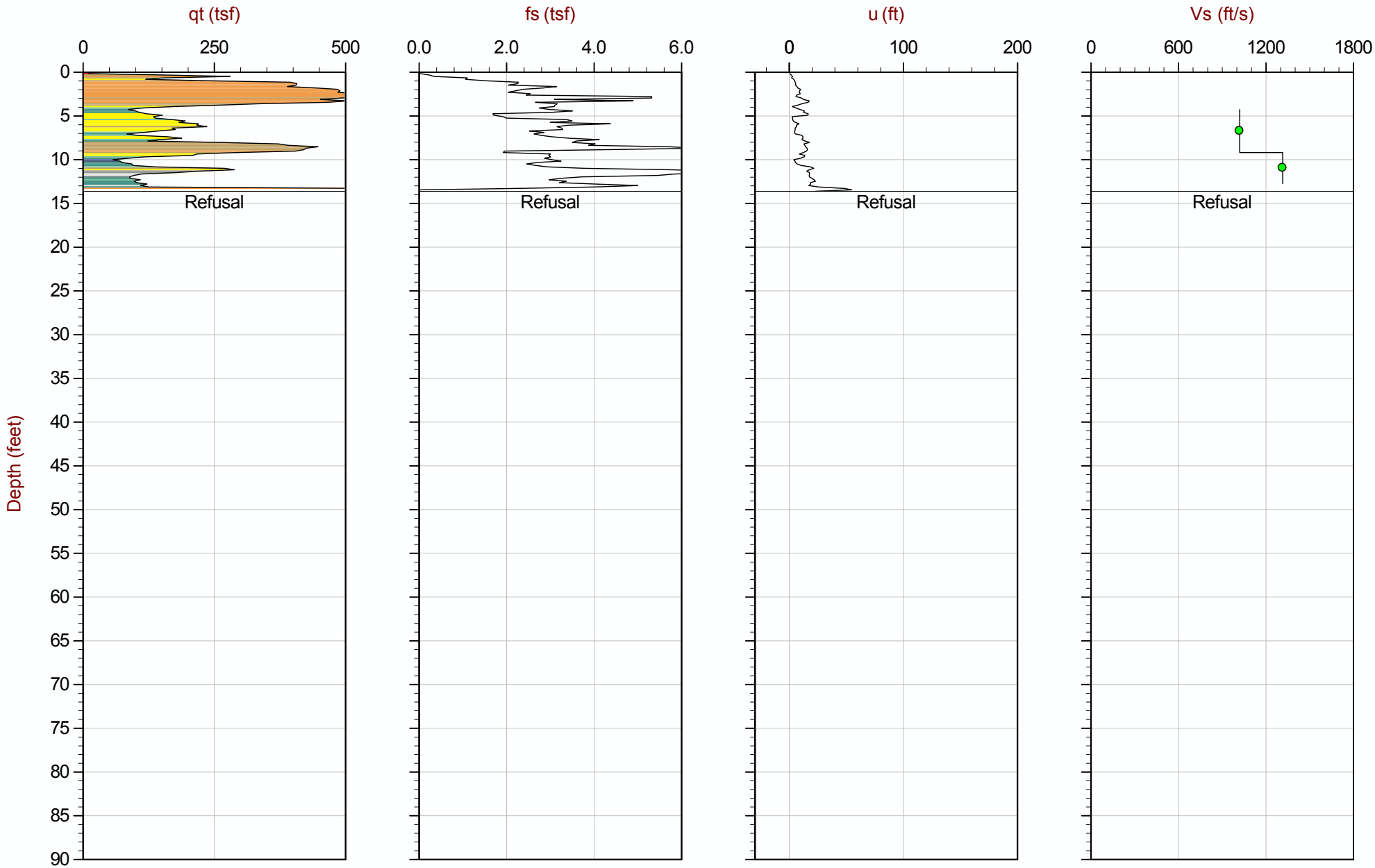
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 11:13
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C024
Cone: 340:T1500F15U500



Max Depth: 4.150 m / 13.62 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP24.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575150m E: 306819m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

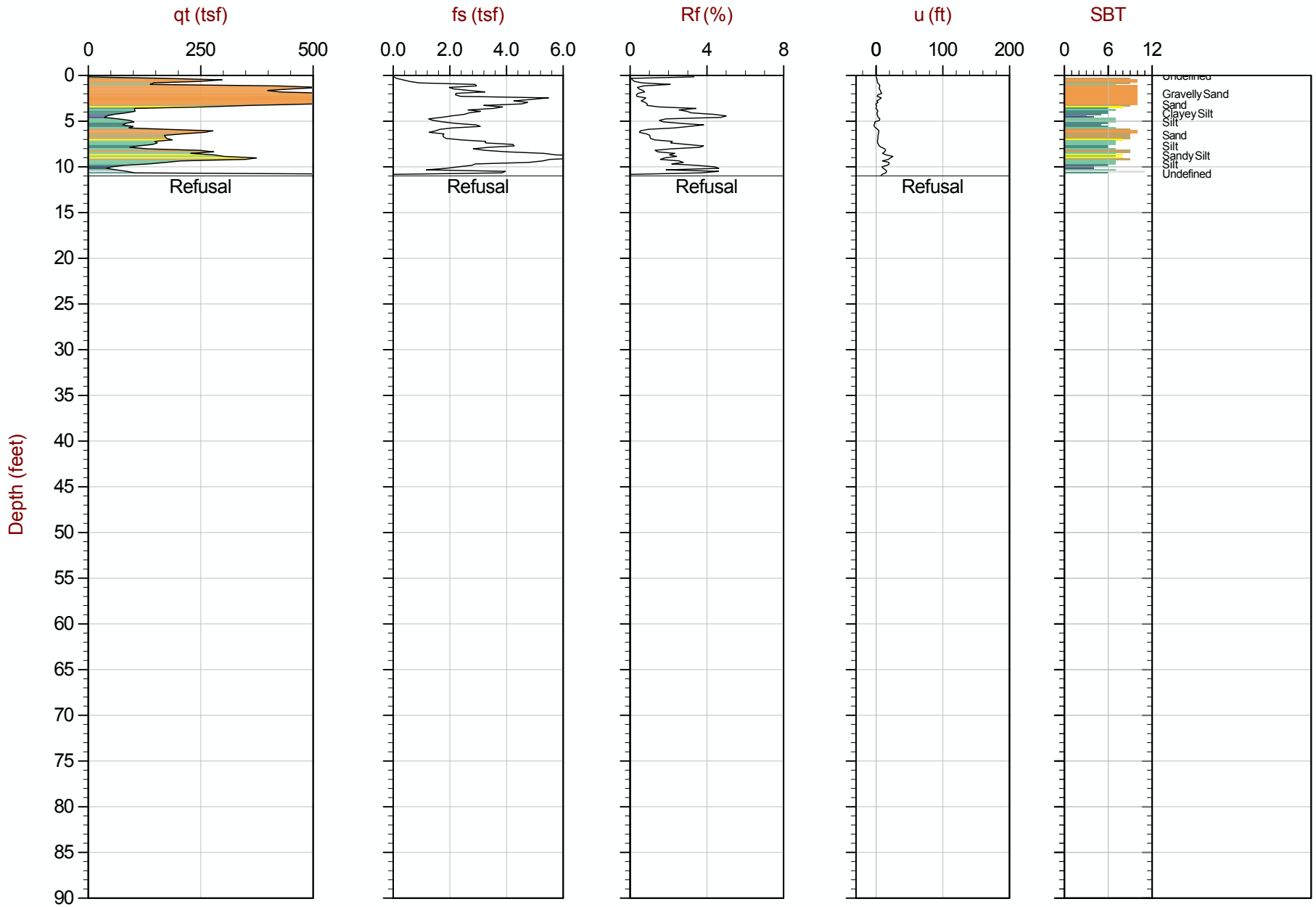
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 11:52
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C024A
Cone: 340:T1500F15U500



Max Depth: 3.350 m / 10.99 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP24A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575152m E: 306820m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

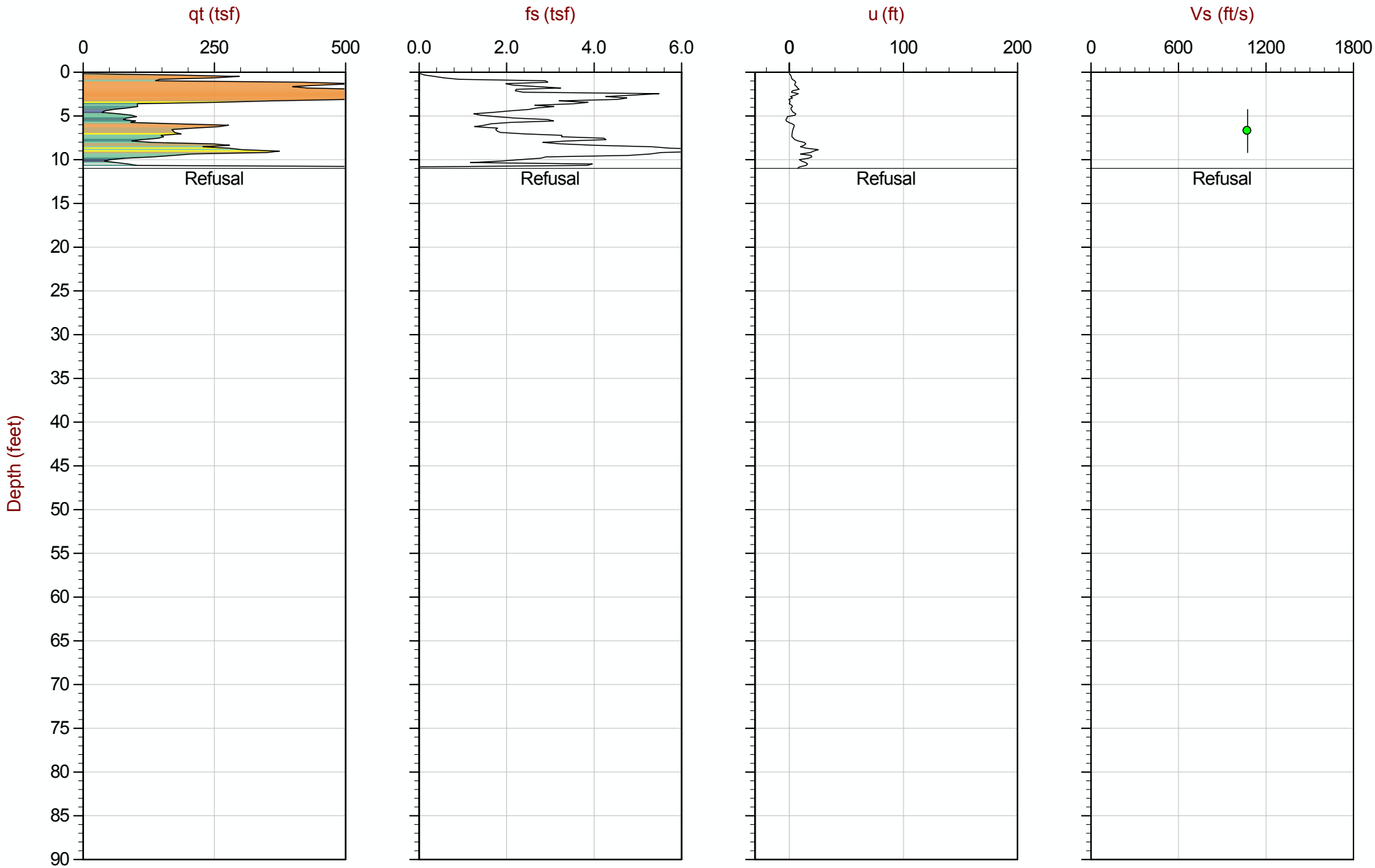
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 11:52
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C024A
Cone: 340:T1500F15U500



Max Depth: 3.350 m / 10.99 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP24A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575152m E: 306820m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

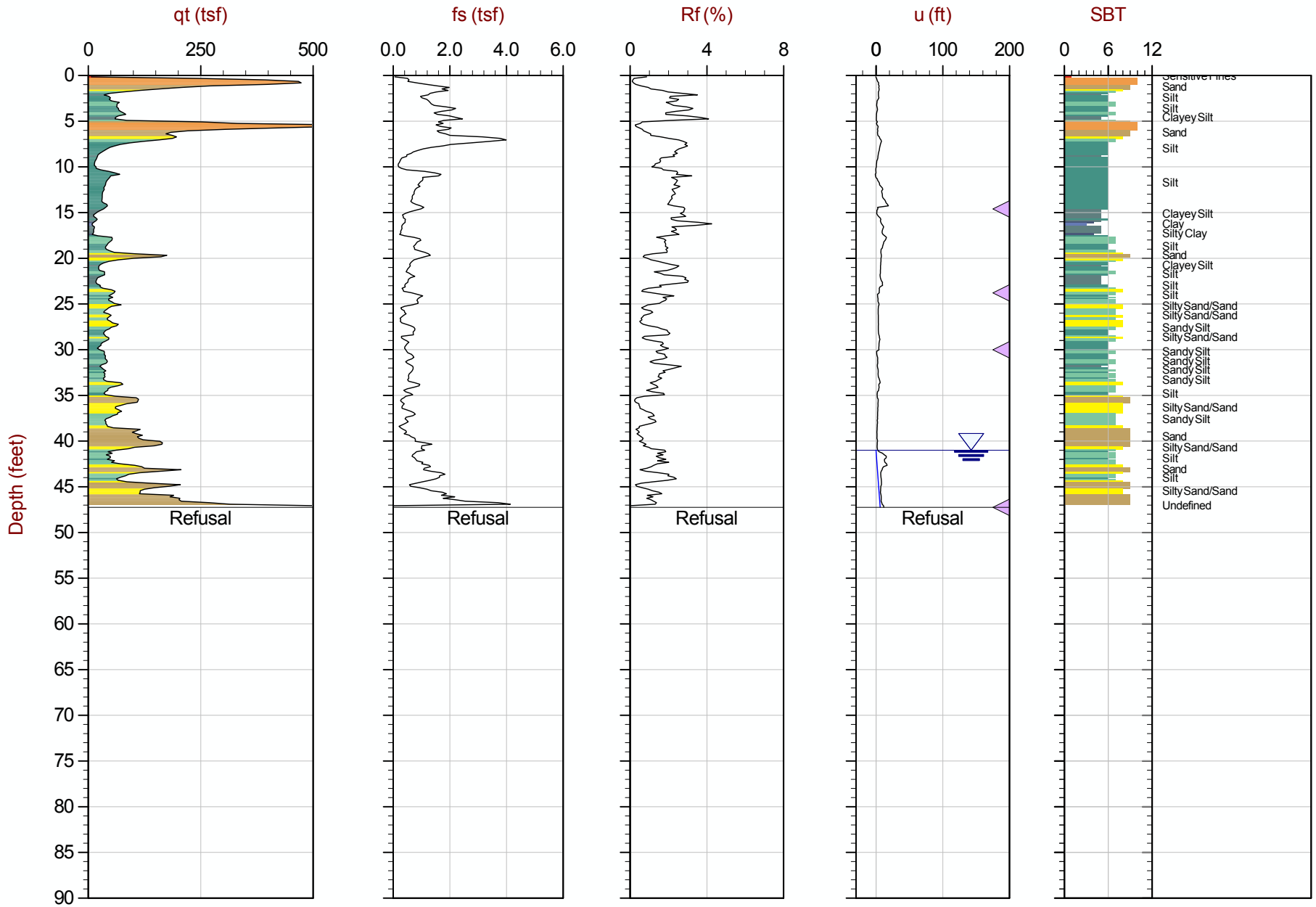
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 08:19
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C025
Cone: 340:T1500F15U500



Max Depth: 14.400 m / 47.24 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP25.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575088m E: 306990m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

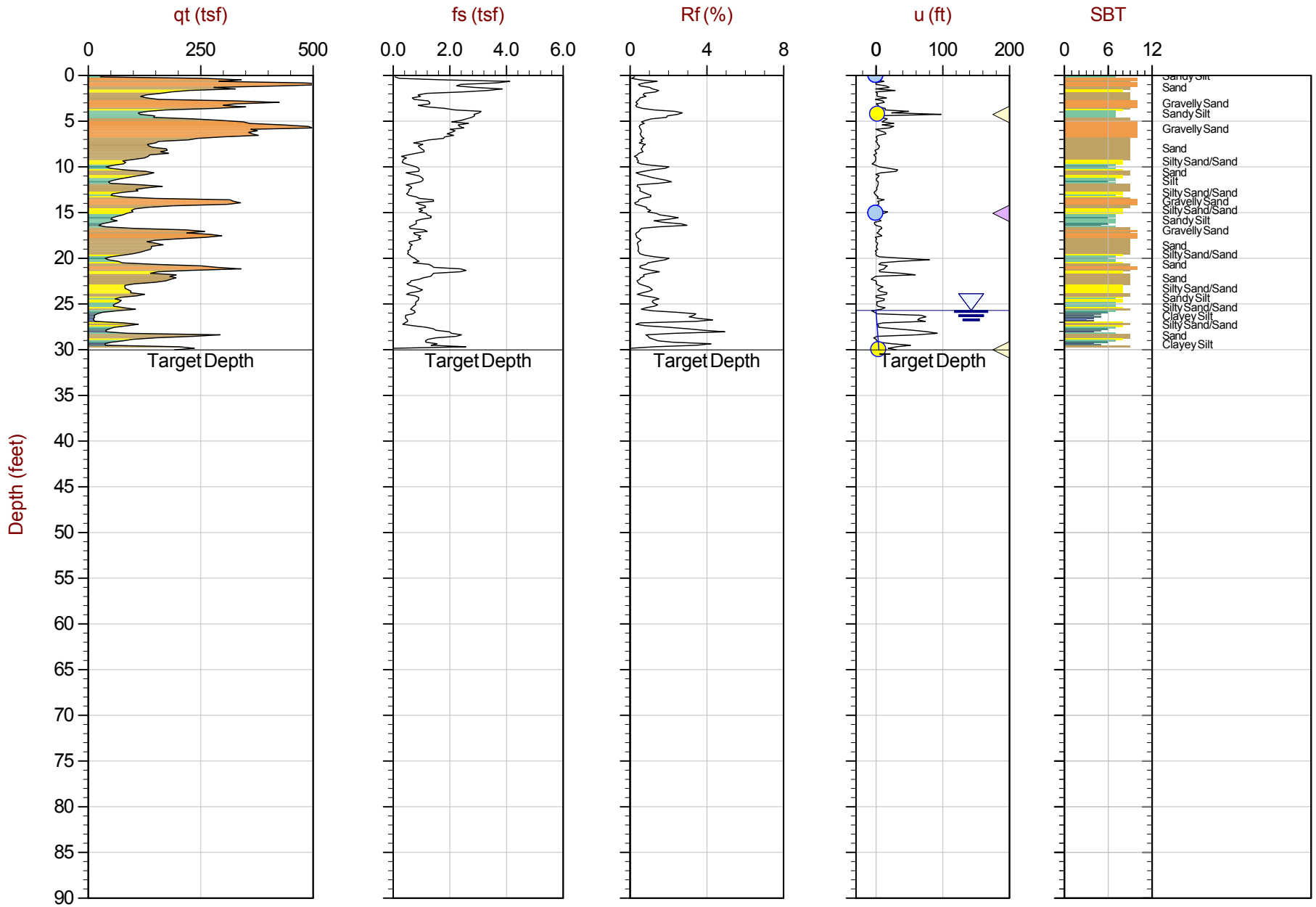
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:03:15 11:32
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C026
Cone: 374:T1500F15U500



Max Depth: 9.150 m / 30.02 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP26.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574976m E: 306648m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

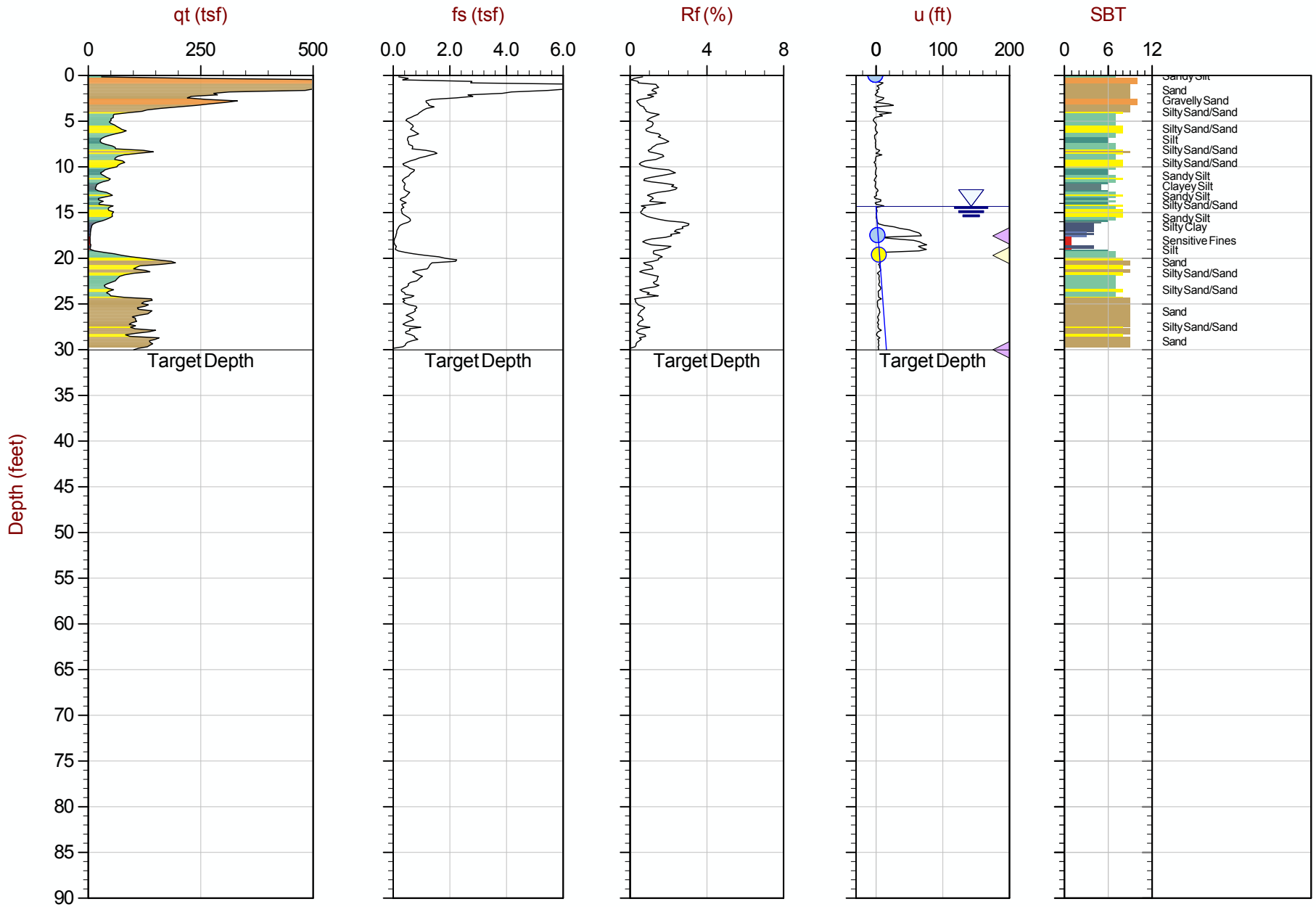
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:03:15 09:01
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C027
Cone: 374:T1500F15U500



Max Depth: 9.150 m / 30.02 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP27.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575057m E: 306848m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

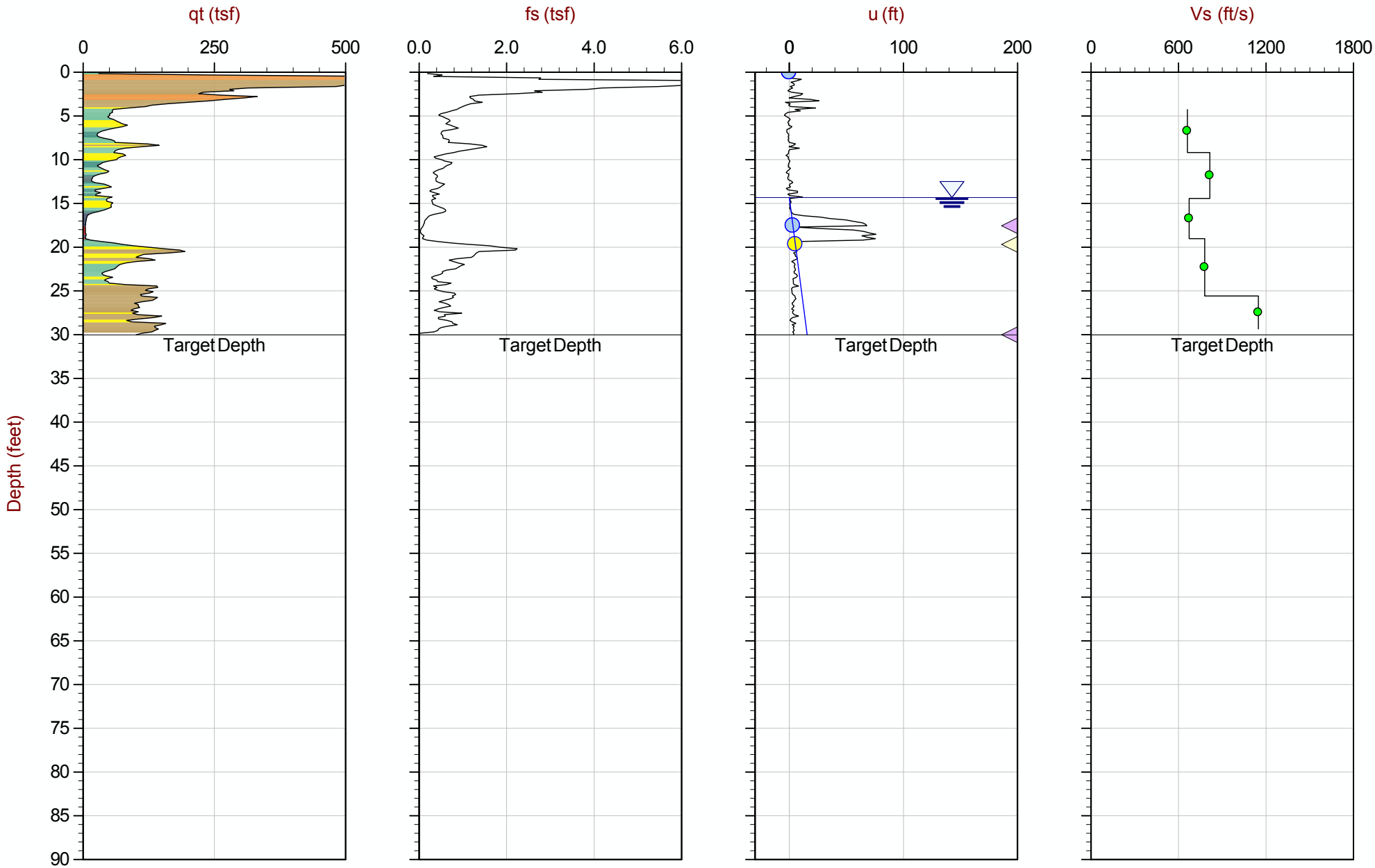
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:03:15 09:01
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C027
Cone: 374:T1500F15U500



Max Depth: 9.150 m / 30.02 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP27.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575057m E: 306848m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

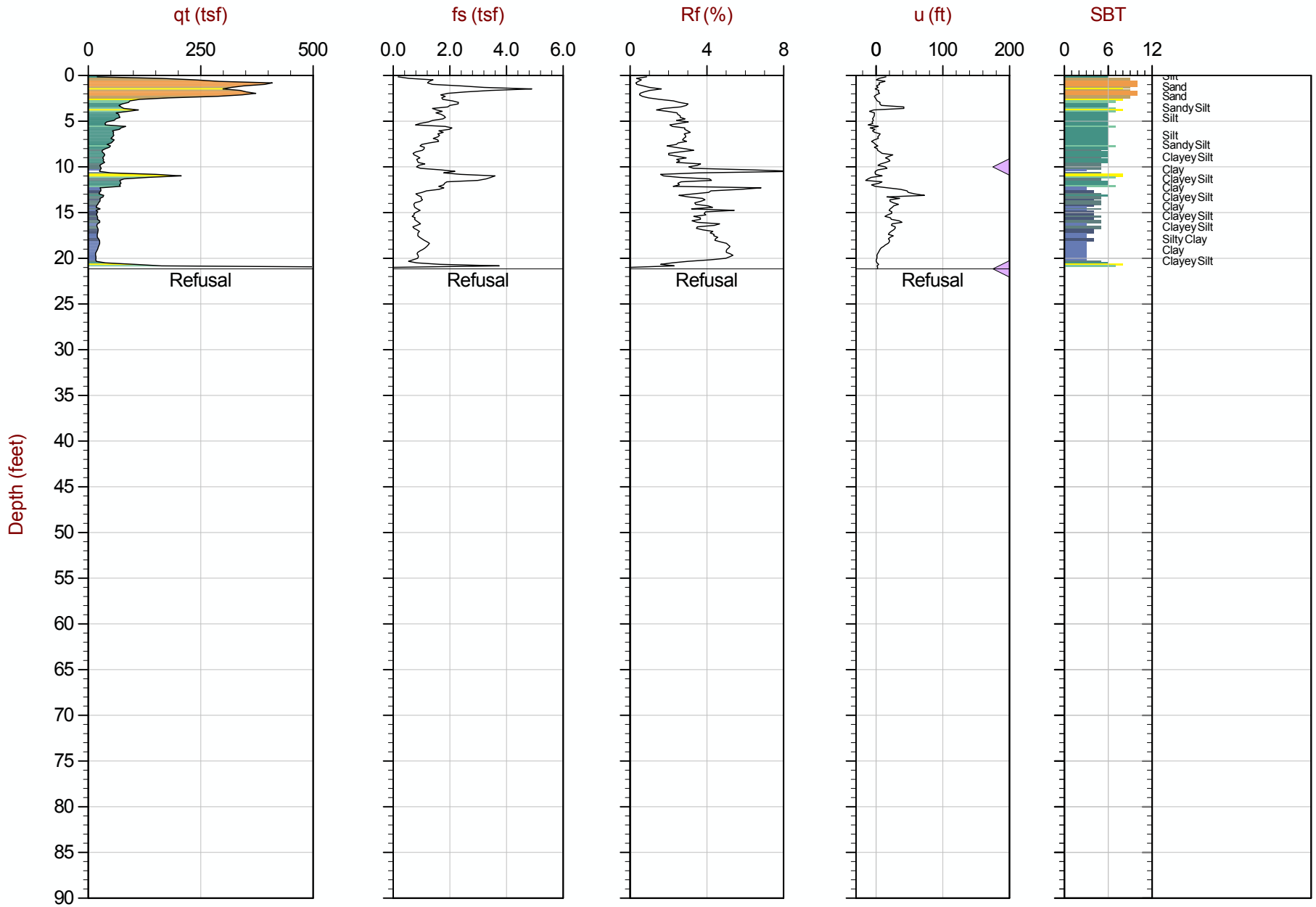
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:01:15 15:44
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C029
Cone: 374:T1500F15U500



Max Depth: 6.450 m / 21.16 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP29.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574869m E: 306935m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

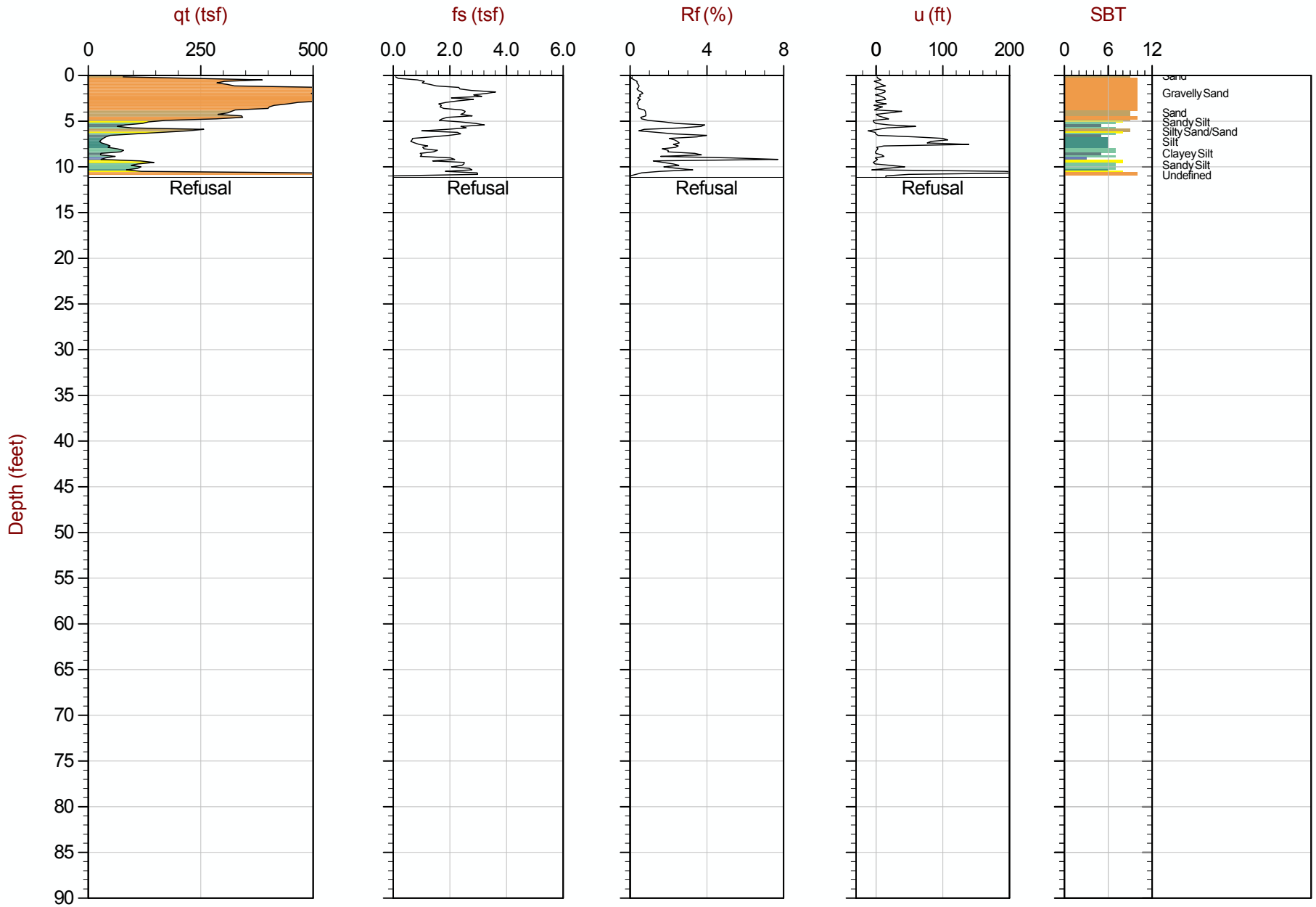
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 14:24
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C030
Cone: 374:T1500F15U500



Max Depth: 3.400 m / 11.15 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP30.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575040m E: 307109m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

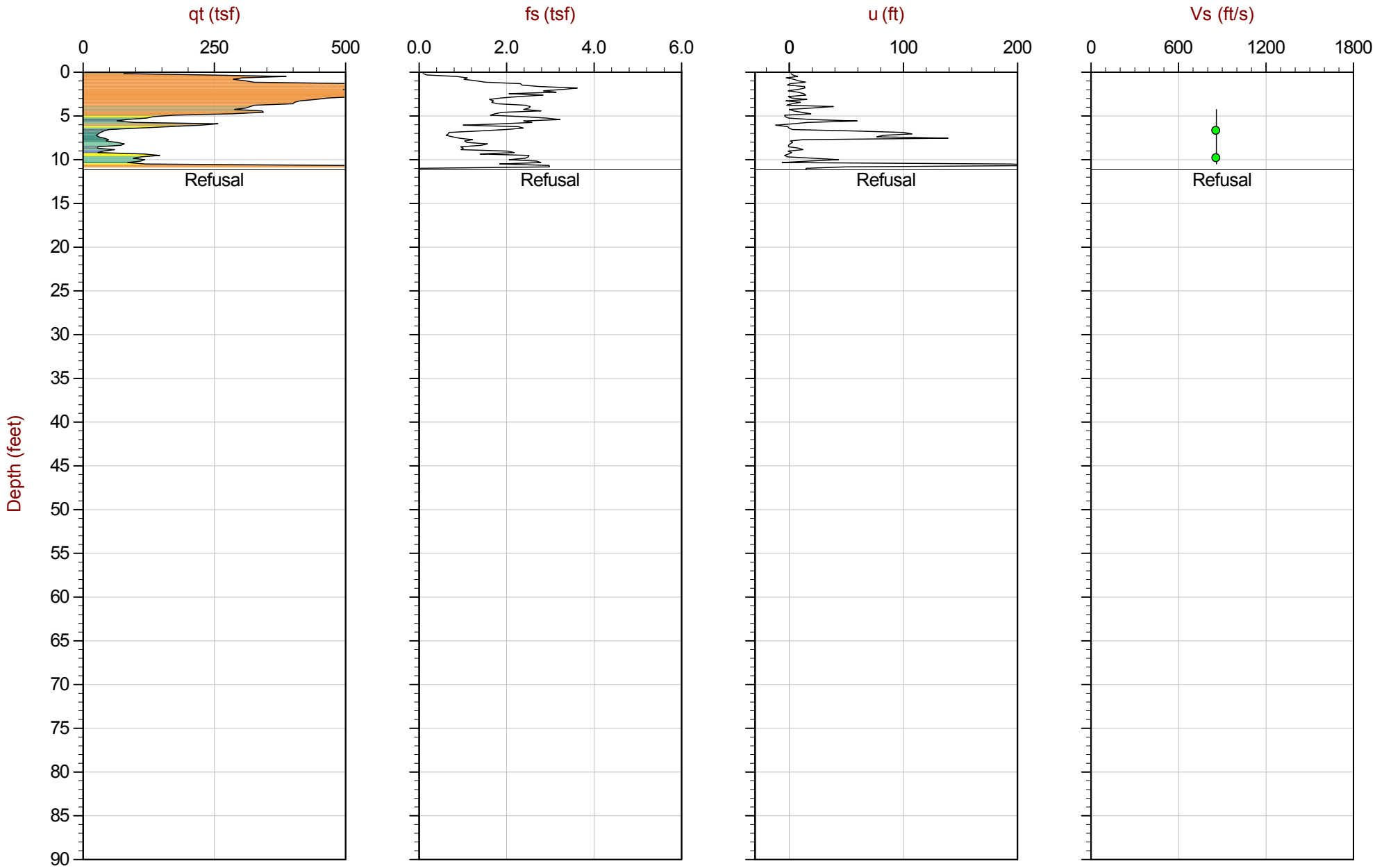
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 14:24
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C030
Cone: 374:T1500F15U500



Max Depth: 3.400 m / 11.15 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP30.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575040m E: 307109m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

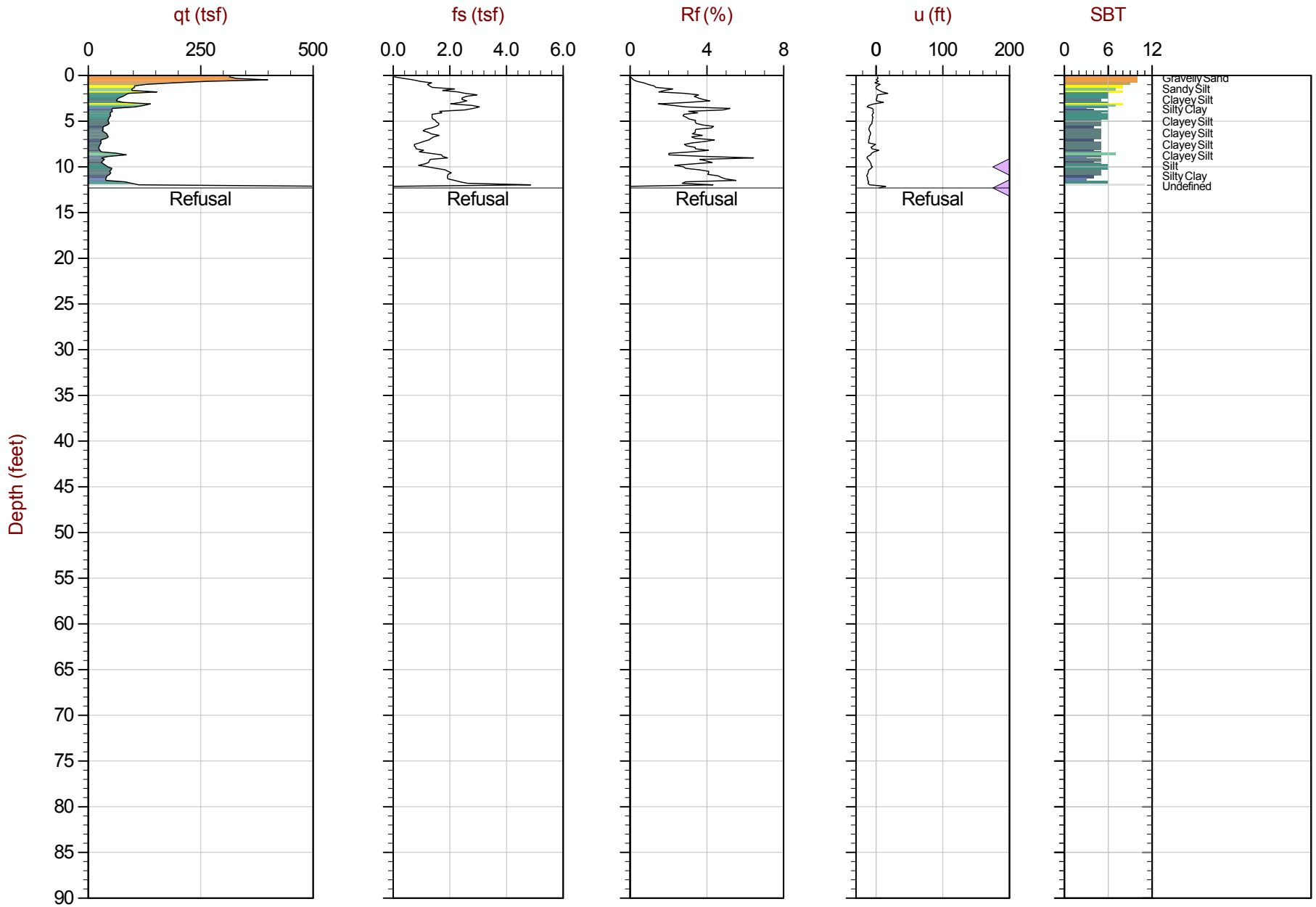
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 10:27
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C032
Cone: 374:T1500F15U500



Max Depth: 3.750 m / 12.30 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP32.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574980m E: 307252m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

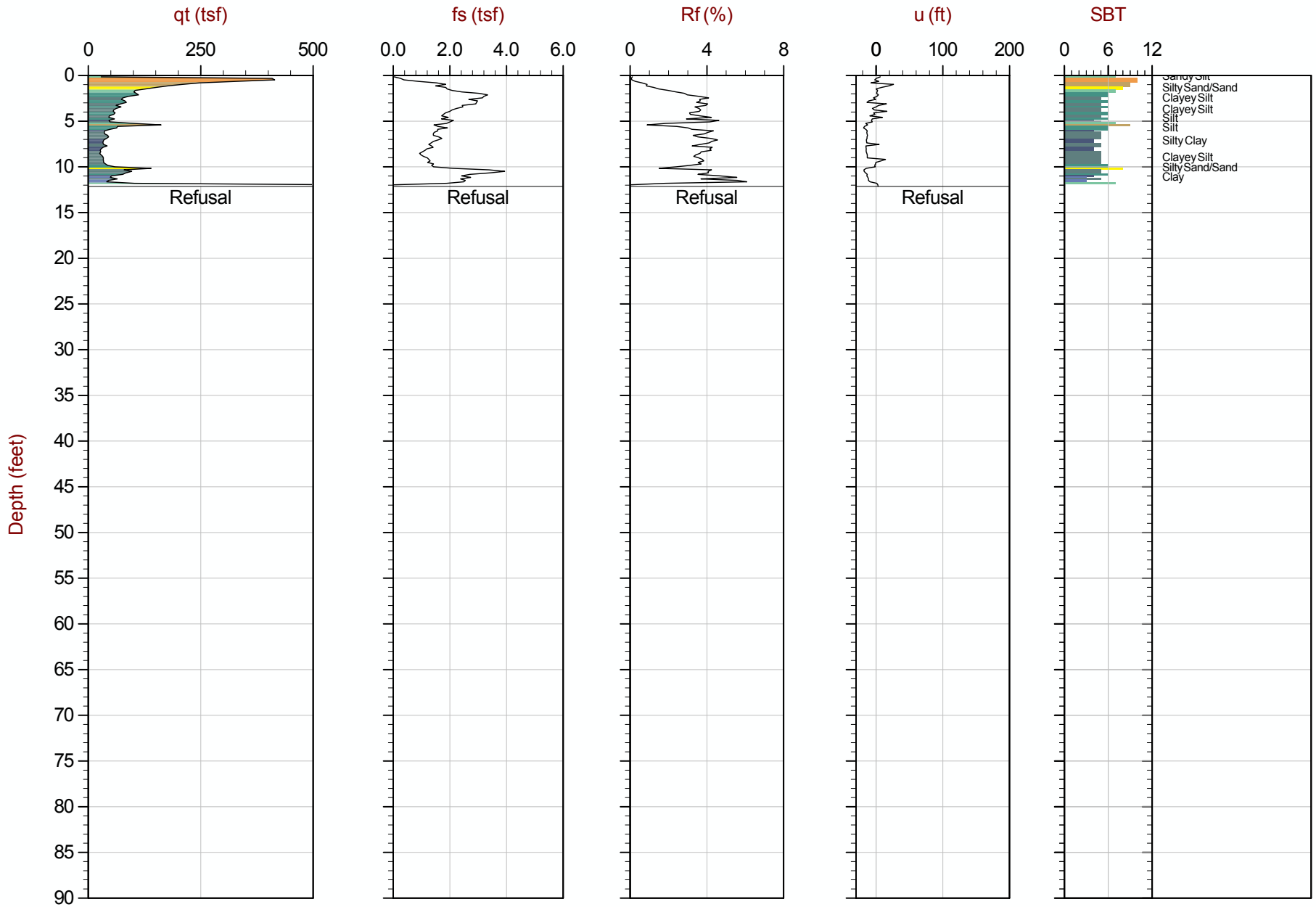
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 11:26
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C032B
Cone: 374:T1500F15U500



Max Depth: 3.700 m / 12.14 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP32B.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574980m E: 307253m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

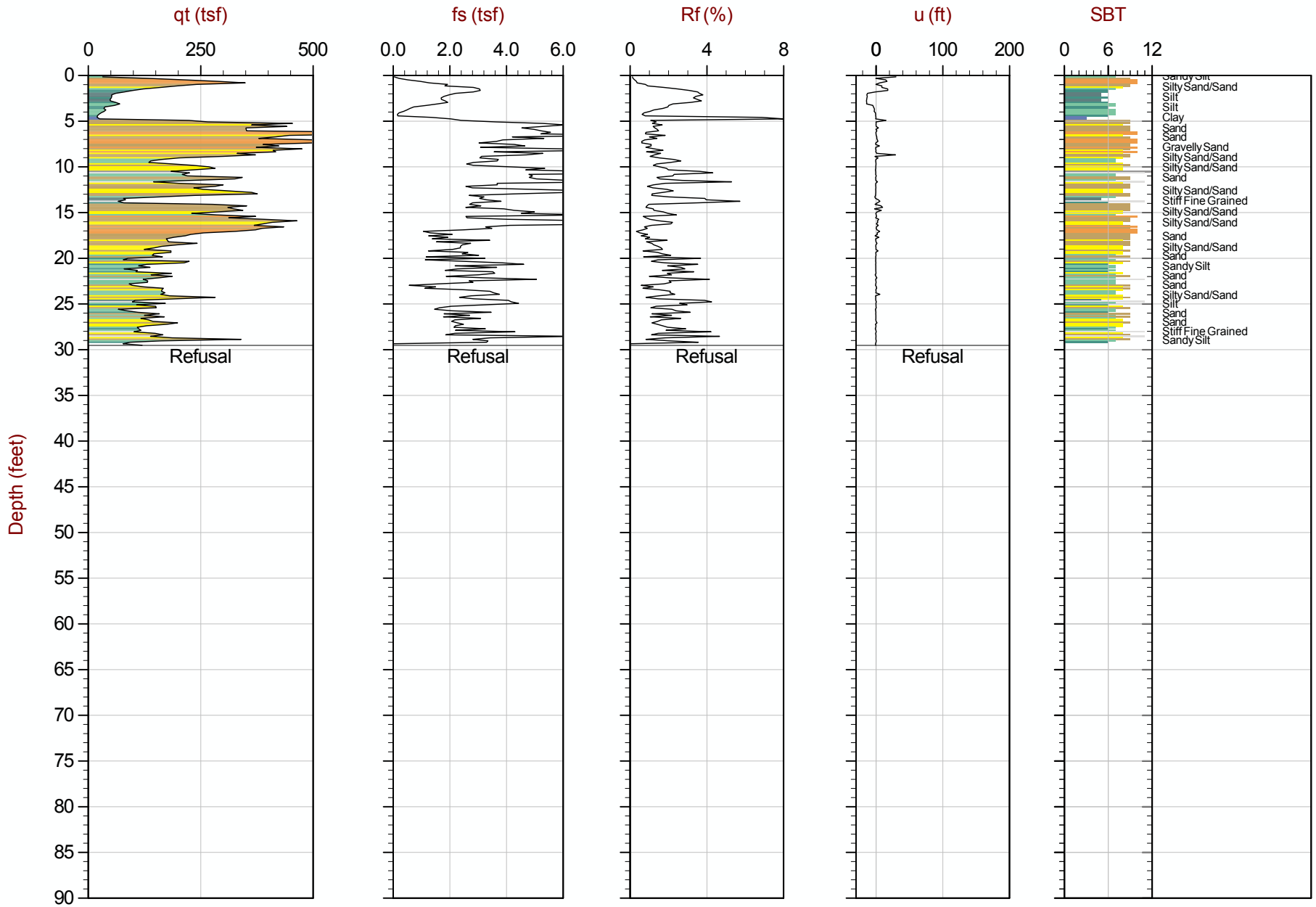
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 08:46
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C034
Cone: 374:T1500F15U500



Max Depth: 9.000 m / 29.53 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP34.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574804m E: 307178m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

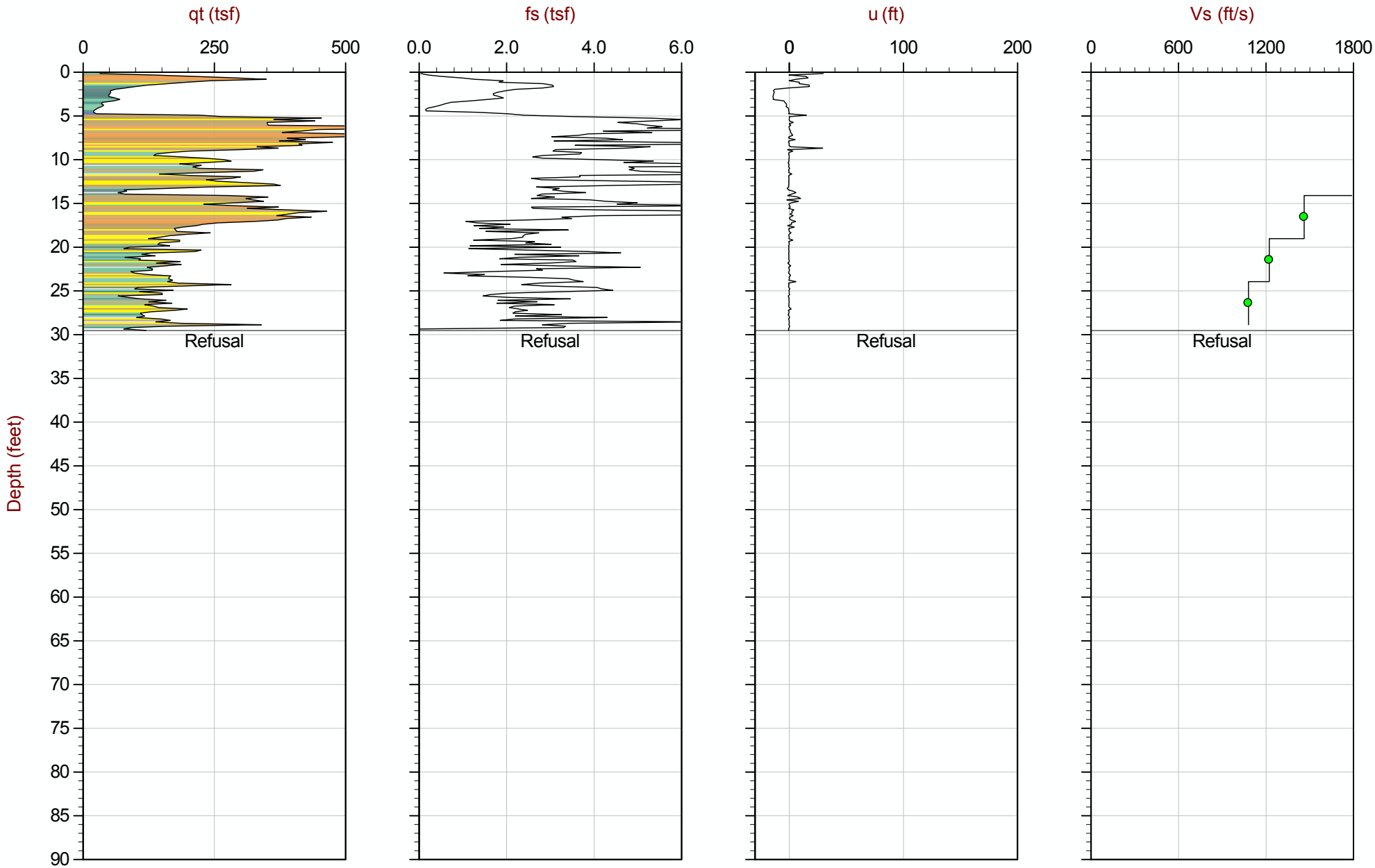
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 08:46
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C034
Cone: 374:T1500F15U500



Max Depth: 9.000 m / 29.53 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP34.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574804m E: 307178m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

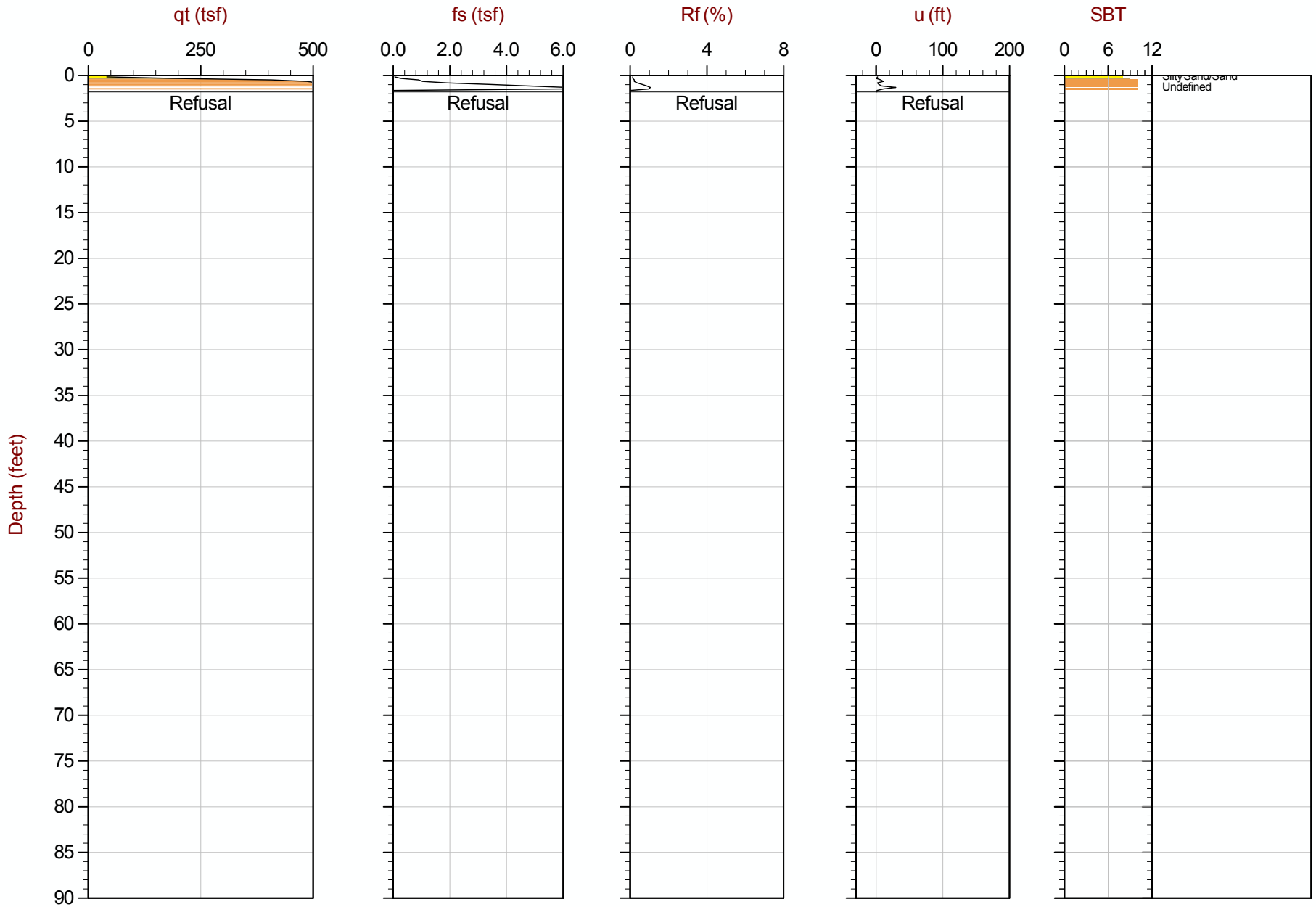
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 13:27
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C038
Cone: 374:T1500F15U500



Max Depth: 0.550 m / 1.80 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP38.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575106m E: 307334m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

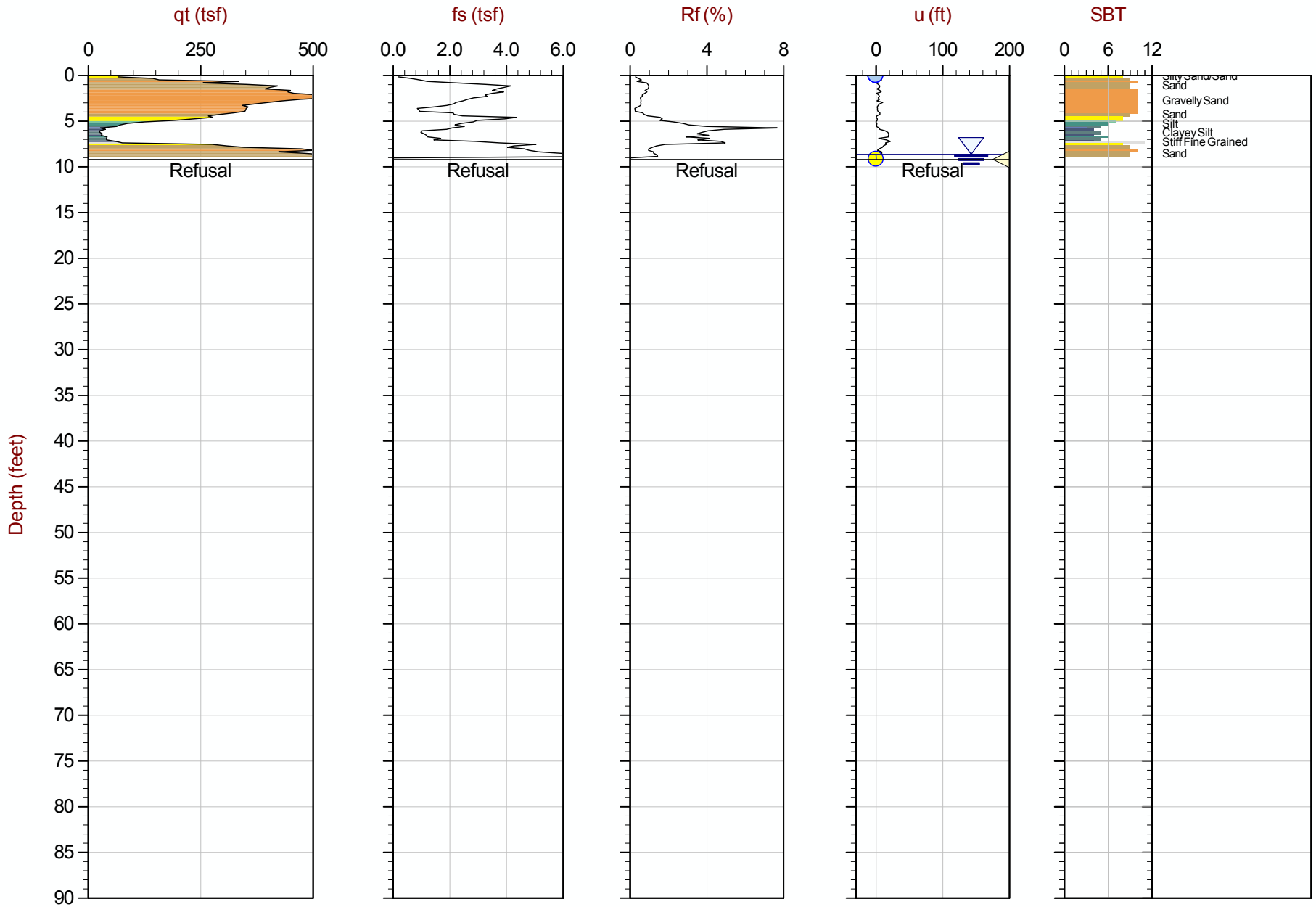
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 15:55
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C038A
Cone: 301:T1500F15U500



Max Depth: 2.800 m / 9.19 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP38A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575087m E: 307369m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

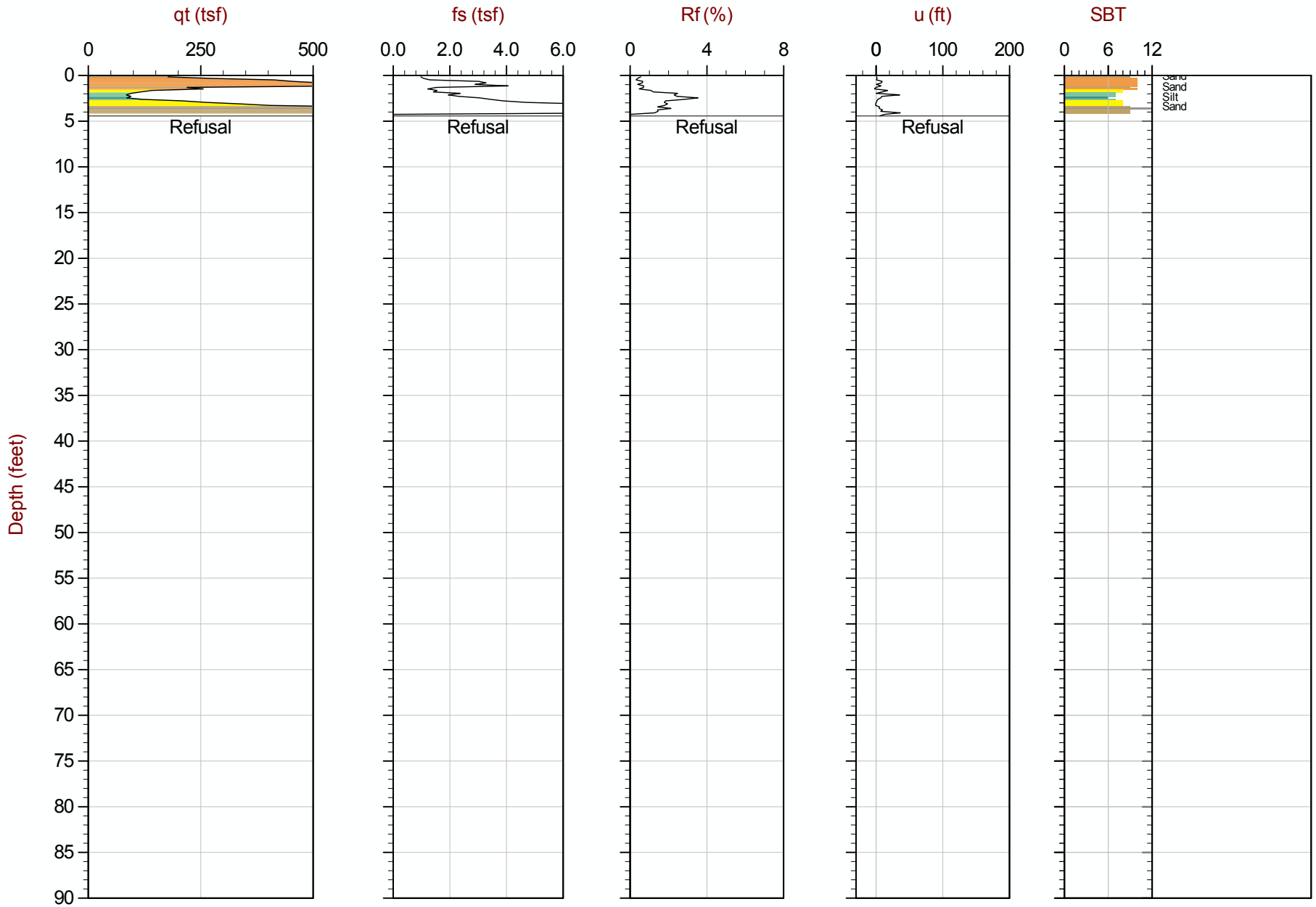
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 12:25
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C039
Cone: 374:T1500F15U500



Max Depth: 1.350 m / 4.43 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP39.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575108m E: 307373m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Pore Pressure Dissipation Summary and

Pore Pressure Dissipation Plots

Job No: 15-53081
Client: AECOM
Project: Hennepin Power Station, Hennepin, IL
Start Date: 01-Sep-2015
End Date: 11-Sep-2015

CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (ft)	Calculated Phreatic Surface (ft)	Estimated Phreatic Surface (ft)	t_{50} [a] (s)	Assumed Rigidity Index (I_r)	c_h [b] (cm^2/min)
HEN-C002	15-53081_CP02	15	8000	30.02	12.31		17.71	4157	100	0.17
HEN-C002	15-53081_CP02	15	600	47.90	30.56	17.34				
HEN-C002	15-53081_CP02	15	500	55.61	37.90	17.71				
HEN-C004	15-53081_CP04	15	8000	30.02	13.29		16.73	2533	100	0.28
HEN-C004	15-53081_CP04	15	500	35.27	18.99	16.28				
HEN-C004	15-53081_CP04	15	1005	41.34	24.61	16.73				
HEN-C005	15-53081_SP05	15	500	21.82	2.25	18.84				
HEN-C005	15-53081_SP05	15	800	24.93	1.91	19.00				
HEN-C005A	15-53081_SP05A	15	605	41.99	10.28	18.29				
HEN-C005A	15-53081_SP05A	15	2000	62.66	8.20	18.28				
HEN-C006	15-53081_CP06	15	500	7.71	16.63	5.46				
HEN-C006	15-53081_CP06	15	300	17.39	0.75	15.48				
HEN-C006	15-53081_CP06	15	1800	26.74	9.31	16.46				
HEN-C007B	15-53081_SP07B	15	700	22.31	12.43	17.59				
HEN-C007B	15-53081_SP07B	15	1100	40.35	23.26	17.55				
HEN-C007B	15-53081_SP07B	15	500	60.04	3.99	16.97				
HEN-C007B	15-53081_SP07B	15	1700	88.91	0.77	17.00				
HEN-C008	15-53081_SP08	15	300	19.36	2.59	17.07				
HEN-C008B	15-53081_SP08B	15	400	21.33	0.90	17.51				
HEN-C008B	15-53081_SP08B	15	700	40.52	0.00	17.71				
HEN-C008B	15-53081_SP08B	15	600	85.79	0.00	17.78				
HEN-C009	15-53081_CP09	15	1800	15.09	0.00	6.89				
HEN-C009	15-53081_CP09	15	3000	23.46		6.83				
HEN-C010	15-53081_SP10	15	855	35.10	2.70					
HEN-C010	15-53081_SP10	15	3000	38.22	0.00		17.60	228	100	3.08
HEN-C010	15-53081_SP10	15	605	42.16	4.31	17.60				
HEN-C012	15-53081_CP12	15	900	11.15		10.41		42	100	16.90
HEN-C012	15-53081_CP12	15	3600	20.01	0.09		10.70	1719	100	0.41
HEN-C012	15-53081_CP12	15	300	22.97		10.53				
HEN-C012	15-53081_CP12	15	300	33.96	0.00	10.70				
HEN-C014	15-53081_CP14	15	900	20.01	0.56	16.02				
HEN-C015	15-53081_SP15	15	7500	25.59	2.98		11.64	969	100	0.72
HEN-C015	15-53081_SP15	15	500	51.34	5.93	11.64				
HEN-C015	15-53081_SP15	15	300	52.33	23.71	12.07				
HEN-C017	15-53081_SP17	15	400	5.58	44.38					
HEN-C017	15-53081_SP17	15	1000	15.58	4.72		12.05	103	100	6.78
HEN-C017	15-53081_SP17	15	500	50.69	22.81	12.64				
HEN-C017	15-53081_SP17	15	600	66.44	43.07	12.05				
HEN-C019	15-53081_SP19	15	4000	14.76	71.91		11.53	654	100	1.07
HEN-C019	15-53081_SP19	15	2010	40.35	2.28	11.52		48	100	14.73
HEN-C019	15-53081_SP19	15	500	54.79	3.82	11.53				
HEN-C019	15-53081_SP19	15	3600	62.83	22.81					
HEN-C021A	15-53081_SP21A	15	1500	16.73	68.01	10.29		86	100	8.16
HEN-C021A	15-53081_SP21A	15	900	25.75		23.36		174	100	4.04
HEN-C021A	15-53081_SP21A	15	1500	32.48	20.62	27.91		268	100	2.62

Job No: 15-53081
Client: AECOM
Project: Hennepin Power Station, Hennepin, IL
Start Date: 01-Sep-2015
End Date: 11-Sep-2015

CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (ft)	Calculated Phreatic Surface (ft)	Estimated Phreatic Surface (ft)	t_{50} [a] (s)	Assumed Rigidity Index (I_r)	c_h [b] (cm^2/min)
HEN-C022	15-53081_CP22	15	800	7.71	24.56	6.94				
HEN-C022	15-53081_CP22	15	3700	13.78	13.95	11.19		168	100	4.17
HEN-C023	15-53081_CP23	15	1600	11.32	39.70					
HEN-C025	15-53081_CP25	15	1500	14.60	40.26					
HEN-C025	15-53081_CP25	15	805	23.79						
HEN-C025	15-53081_CP25	15	1000	30.02	3.53					
HEN-C025	15-53081_CP25	15	3200	47.24	38.05					
HEN-C026	15-53081_CP26	15	900	4.27	54.38	1.57		17	100	40.40
HEN-C026	15-53081_CP26	15	900	15.09	3.23		15.09	36	100	19.26
HEN-C026	15-53081_CP26	15	1800	30.02	28.84	25.71		18	100	38.18
HEN-C027	15-53081_SP27	15	4200	17.55	43.26		14.33			
HEN-C027	15-53081_SP27	15	600	19.68		14.33				
HEN-C027	15-53081_SP27	15	500	30.02	6.44					
HEN-C029	15-53081_CP29	15	900	10.01						
HEN-C029	15-53081_CP29	15	600	21.16						
HEN-C032	15-53081_CP32	15	1200	10.01	2.40					
HEN-C032	15-53081_CP32	15	300	12.30	4.57					
HEN-C038A	15-53081_CP38A	15	905	9.19	4.65	8.63				
Totals	63 dissipations		1609.8 min							

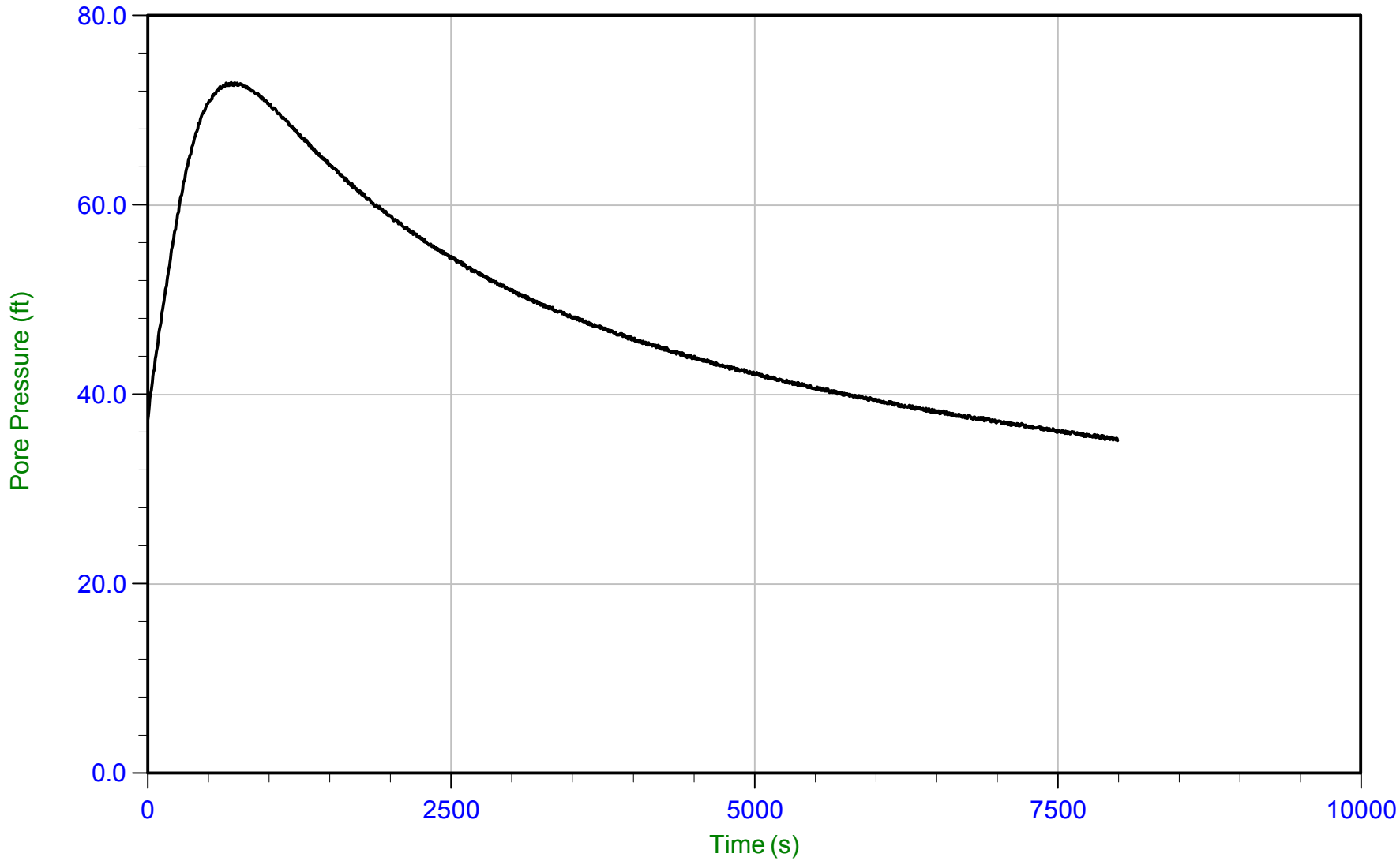
a. Time is relative to where umax occurred
b. Houlsby and Teh, 1991

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 08:58:37
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C002
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP02.PPD
Depth: 9.150 m / 30.019 ft
Duration: 8000.0 s

U Min: 35.1 ft
U Max: 72.9 ft

WT: 5.397 m / 17.706 ft
Ueq: 12.3 ft
U(50): 42.61 ft

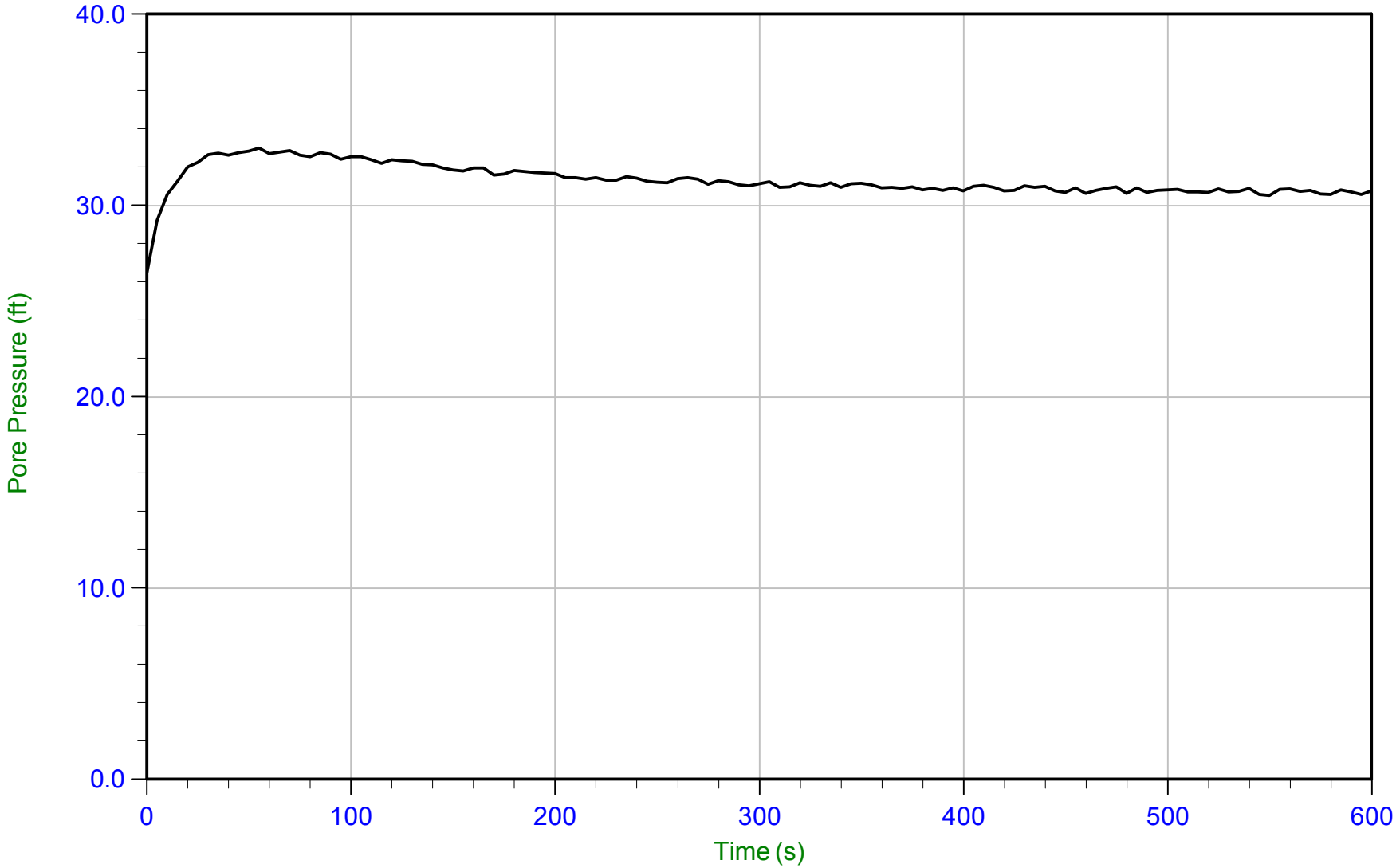
T(50): 4157.5 s
Ir: 100
Ch: 0.2 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 08:58:37
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C002
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP02.PPD
Depth: 14.600 m / 47.900 ft
Duration: 600.0 s

U Min: 26.5 ft
U Max: 33.0 ft

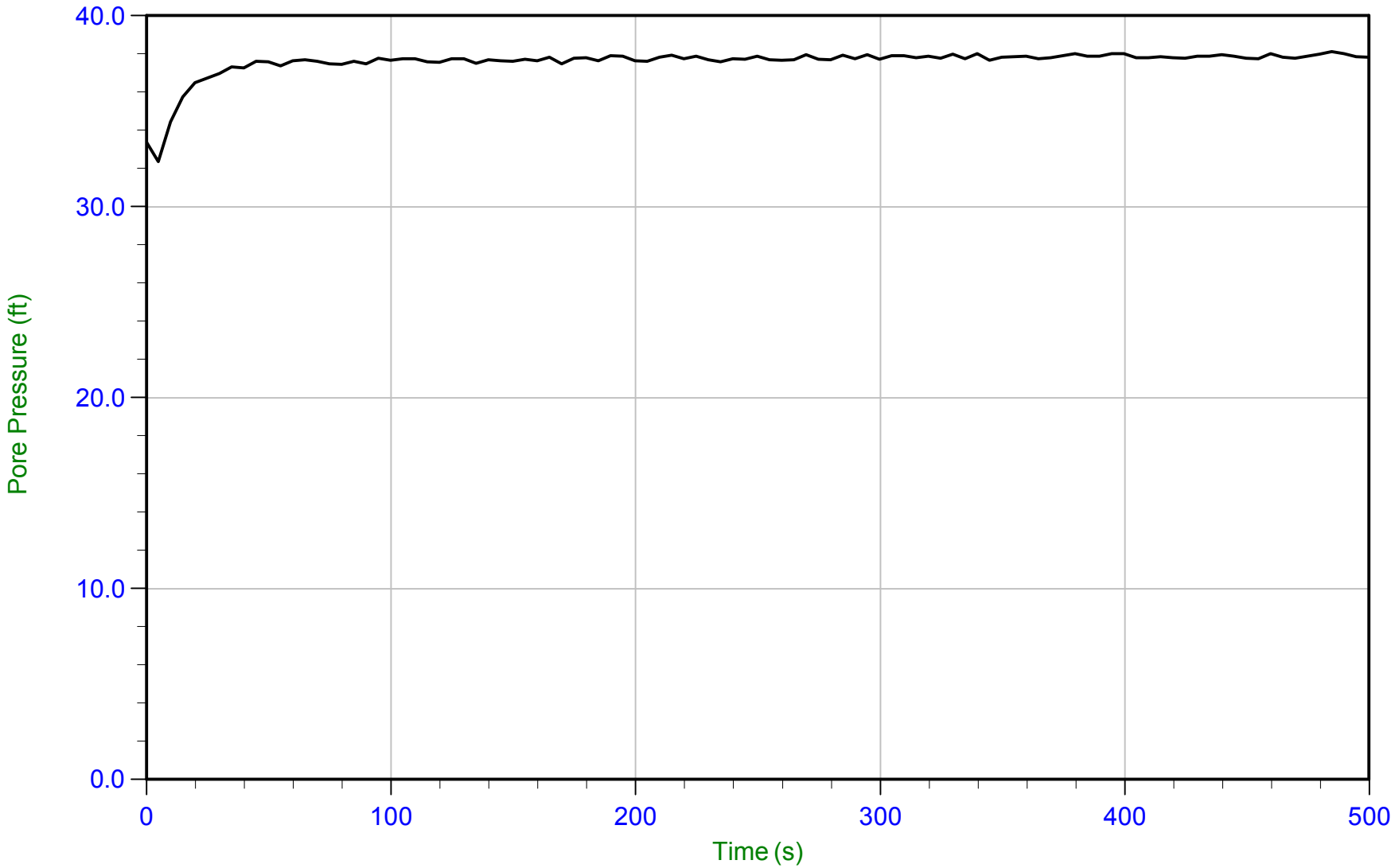
WT: 5.285 m / 17.339 ft
Ueq: 30.6 ft

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 08:58:37
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C002
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP02.PPD
Depth: 16.950 m / 55.610 ft
Duration: 500.0 s

U Min: 32.4 ft
U Max: 38.1 ft

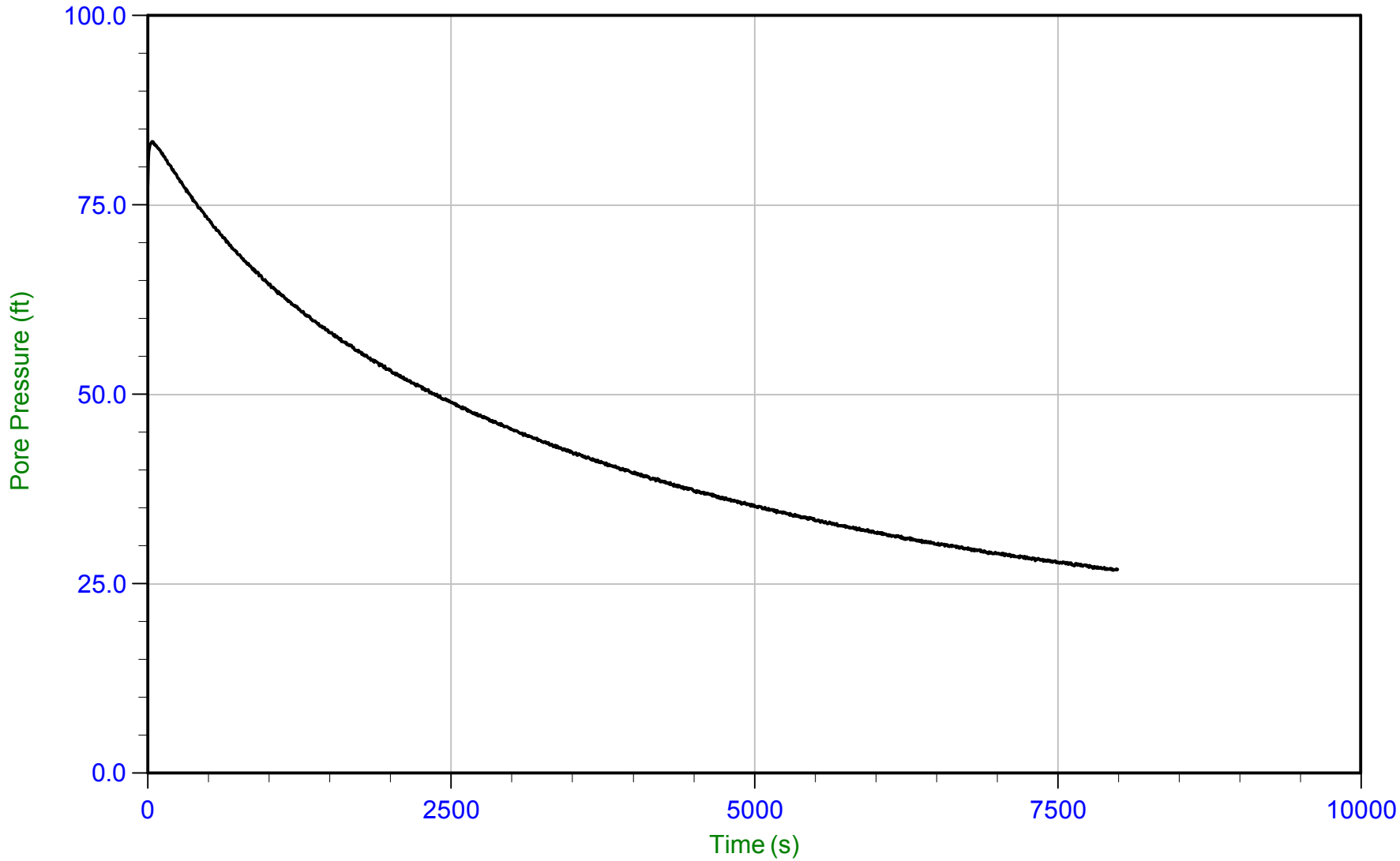
WT: 5.397 m / 17.706 ft
Ueq: 37.9 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 12:09:43
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C004
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP04.PPD
Depth: 9.150 m / 30.019 ft
Duration: 8000.0 s

U Min: 26.8 ft
U Max: 83.4 ft

WT: 5.100 m / 16.732 ft
Ueq: 13.3 ft
U(50): 48.32 ft

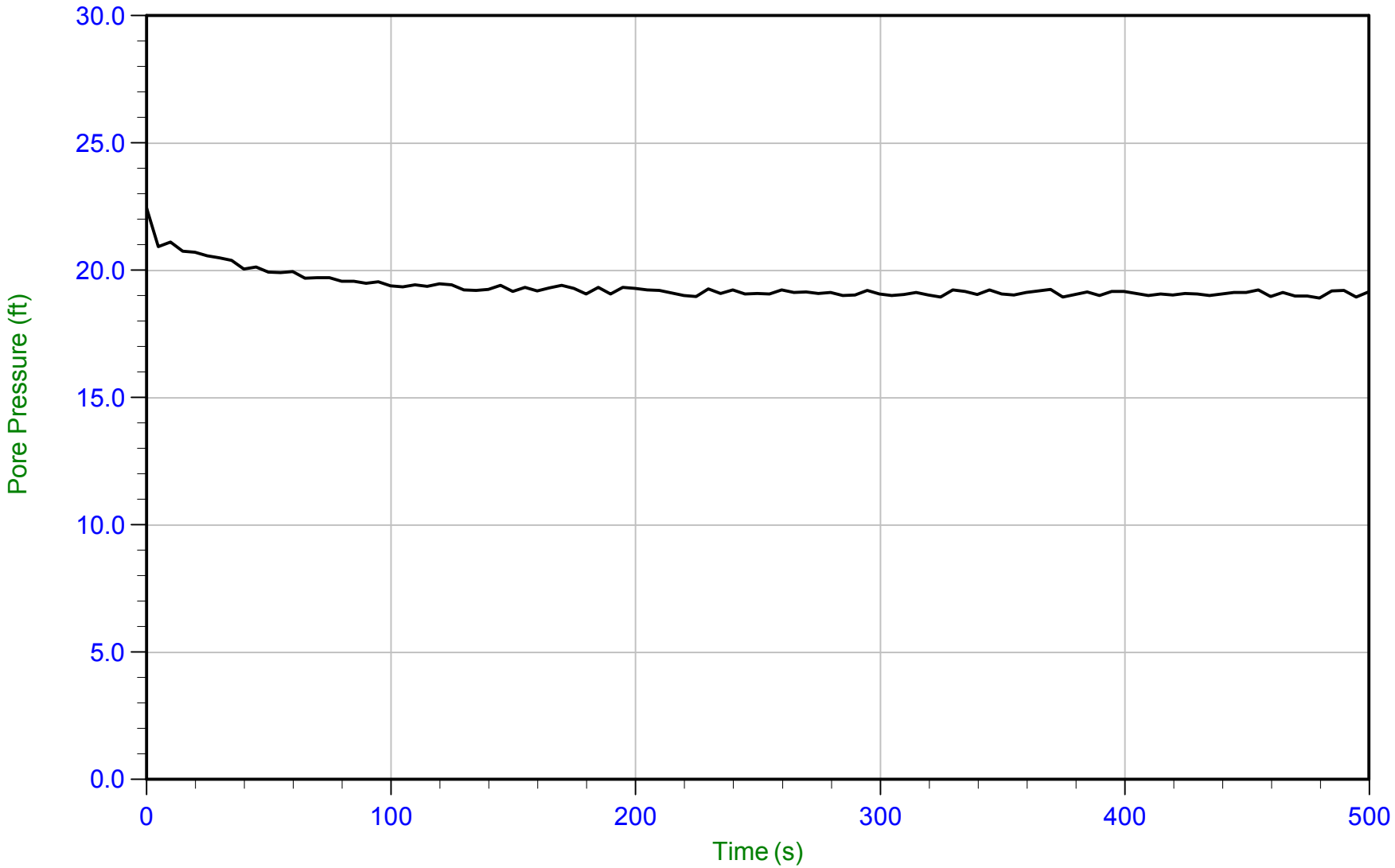
T(50): 2533.4 s
Ir: 100
Ch: 0.3 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 12:09:43
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C004
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP04.PPD
Depth: 10.750 m / 35.269 ft
Duration: 500.0 s

U Min: 18.9 ft
U Max: 22.5 ft

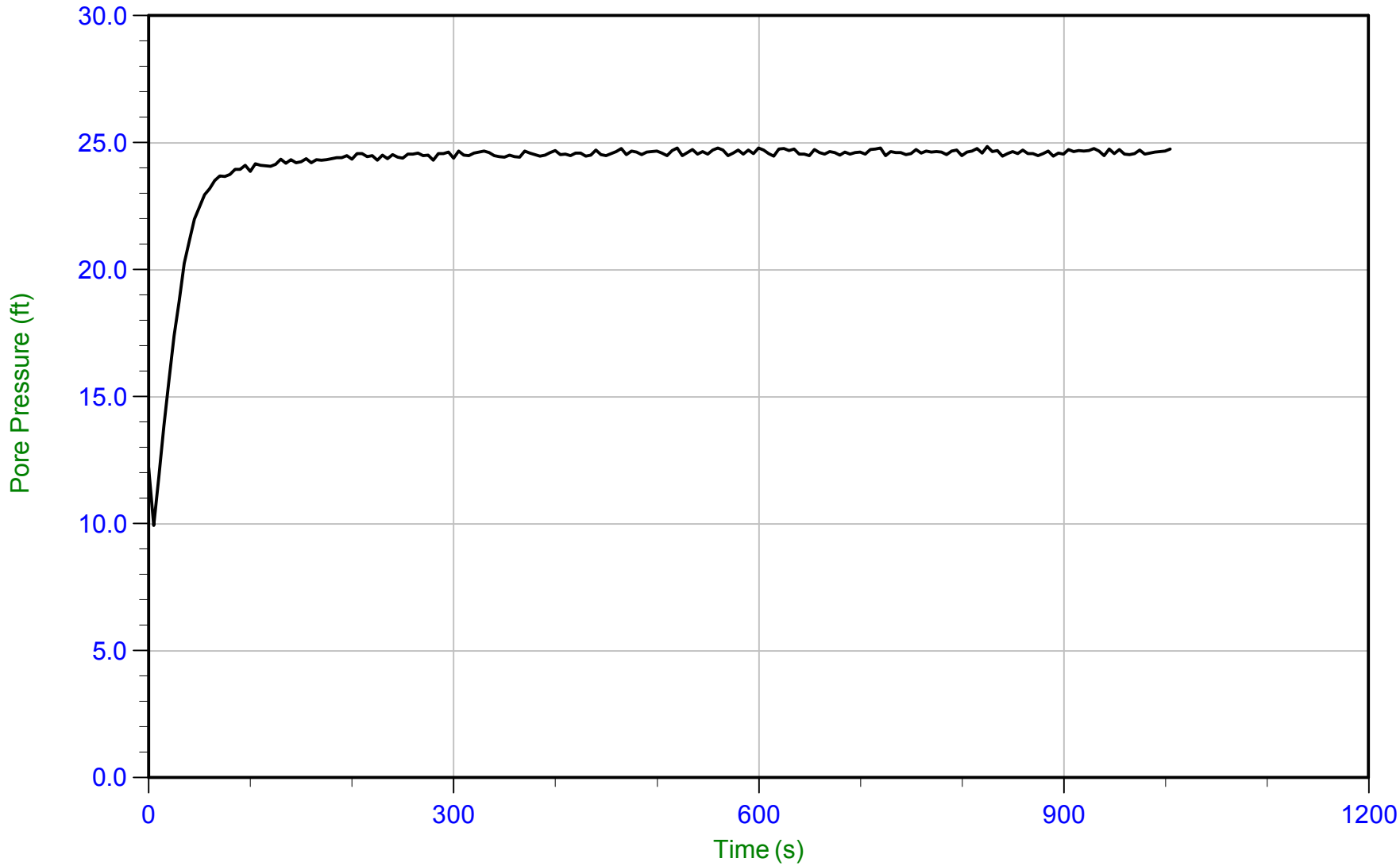
WT: 4.962 m / 16.279 ft
Ueq: 19.0 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 12:09:43
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C004
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP04.PPD
Depth: 12.600 m / 41.338 ft
Duration: 1005.0 s

U Min: 9.9 ft
U Max: 24.9 ft

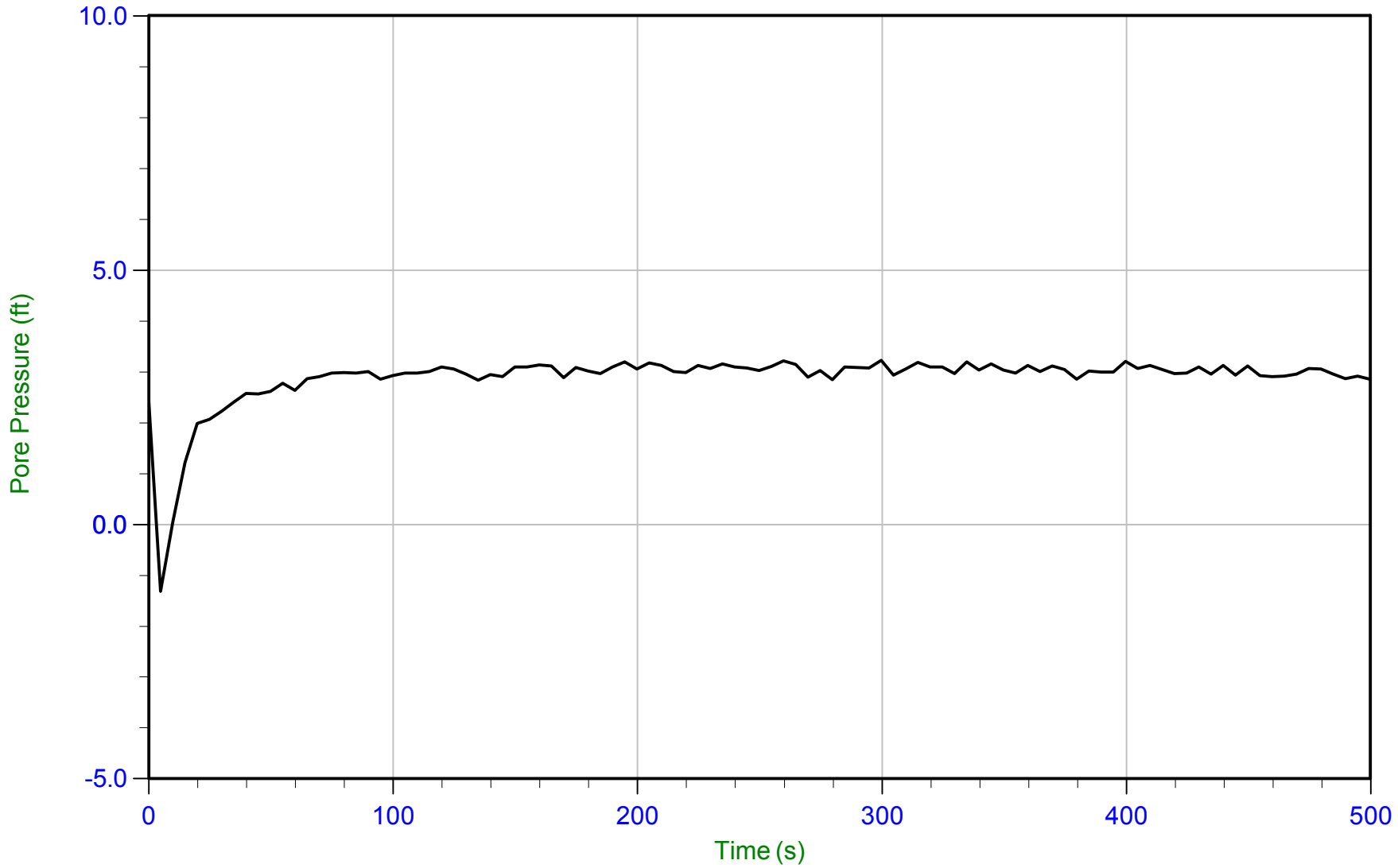
WT: 5.100 m / 16.732 ft
Ueq: 24.6 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 09:08:45
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C005
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP05.PPD
Depth: 6.650 m / 21.817 ft
Duration: 500.0 s

U Min: -1.3 ft
U Max: 3.2 ft

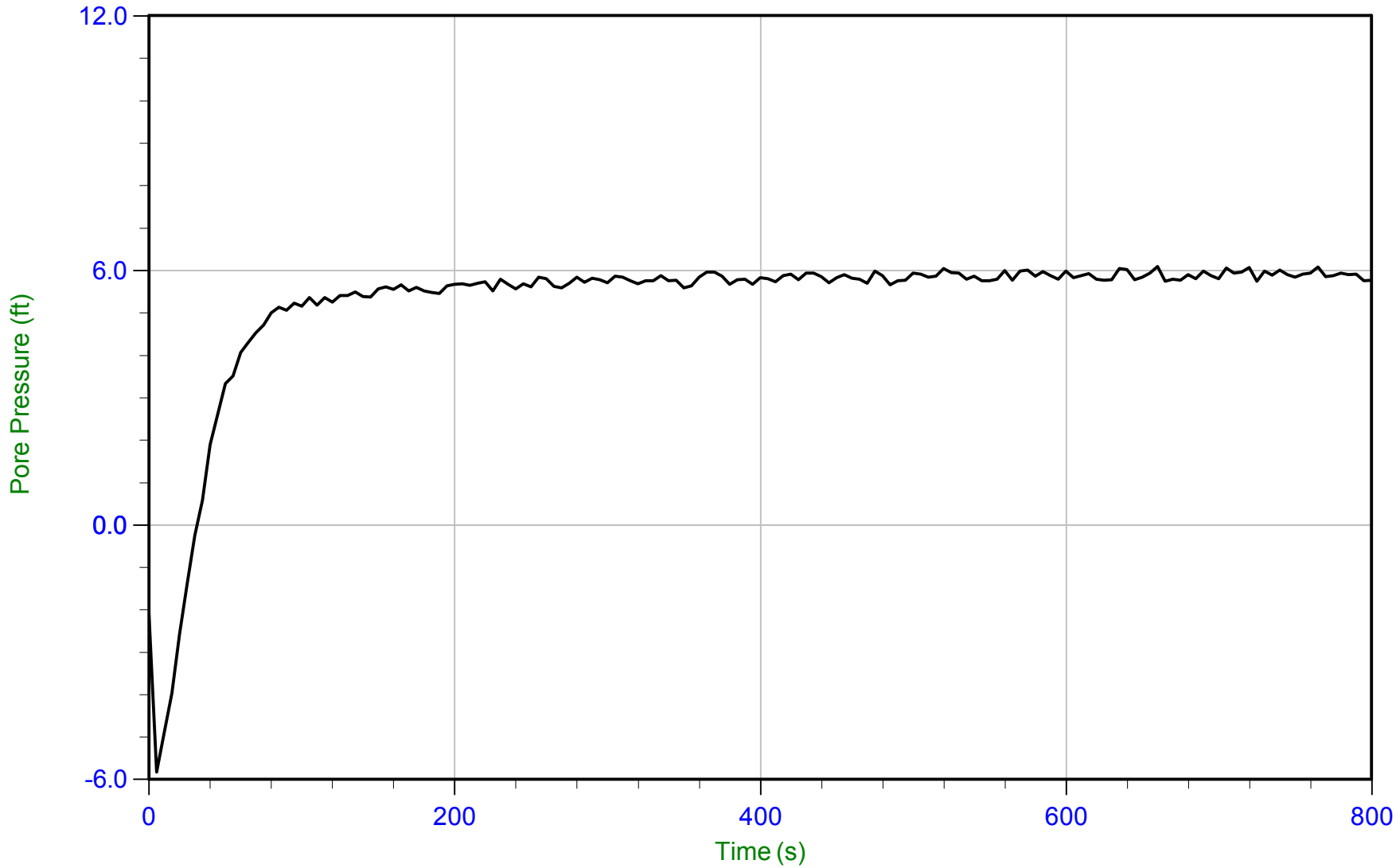
WT: 5.742 m / 18.838 ft
Ueq: 3.0 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 09:08:45
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C005
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP05.PPD
Depth: 7.600 m / 24.934 ft
Duration: 800.0 s

U Min: -5.8 ft
U Max: 6.1 ft

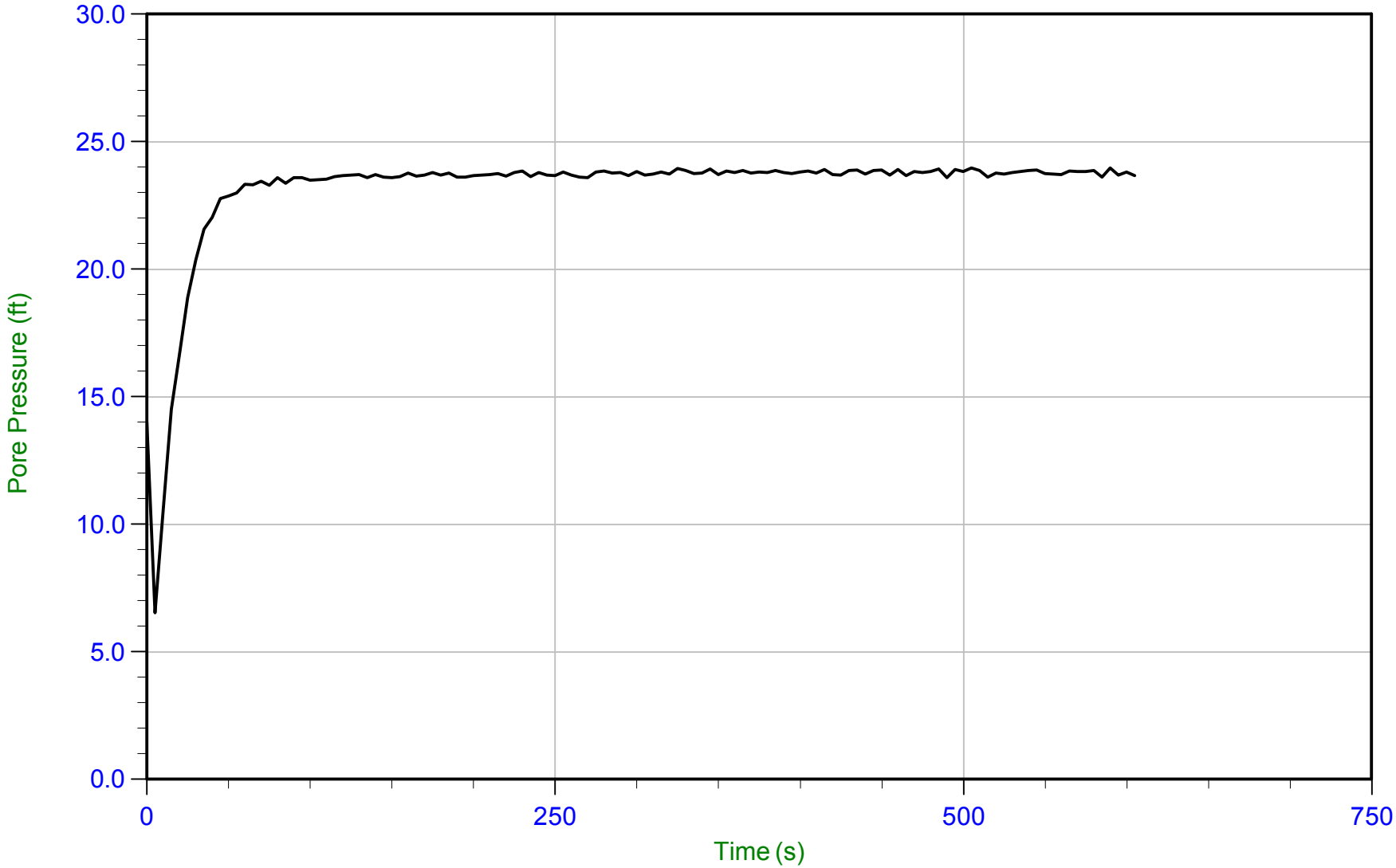
WT: 5.792 m / 19.002 ft
Ueq: 5.9 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 10:10:22
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C005A
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP05A.PPD
Depth: 12.800 m / 41.994 ft
Duration: 605.0 s

U Min: 6.5 ft
U Max: 24.0 ft

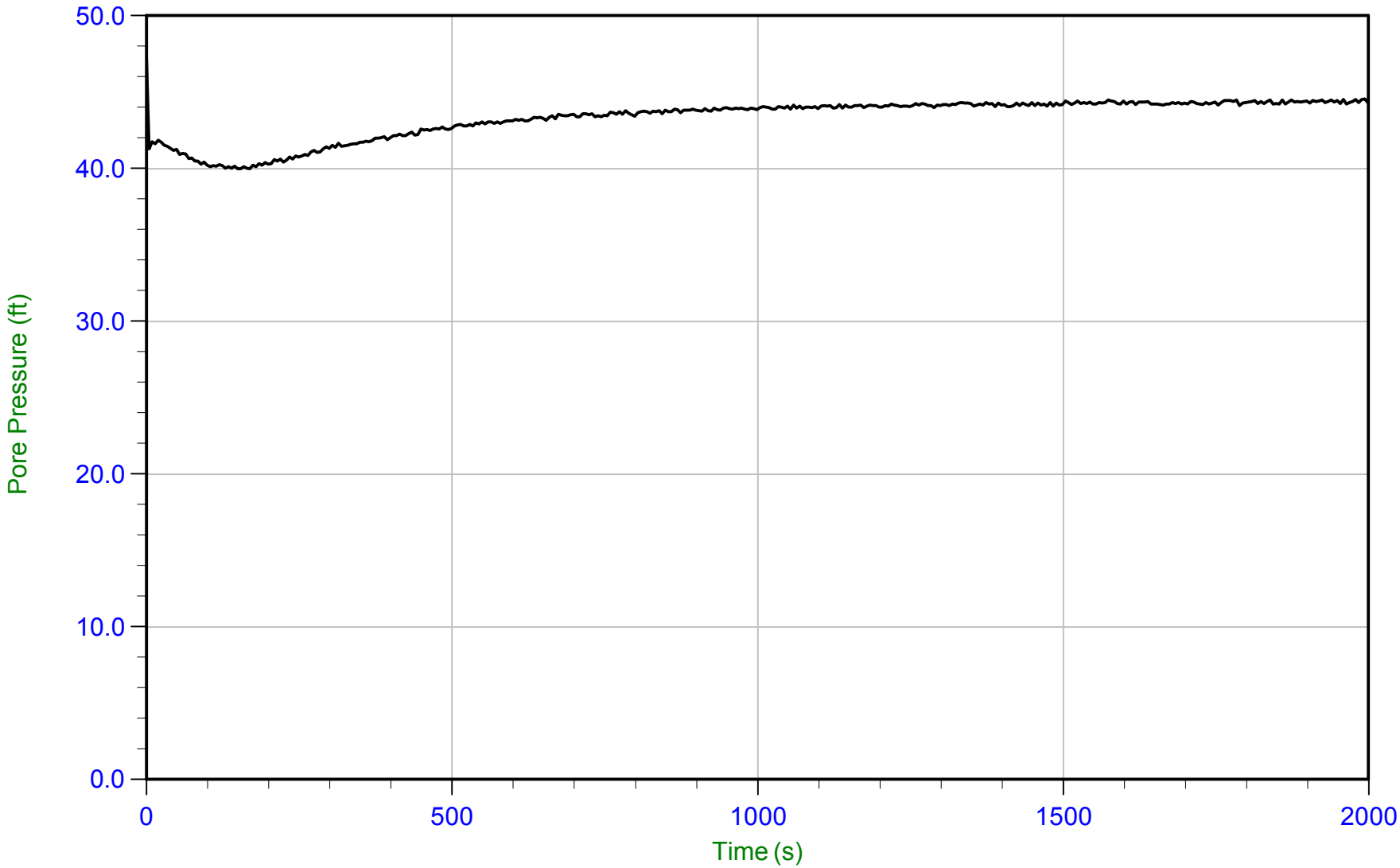
WT: 5.574 m / 18.287 ft
Ueq: 23.7 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 10:10:22
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C005A
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP05A.PPD
Depth: 19.100 m / 62.663 ft
Duration: 2000.0 s

U Min: 40.0 ft
U Max: 47.2 ft

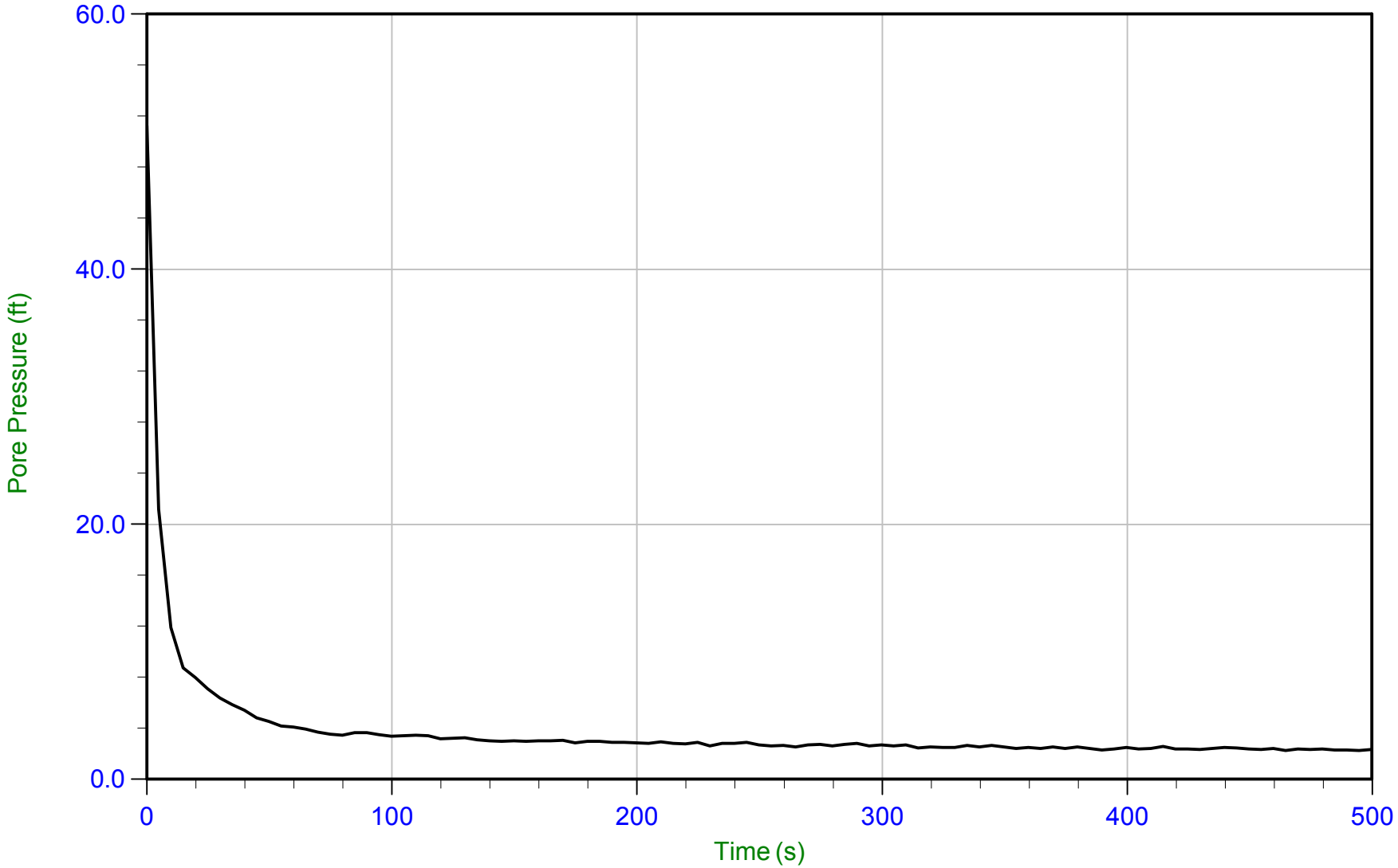
WT: 5.572 m / 18.281 ft
Ueq: 44.4 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 13:48:17
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C006
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP06.PPD
Depth: 2.350 m / 7.710 ft
Duration: 500.0 s

U Min: 2.3 ft
U Max: 51.3 ft

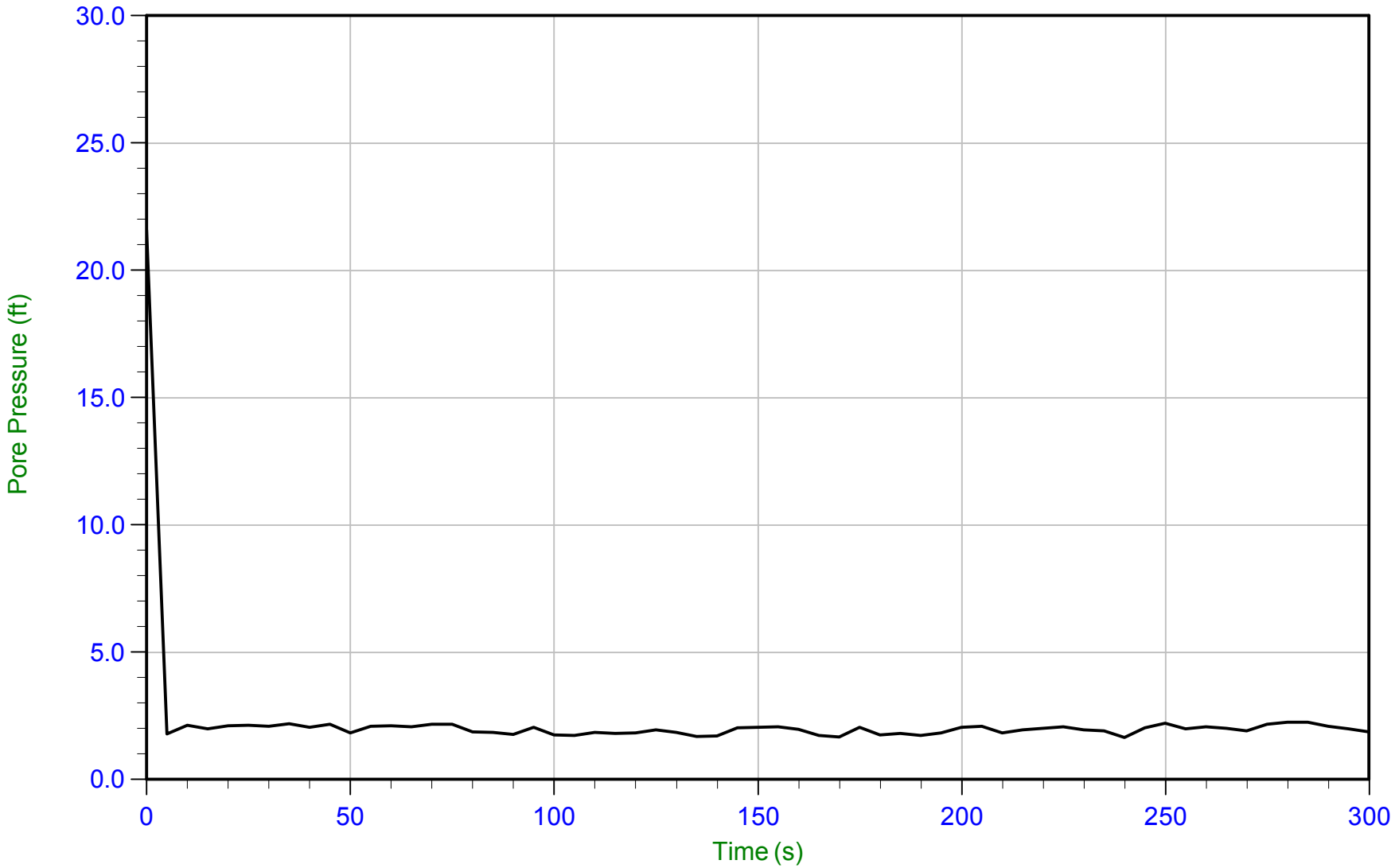
WT: 1.665 m / 5.463 ft
Ueq: 2.2 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 13:48:17
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C006
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP06.PPD
Depth: 5.300 m / 17.388 ft
Duration: 300.0 s

U Min: 1.7 ft
U Max: 21.6 ft

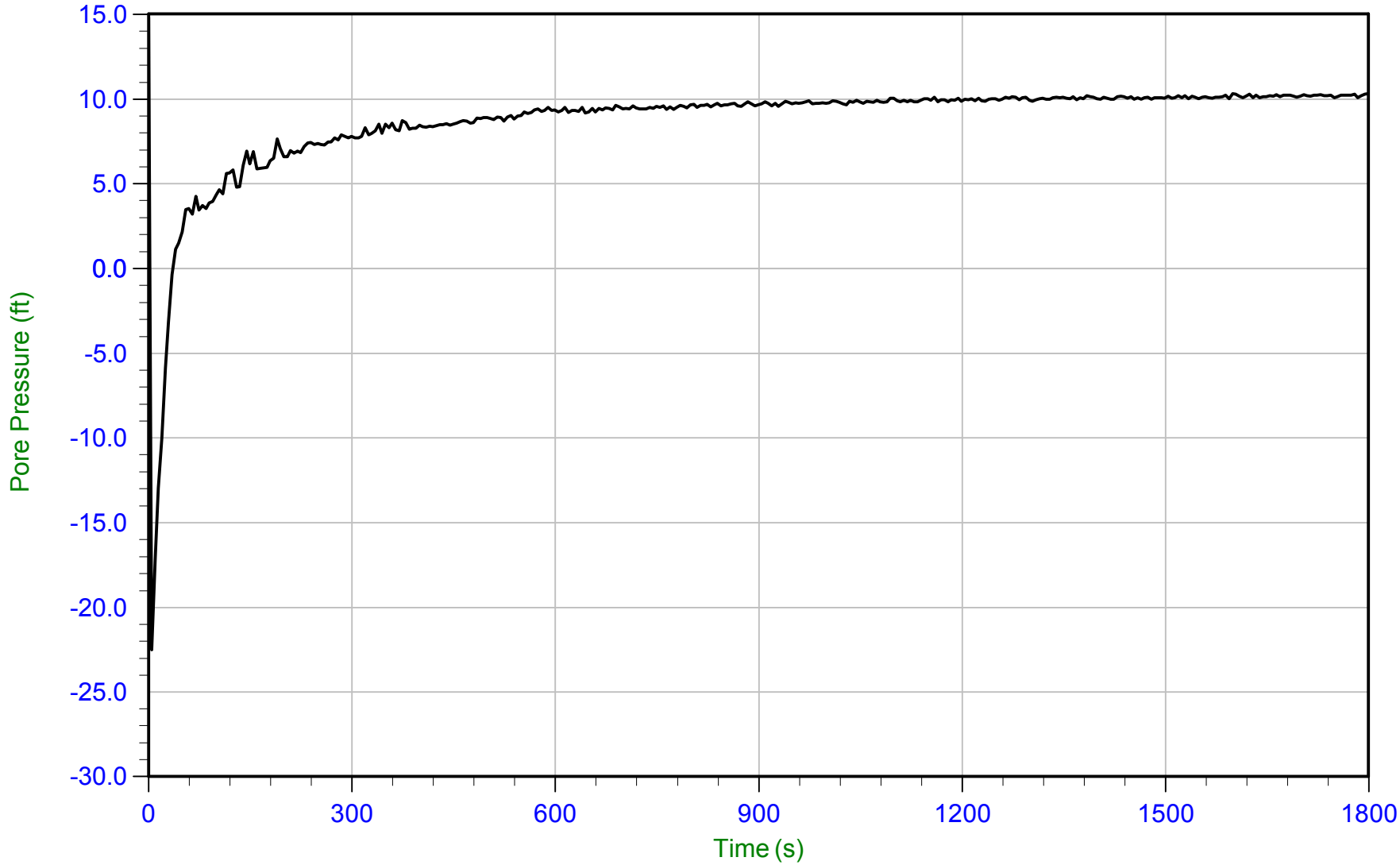
WT: 4.718 m / 15.479 ft
Ueq: 1.9 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 13:48:17
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C006
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP06.PPD
Depth: 8.150 m / 26.739 ft
Duration: 1800.0 s

U Min: -22.5 ft
U Max: 14.8 ft

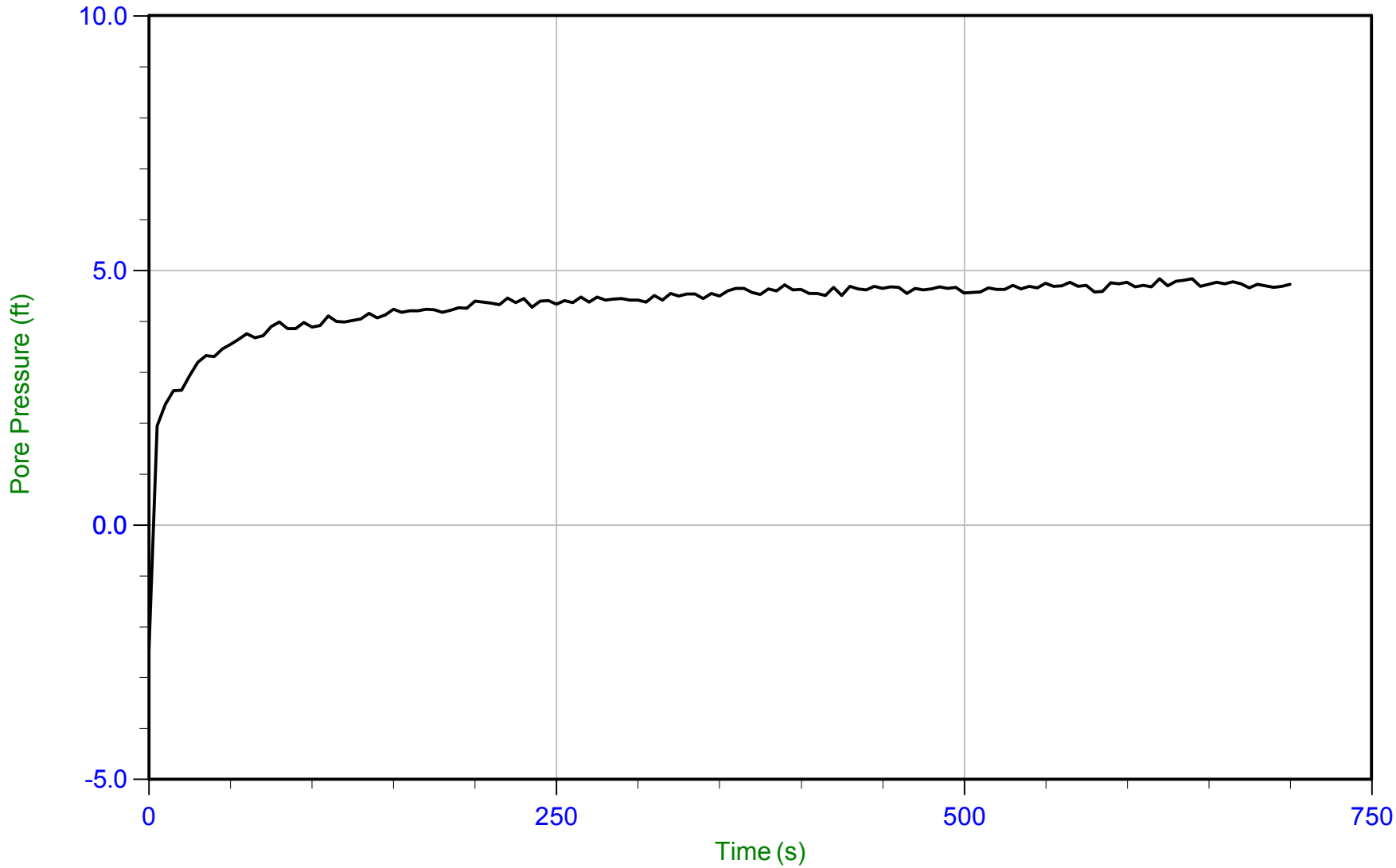
WT: 5.016 m / 16.456 ft
Ueq: 10.3 ft

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 09:54:16
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C007B
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP07B.PPD
Depth: 6.800 m / 22.309 ft
Duration: 700.0 s

U Min: -2.4 ft
U Max: 4.8 ft

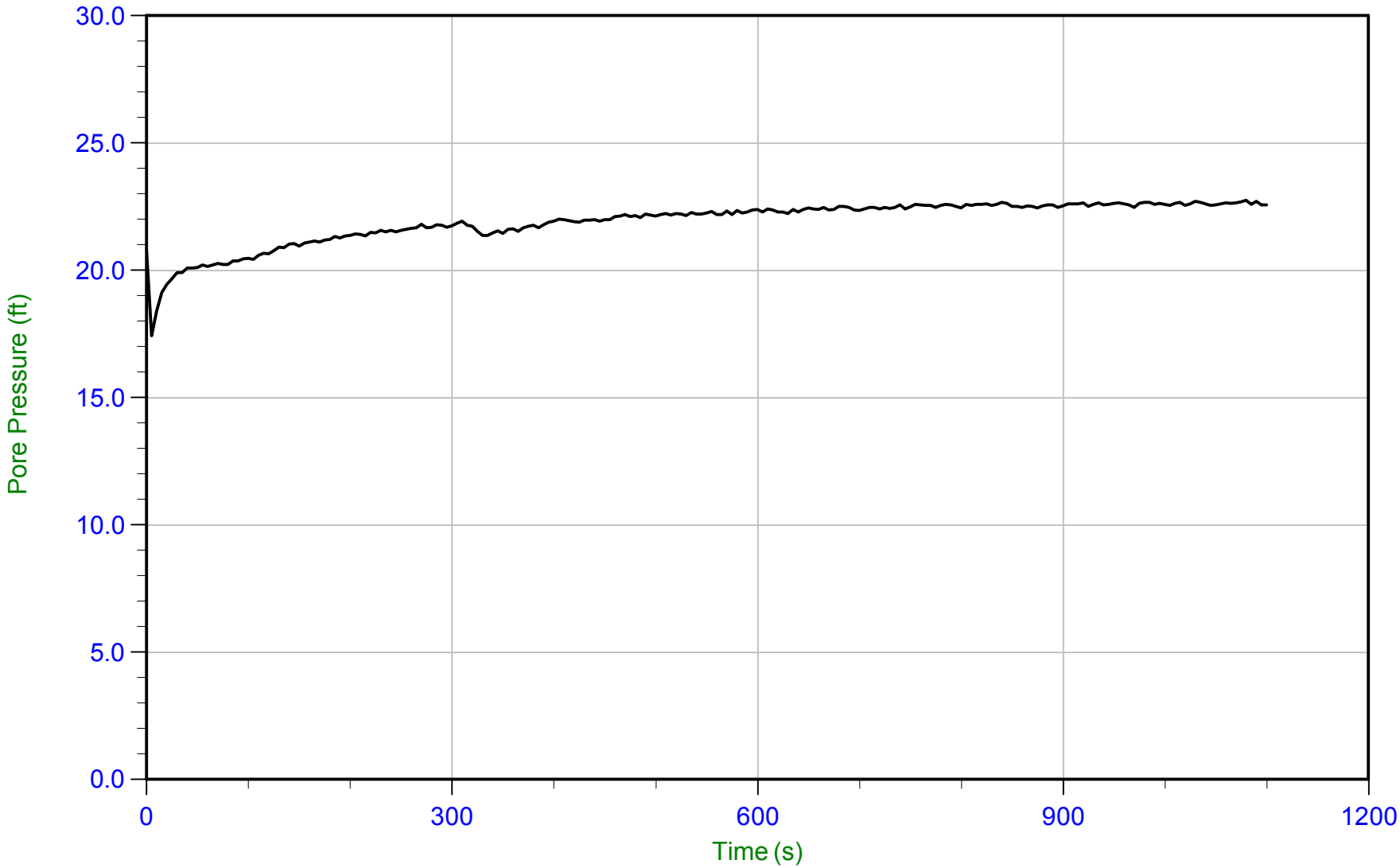
WT: 5.362 m / 17.592 ft
Ueq: 4.7 ft

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 09:54:16
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C007B
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP07B.PPD
Depth: 12.300 m / 40.354 ft
Duration: 1100.0 s

U Min: 17.4 ft
U Max: 22.7 ft

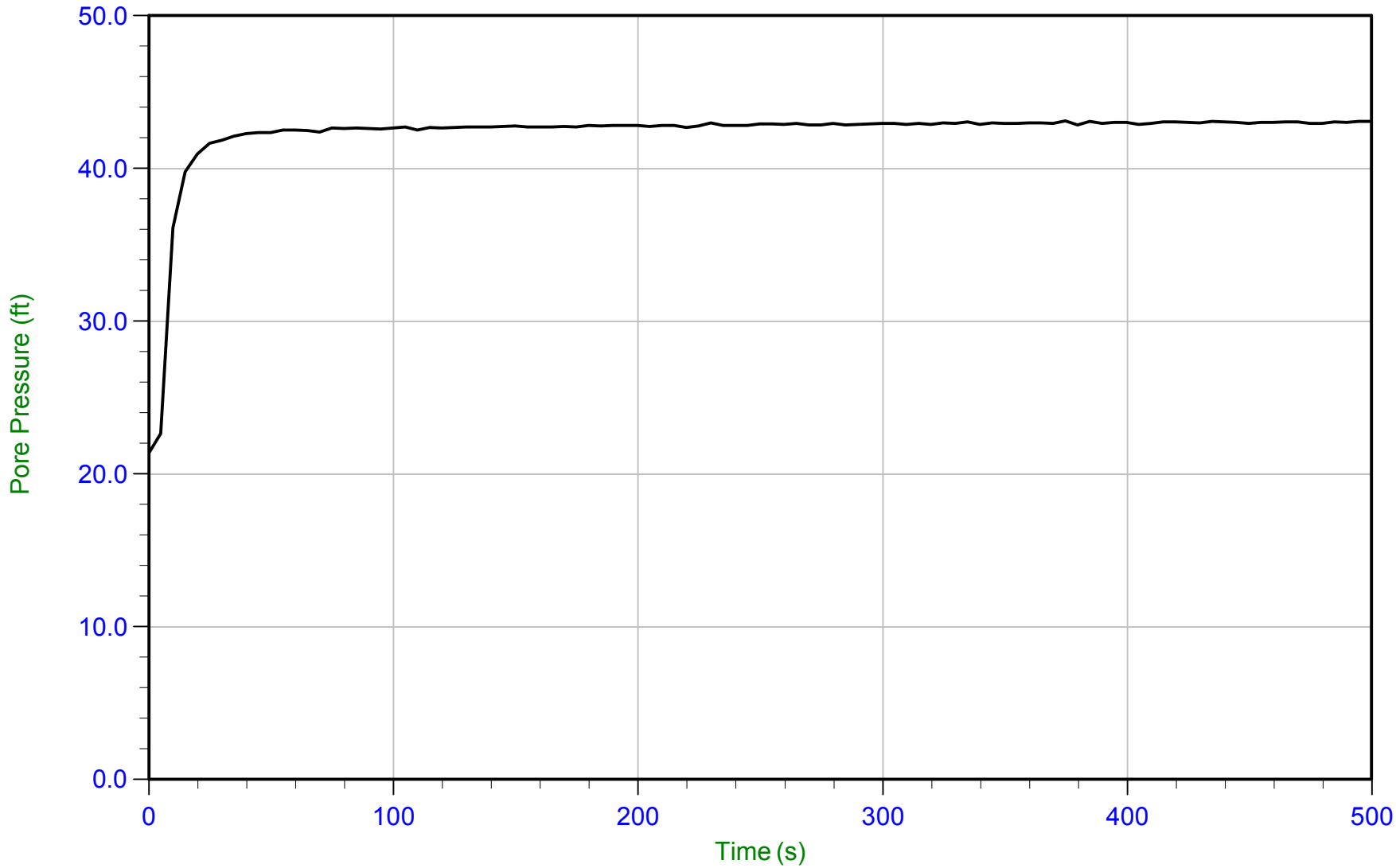
WT: 5.348 m / 17.546 ft
Ueq: 22.8 ft

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 09:54:16
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C007B
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP07B.PPD
Depth: 18.300 m / 60.039 ft
Duration: 500.0 s

U Min: 21.4 ft
U Max: 43.1 ft

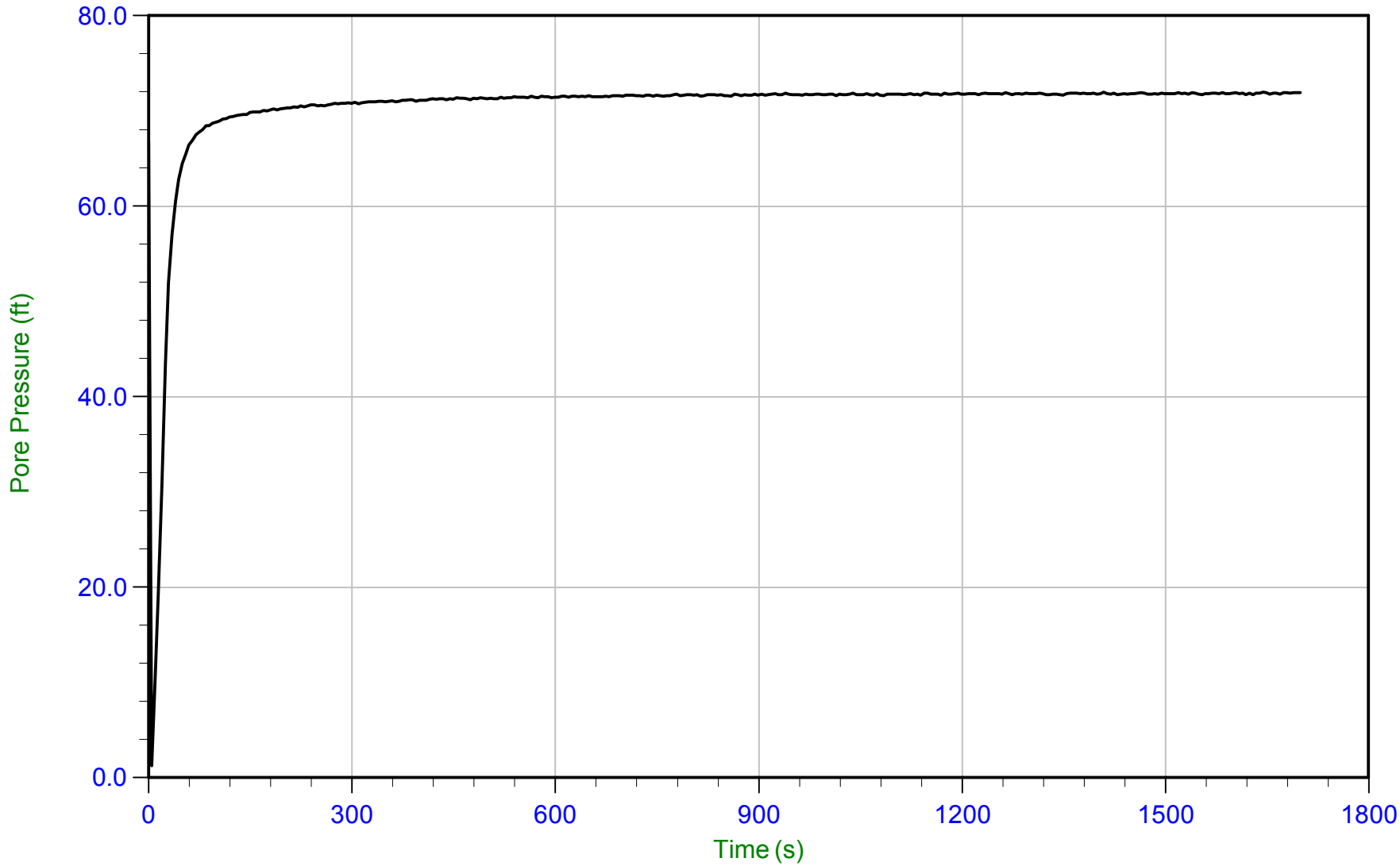
WT: 5.172 m / 16.968 ft
Ueq: 43.1 ft

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 09:54:16
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C007B
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP07B.PPD
Depth: 27.100 m / 88.910 ft
Duration: 1700.0 s

U Min: 1.2 ft
U Max: 72.0 ft

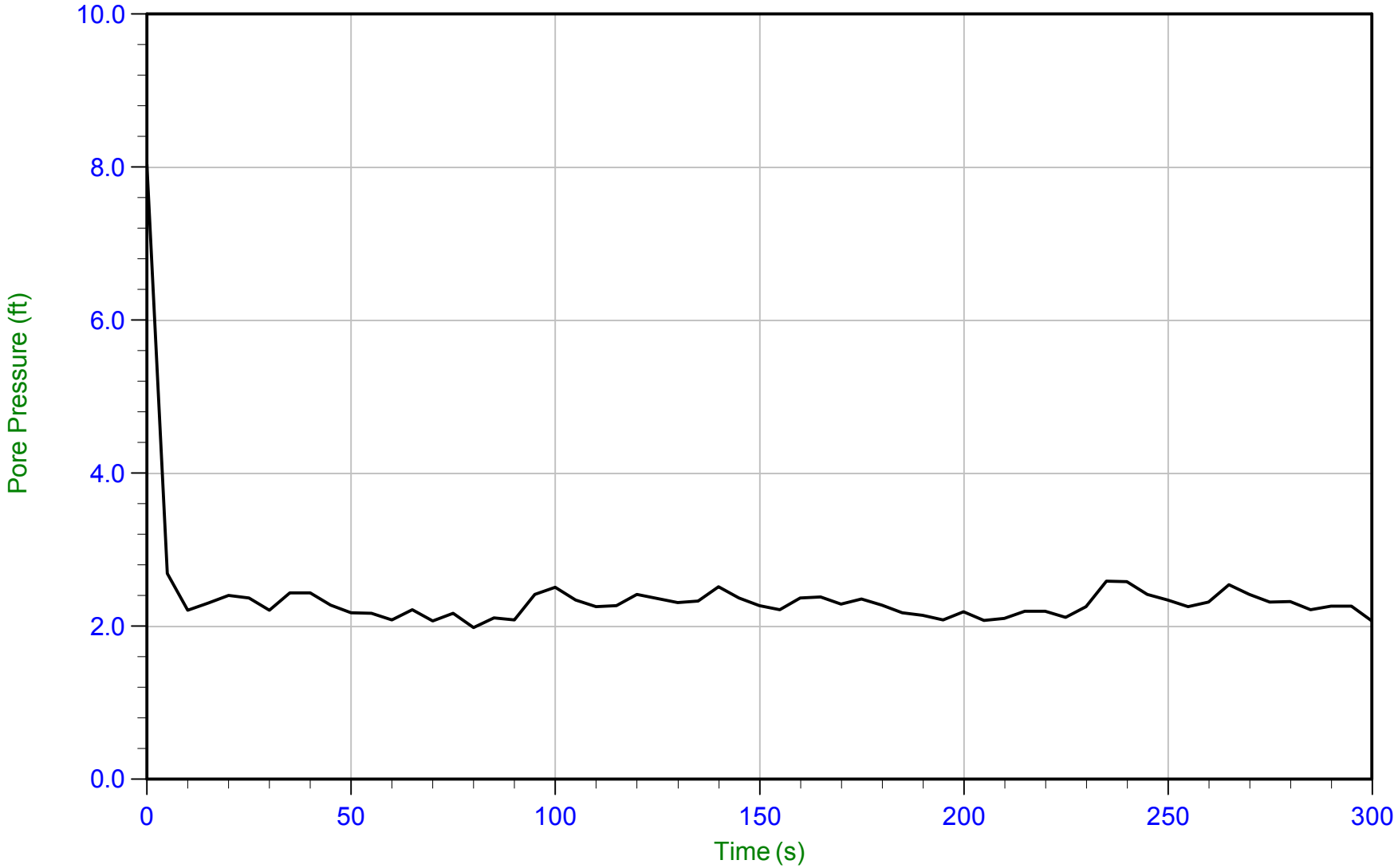
WT: 5.182 m / 17.001 ft
Ueq: 71.9 ft

CONETEC

AECOM

Job No: 15-53081
Date: 11-Sep-2015 09:31:49
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C008
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP08.PPD
Depth: 5.900 m / 19.357 ft
Duration: 300.0 s

U Min: 2.0 ft
U Max: 8.0 ft

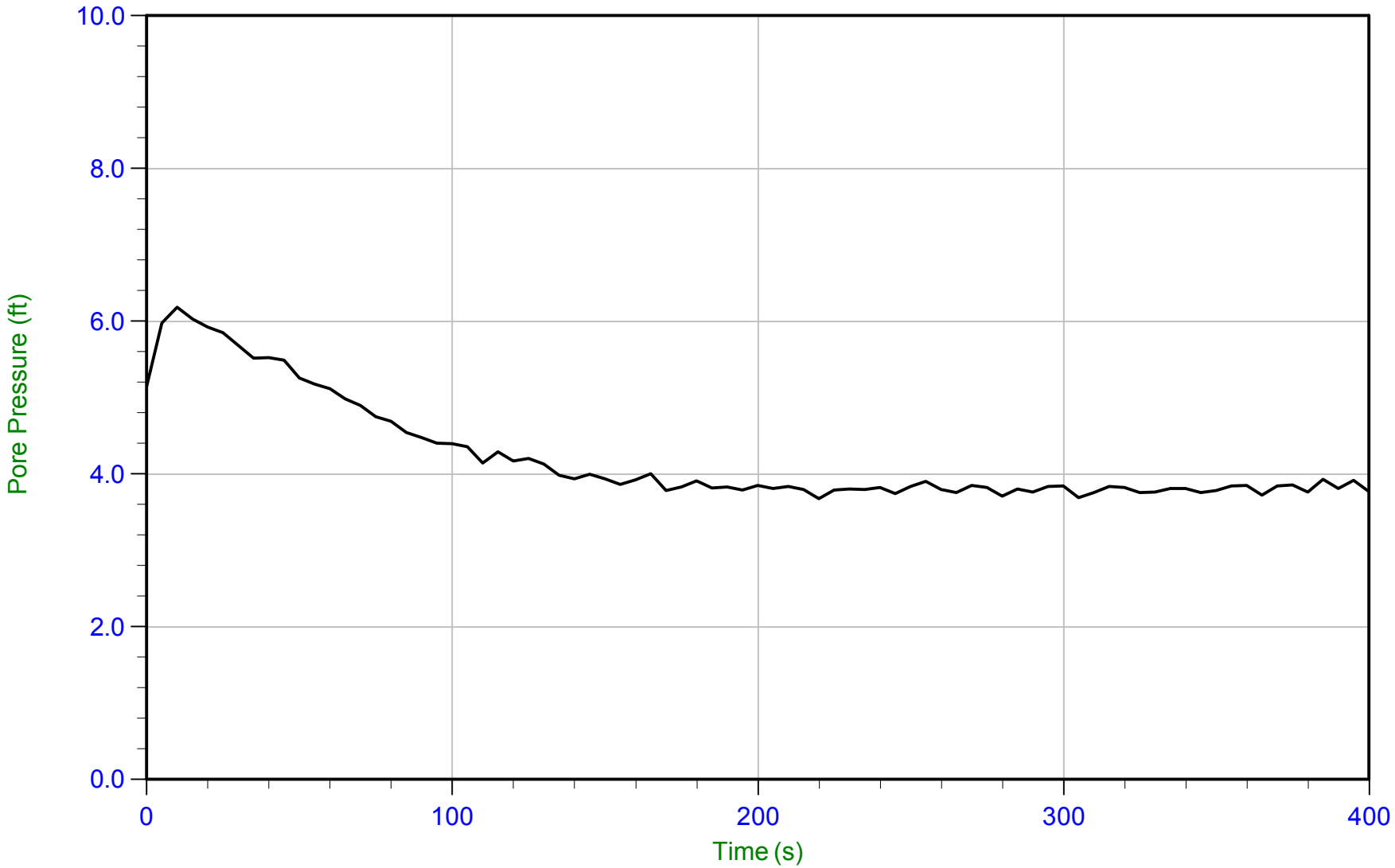
WT: 5.204 m / 17.073 ft
Ueq: 2.3 ft

CONETEC

AECOM

Job No: 15-53081
Date: 11-Sep-2015 10:25:46
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C008B
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP08B.PPD
Depth: 6.500 m / 21.325 ft
Duration: 400.0 s

U Min: 3.7 ft
U Max: 6.2 ft

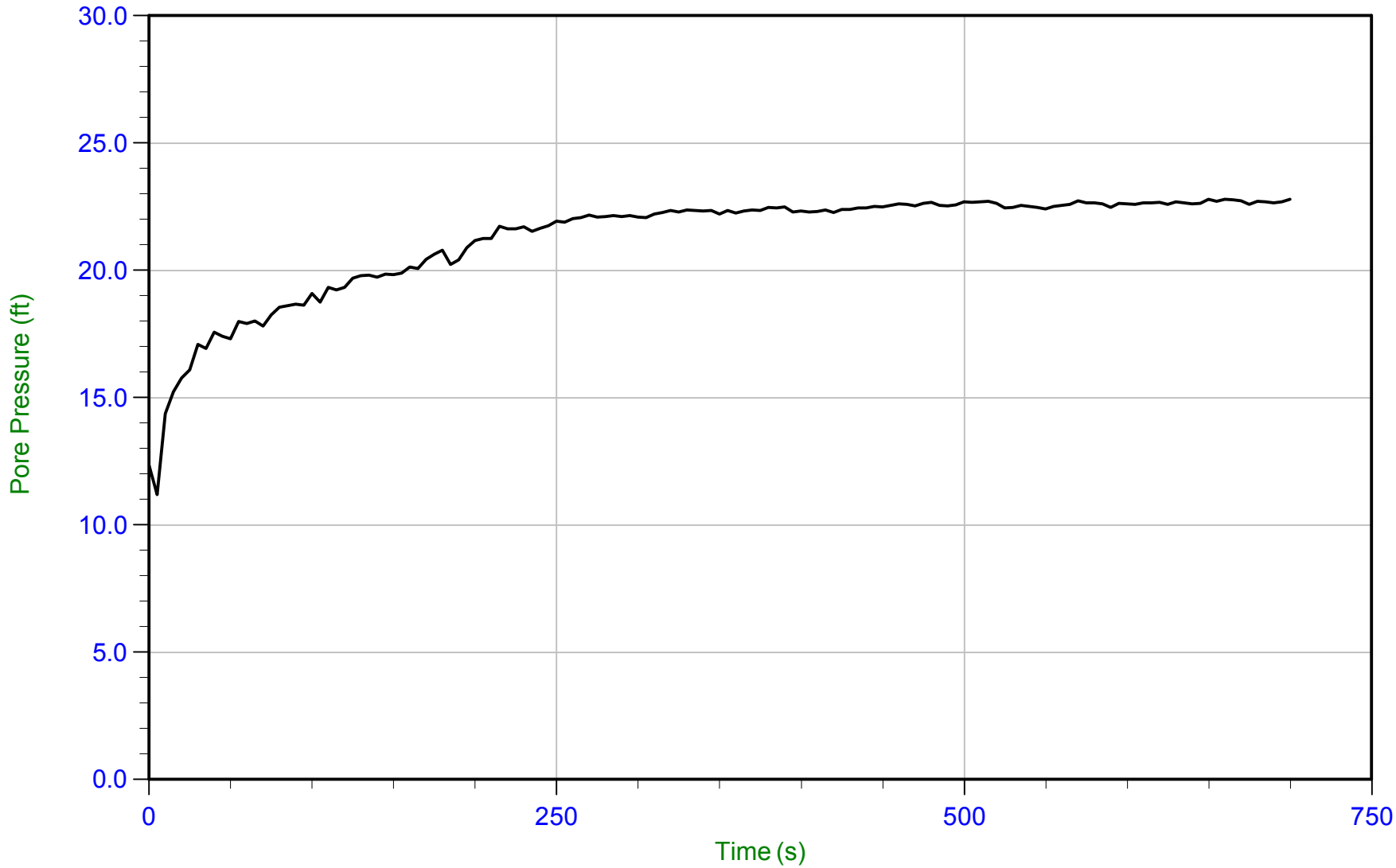
WT: 5.336 m / 17.506 ft
Ueq: 3.8 ft

CONETEC

AECOM

Job No: 15-53081
Date: 11-Sep-2015 10:25:46
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C008B
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP08B.PPD
Depth: 12.350 m / 40.518 ft
Duration: 700.0 s

U Min: 11.2 ft
U Max: 22.8 ft

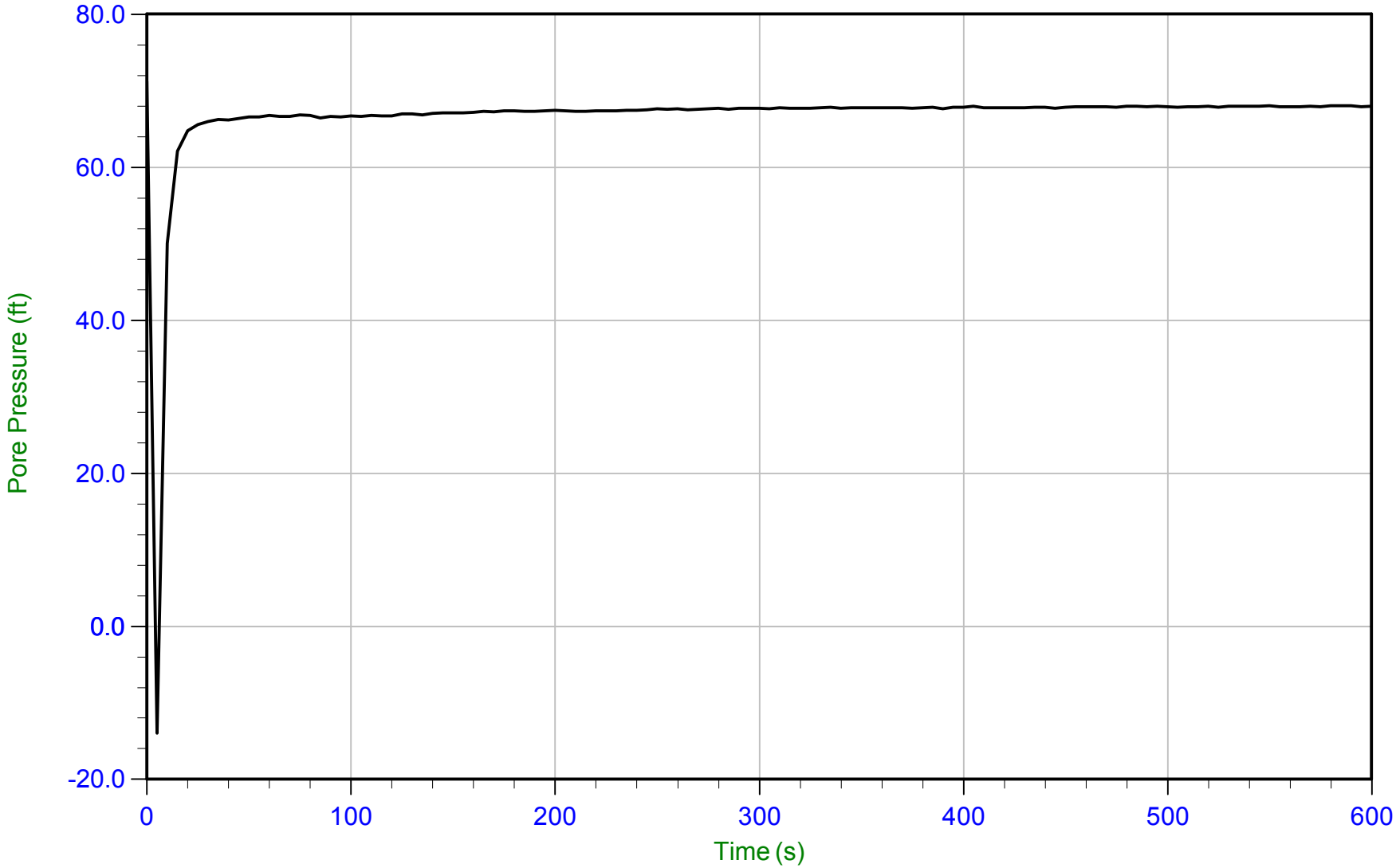
WT: 5.398 m / 17.710 ft
Ueq: 22.8 ft

CONETEC

AECOM

Job No: 15-53081
Date: 11-Sep-2015 10:25:46
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C008B
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP08B.PPD
Depth: 26.150 m / 85.793 ft
Duration: 600.0 s

U Min: -14.0 ft
U Max: 71.2 ft

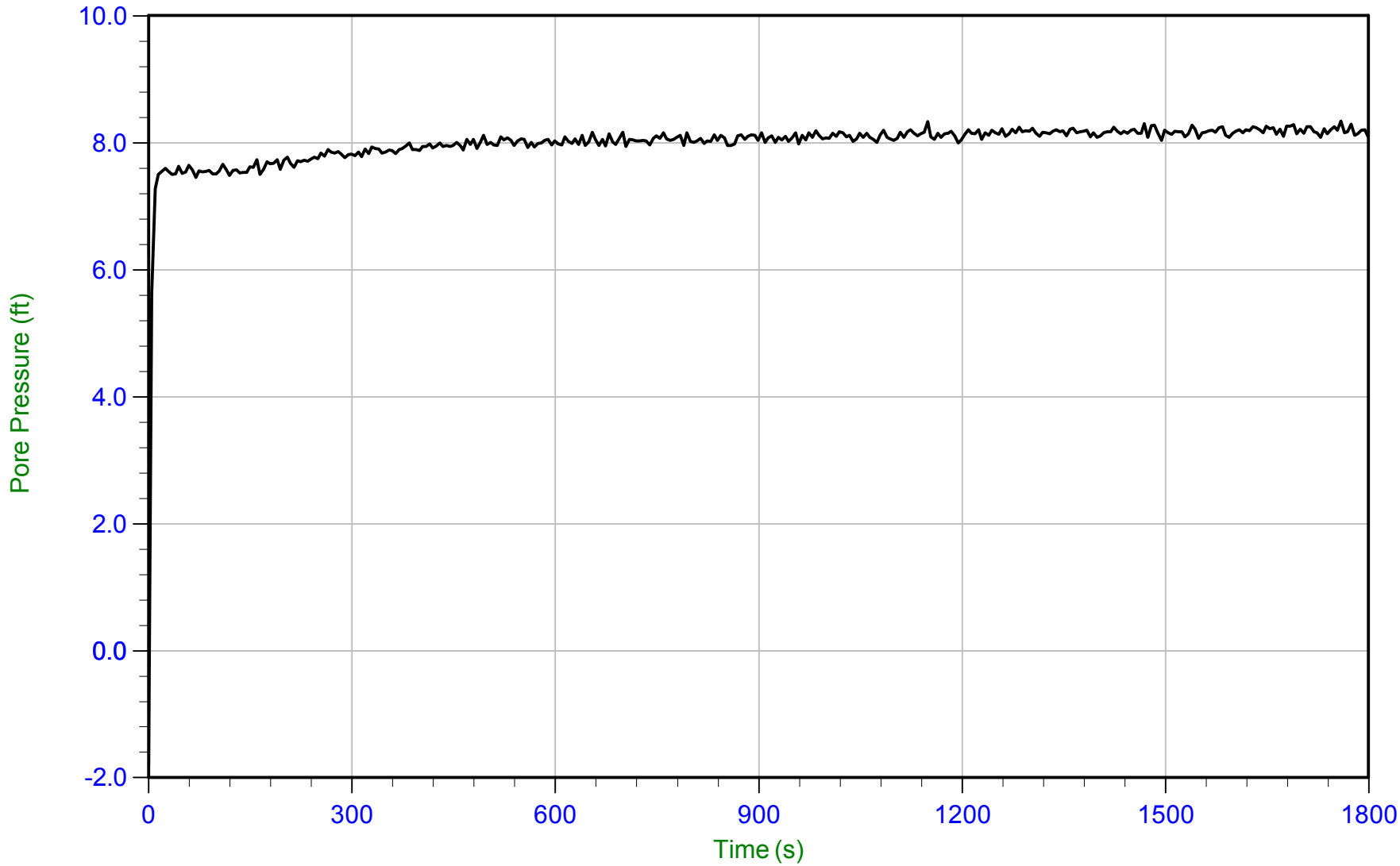
WT: 5.419 m / 17.779 ft
Ueq: 68.0 ft

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 14:28:48
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C009
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP09.PPD
Depth: 4.600 m / 15.092 ft
Duration: 1800.0 s

U Min: -1.8 ft
U Max: 8.3 ft

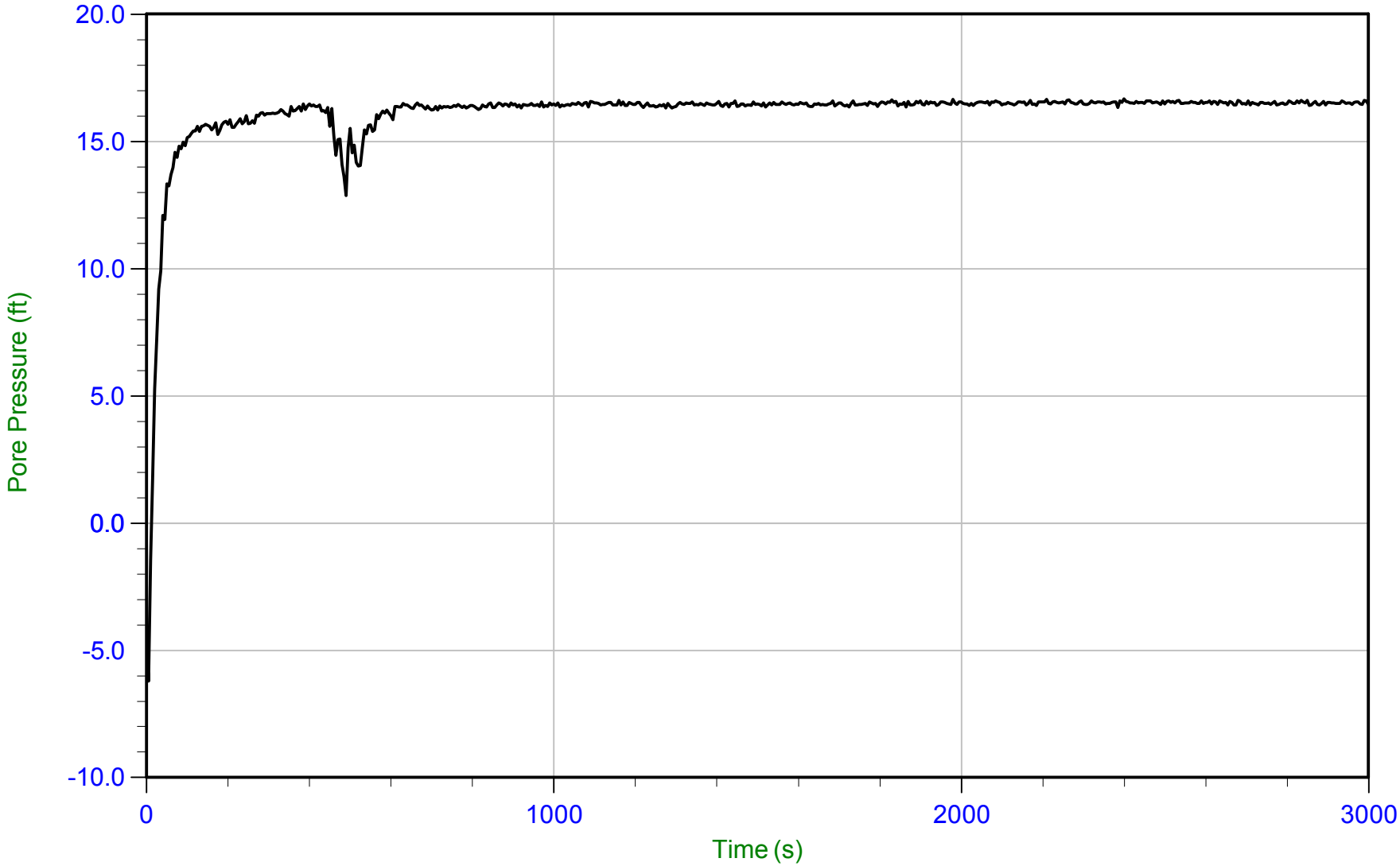
WT: 2.100 m / 6.890 ft
Ueq: 8.2 ft

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 14:28:48
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C009
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP09.PPD
Depth: 7.150 m / 23.458 ft
Duration: 3000.0 s

U Min: -6.2 ft
U Max: 16.7 ft

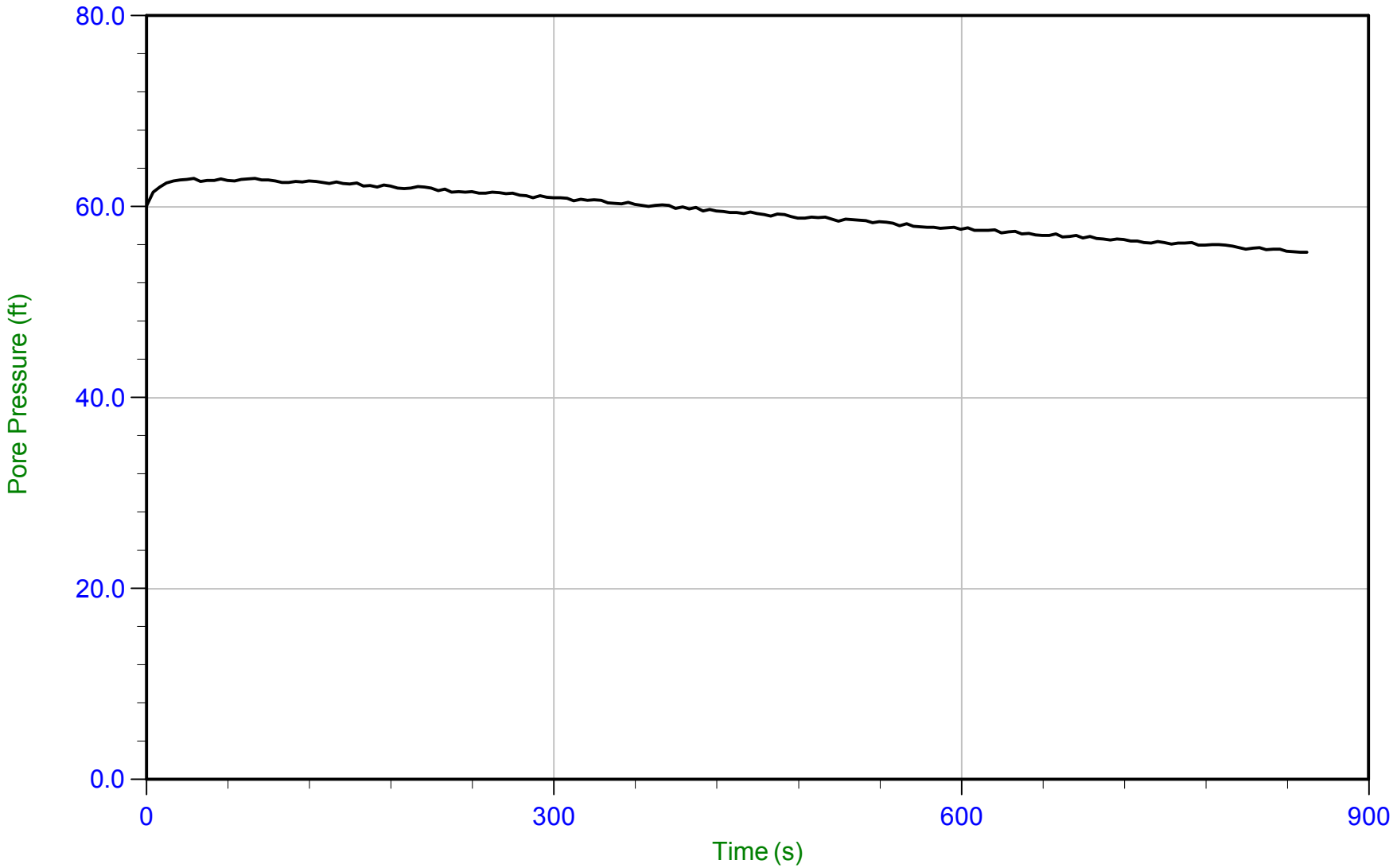
WT: 2.081 m / 6.827 ft
Ueq: 16.6 ft

CONETEC

AECOM

Job No: 15-53081
Date: 11-Sep-2015 09:08:18
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C010
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP10.PPD
Depth: 10.700 m / 35.105 ft
Duration: 855.0 s

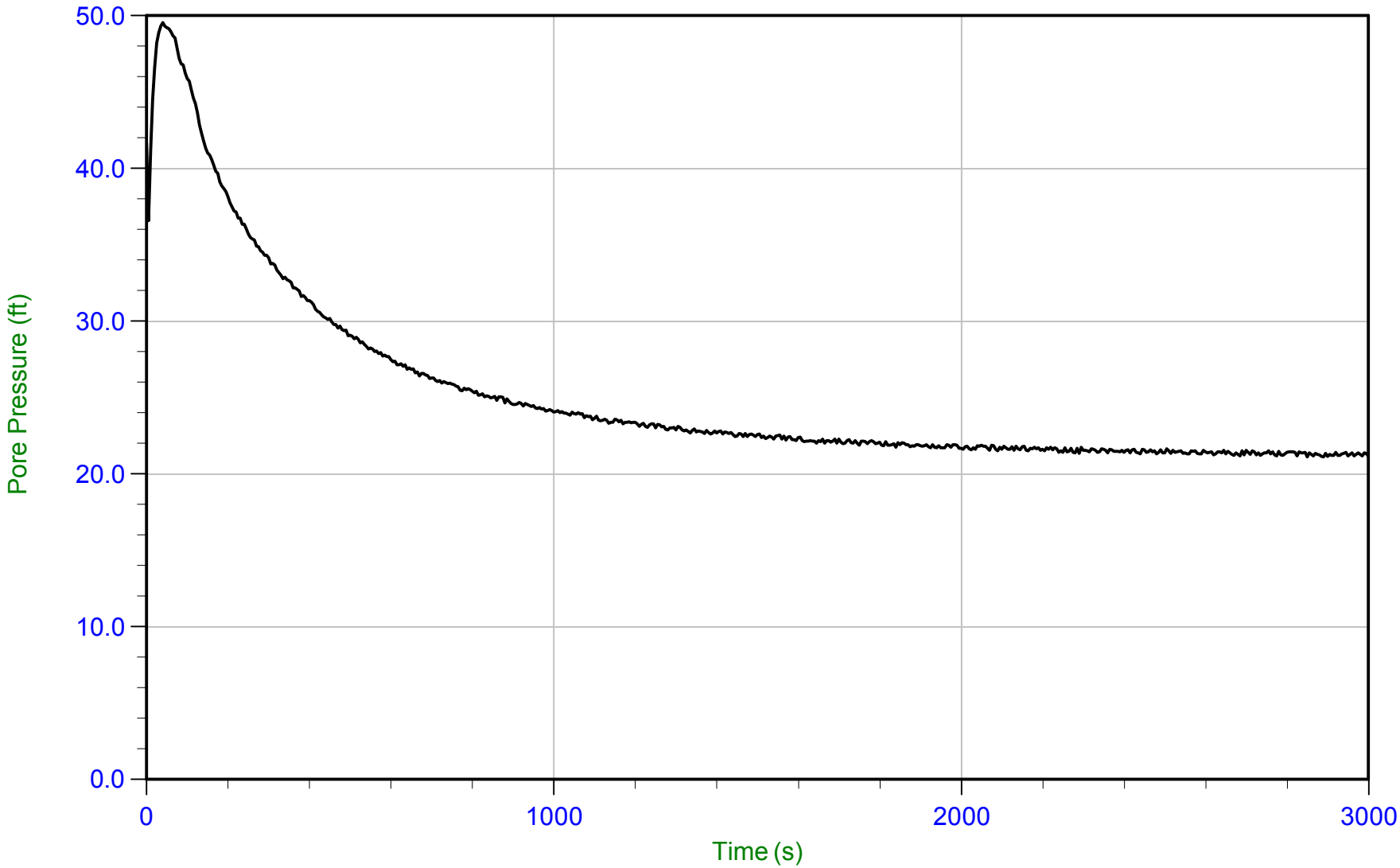
U Min: 55.2 ft
U Max: 62.9 ft

CONETEC

AECOM

Job No: 15-53081
Date: 11-Sep-2015 09:08:18
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C010
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP10.PPD
Depth: 11.650 m / 38.221 ft
Duration: 3000.0 s

U Min: 21.1 ft
U Max: 49.5 ft

WT: 5.365 m / 17.601 ft
Ueq: 20.6 ft
U(50): 35.08 ft

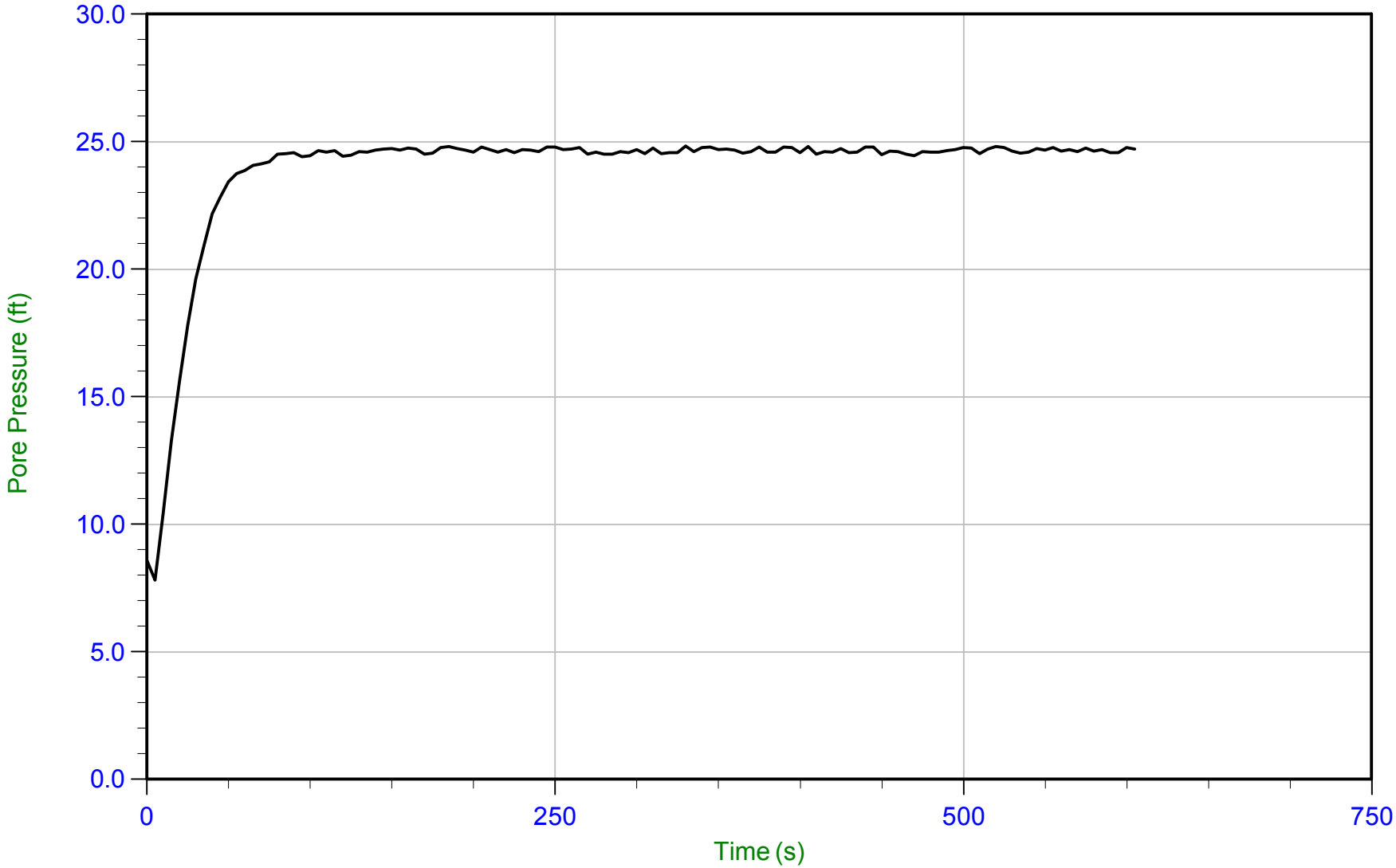
T(50): 228.1 s
Ir: 100
Ch: 3.1 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 11-Sep-2015 09:08:18
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C010
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP10.PPD
Depth: 12.850 m / 42.158 ft
Duration: 605.0 s

U Min: 7.8 ft
U Max: 24.8 ft

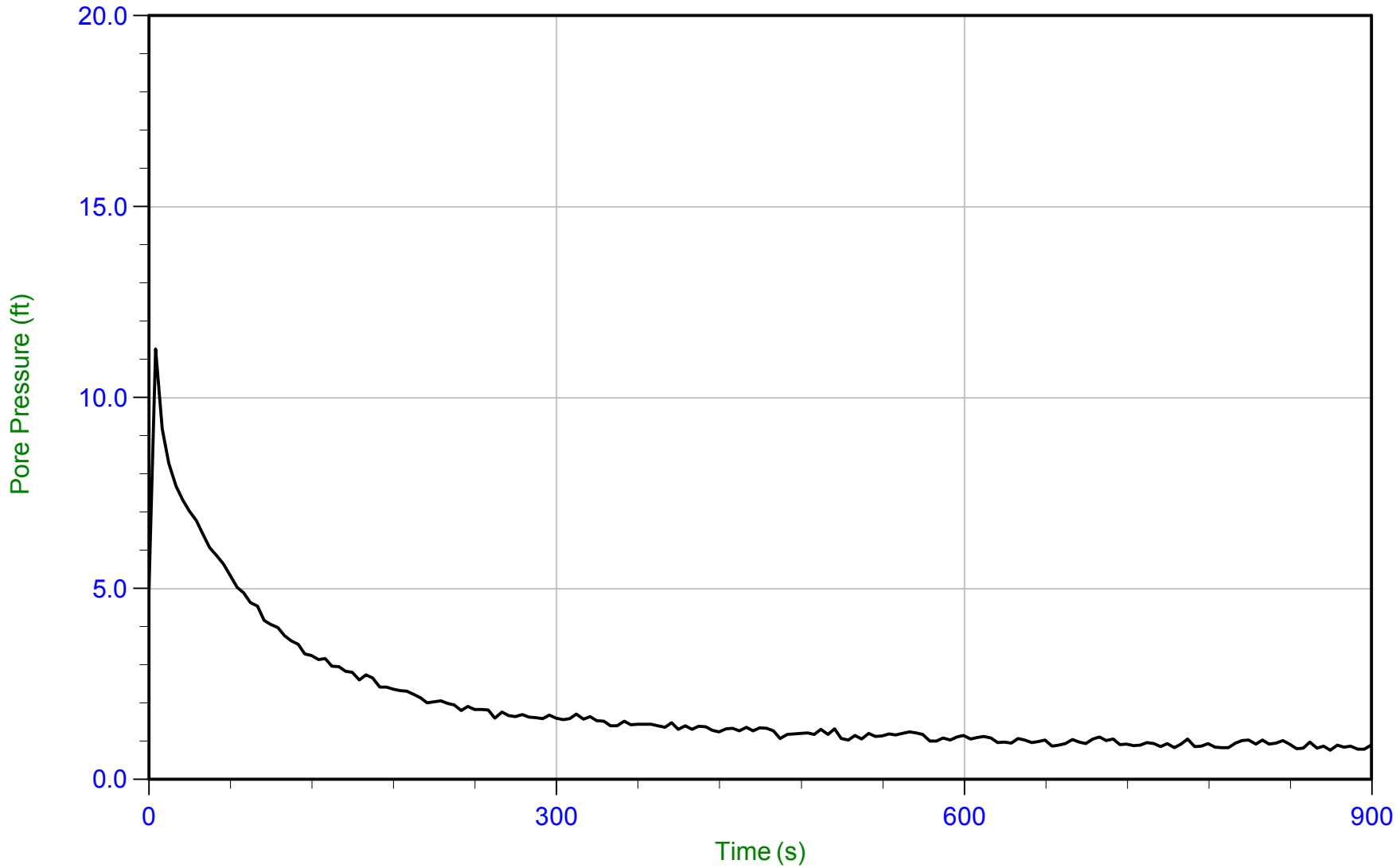
WT: 5.365 m / 17.601 ft
Ueq: 24.6 ft

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 09:34:24
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C012
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP12.PPD
Depth: 3.400 m / 11.155 ft
Duration: 900.0 s

U Min: 0.8 ft
U Max: 11.3 ft

WT: 3.172 m / 10.407 ft
Ueq: 0.7 ft
U(50): 6.01 ft

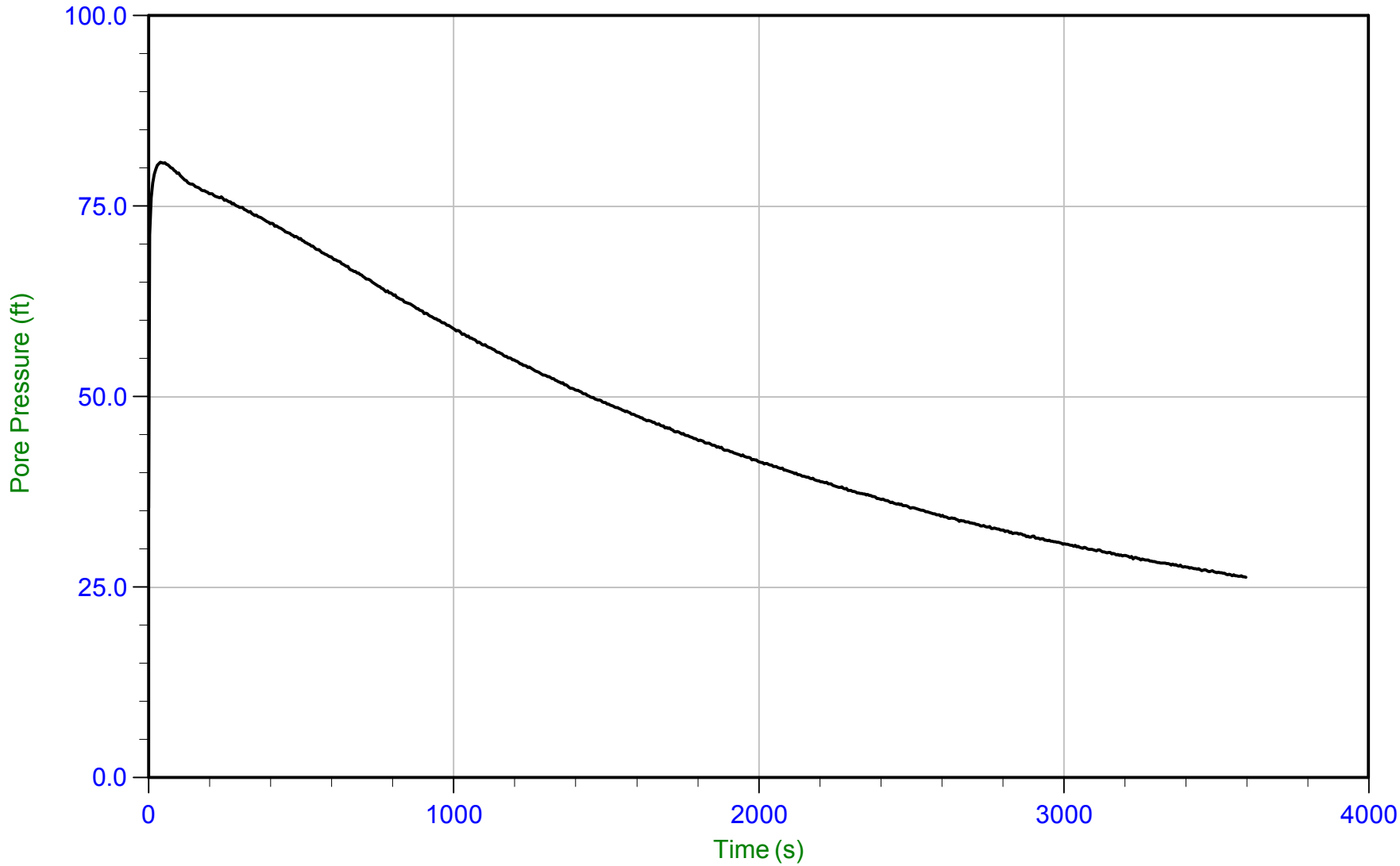
T(50): 41.5 s
Ir: 100
Ch: 16.9 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 09:34:24
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C012
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP12.PPD
Depth: 6.100 m / 20.013 ft
Duration: 3600.0 s

U Min: 26.3 ft
U Max: 80.7 ft

WT: 3.261 m / 10.699 ft
Ueq: 9.3 ft
U(50): 45.03 ft

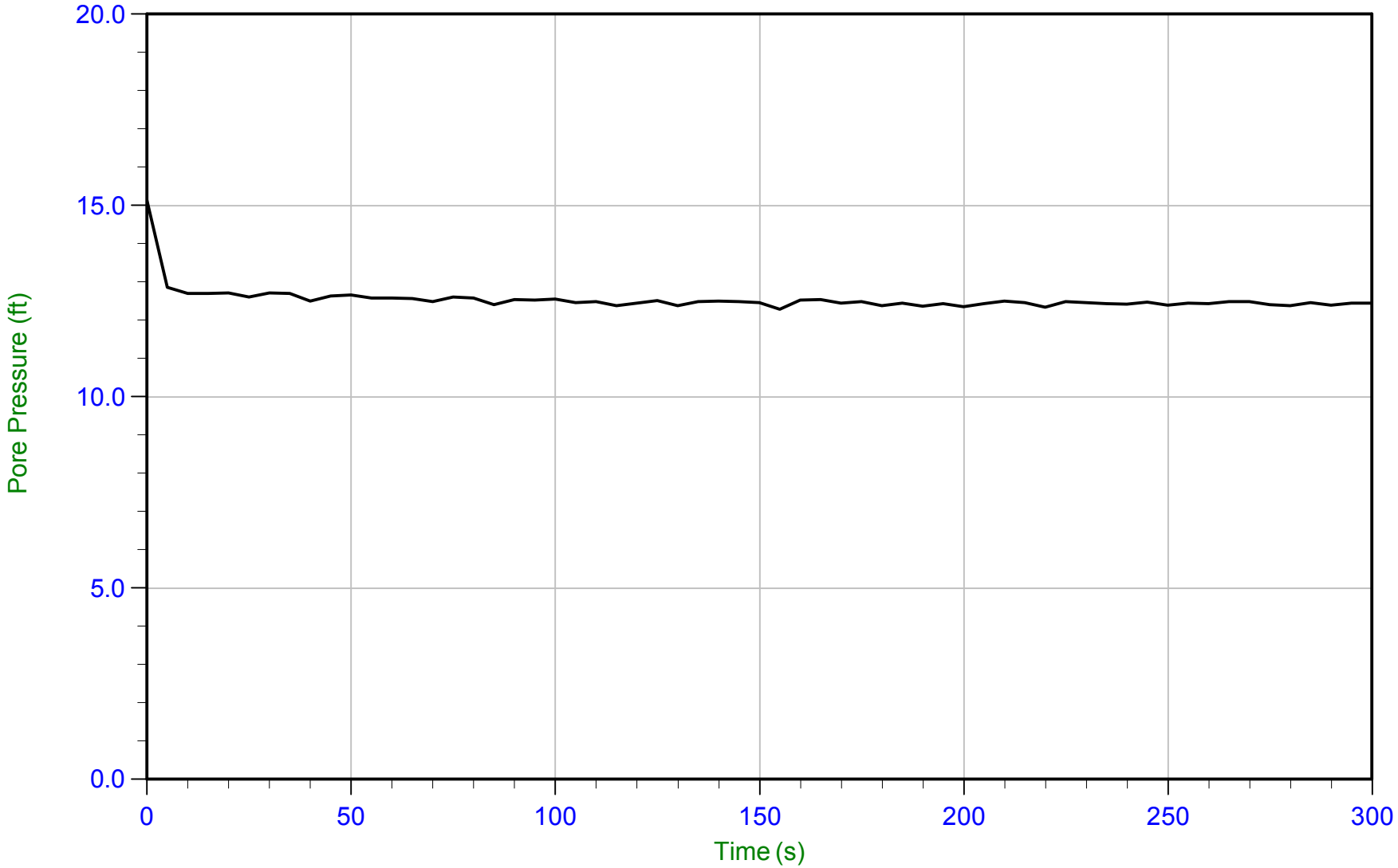
T(50): 1718.6 s
Ir: 100
Ch: 0.4 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 09:34:24
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C012
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP12.PPD
Depth: 7.000 m / 22.966 ft
Duration: 300.0 s

U Min: 12.3 ft
U Max: 15.1 ft

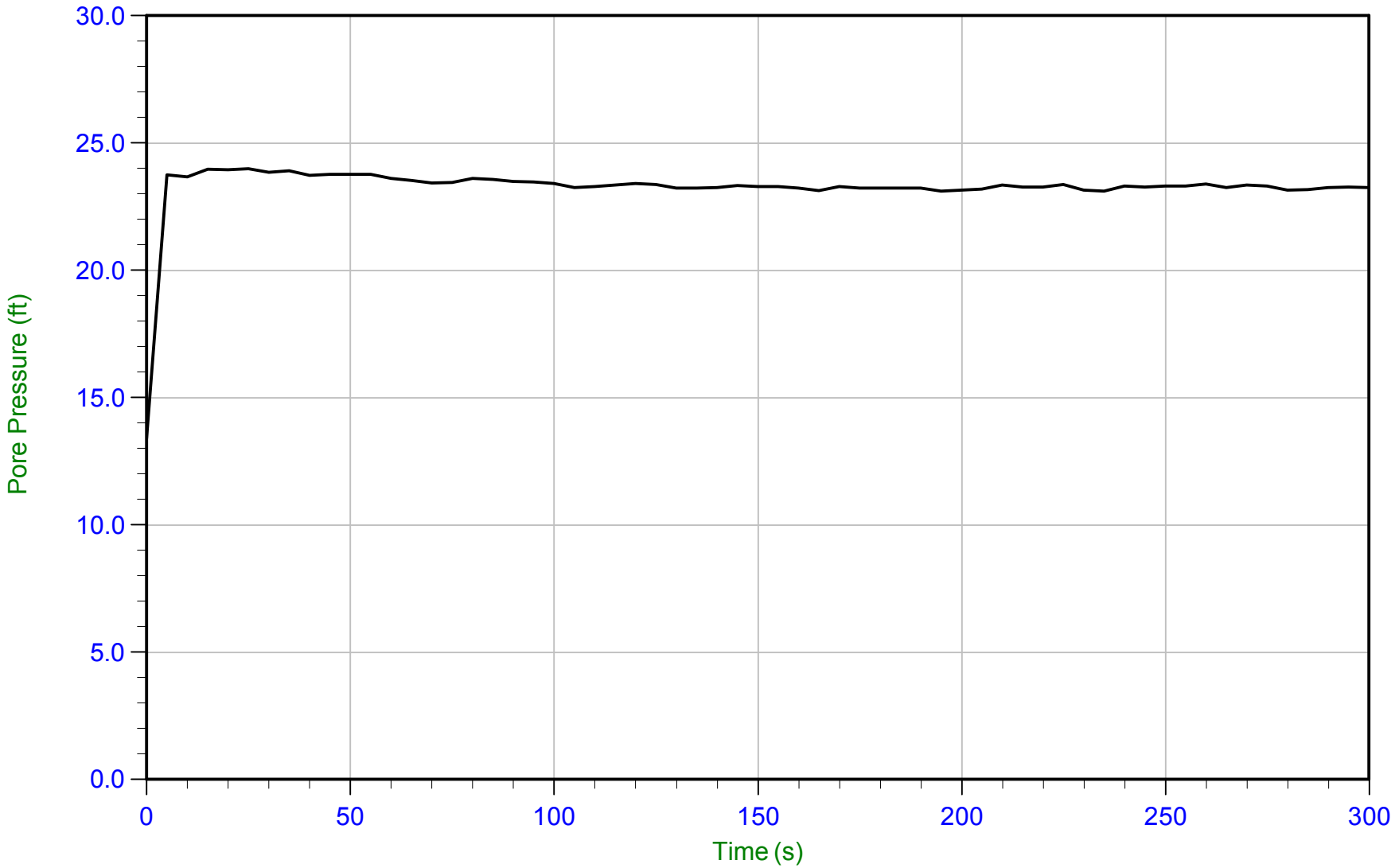
WT: 3.210 m / 10.531 ft
Ueq: 12.4 ft

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 09:34:24
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C012
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP12.PPD
Depth: 10.350 m / 33.956 ft
Duration: 300.0 s

U Min: 13.4 ft
U Max: 24.0 ft

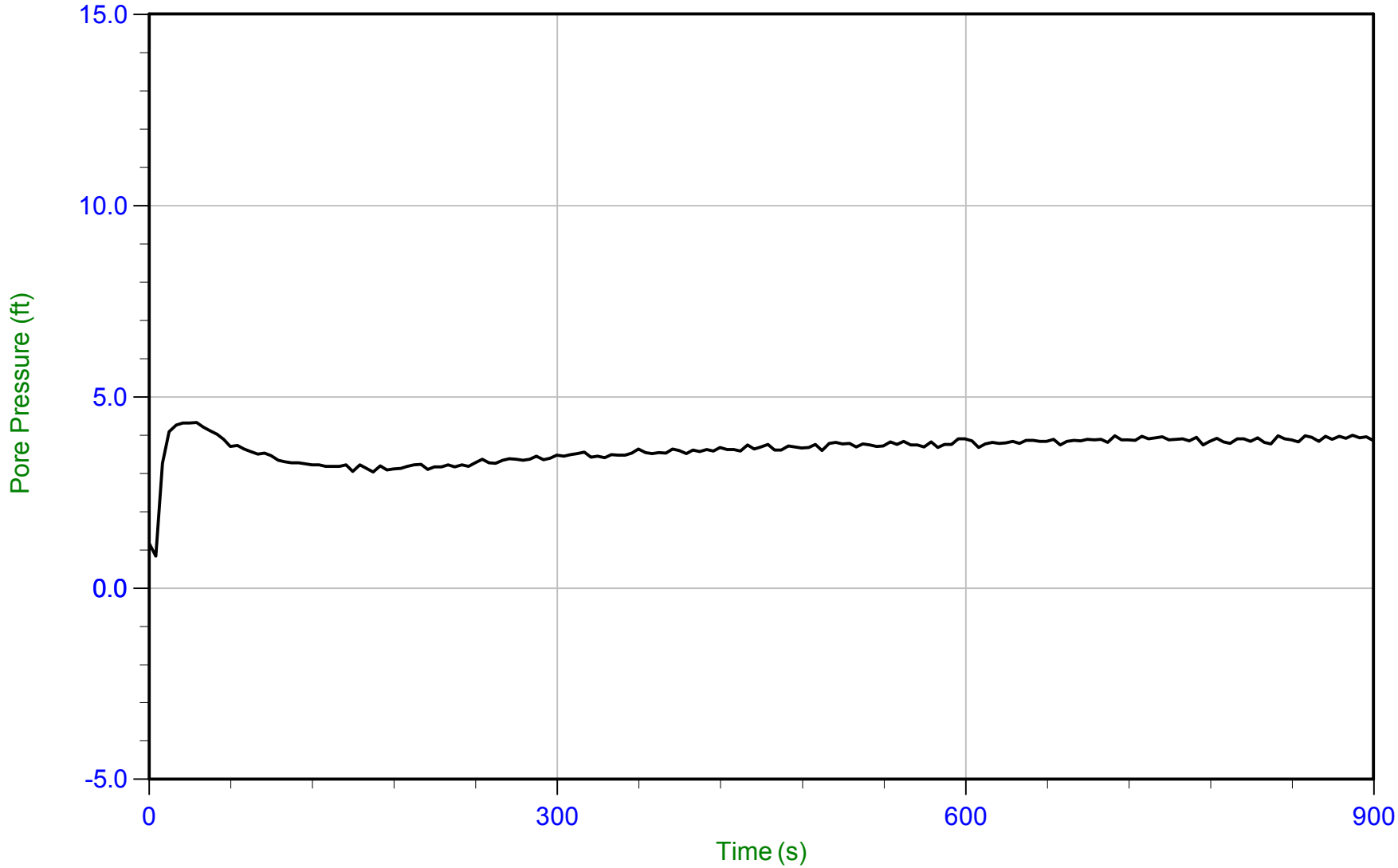
WT: 3.261 m / 10.699 ft
Ueq: 23.3 ft

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 13:22:45
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C014
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP14.PPD
Depth: 6.100 m / 20.013 ft
Duration: 900.0 s

U Min: 0.8 ft
U Max: 4.3 ft

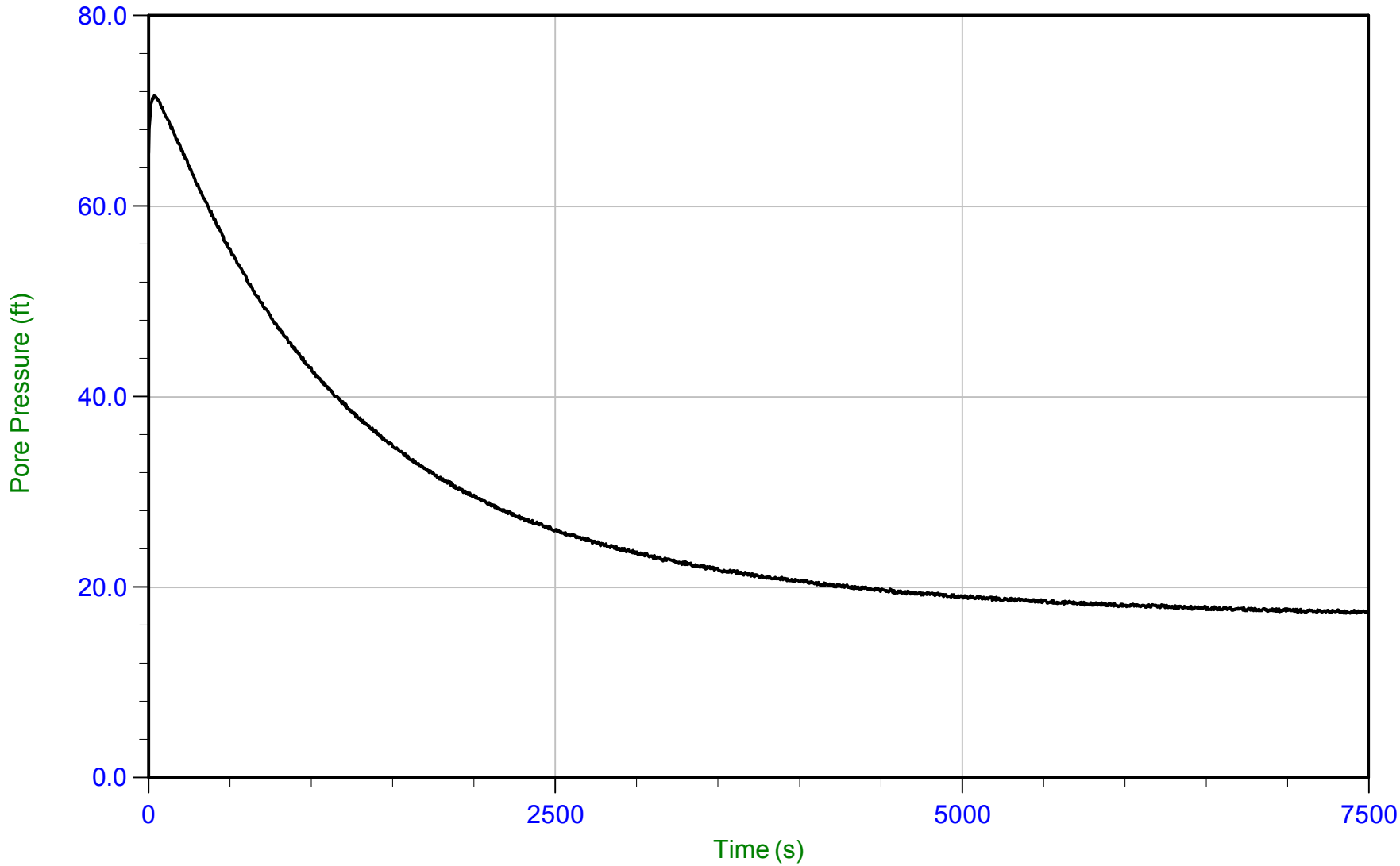
WT: 4.884 m / 16.023 ft
Ueq: 4.0 ft

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 14:10:27
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C015
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP15.PPD
Depth: 7.800 m / 25.590 ft
Duration: 7500.0 s

U Min: 17.2 ft
U Max: 71.6 ft

WT: 3.549 m / 11.644 ft
Ueq: 13.9 ft
U(50): 42.77 ft

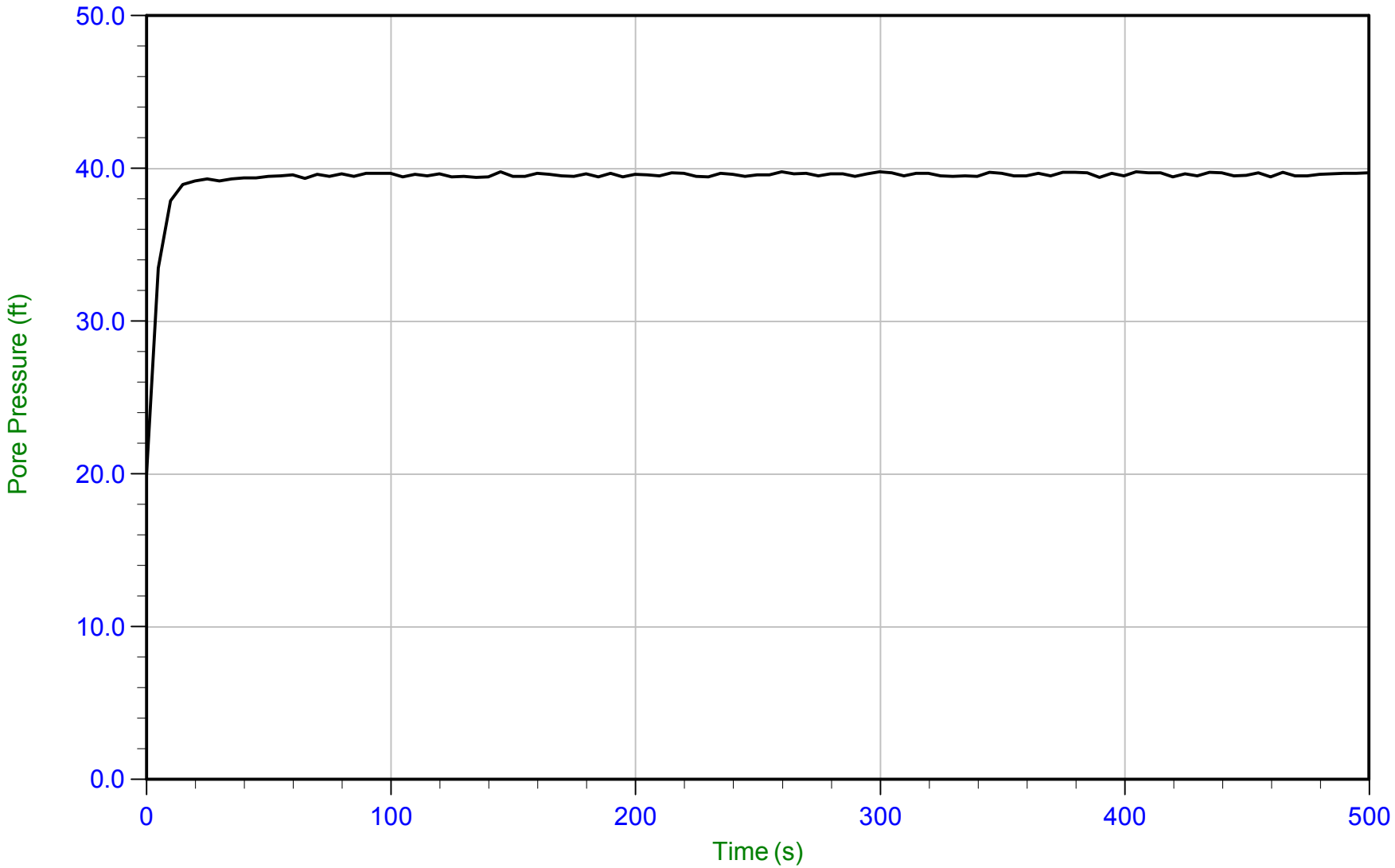
T(50): 969.2 s
Ir: 100
Ch: 0.7 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 14:10:27
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C015
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP15.PPD
Depth: 15.650 m / 51.345 ft
Duration: 500.0 s

U Min: 20.0 ft
U Max: 39.8 ft

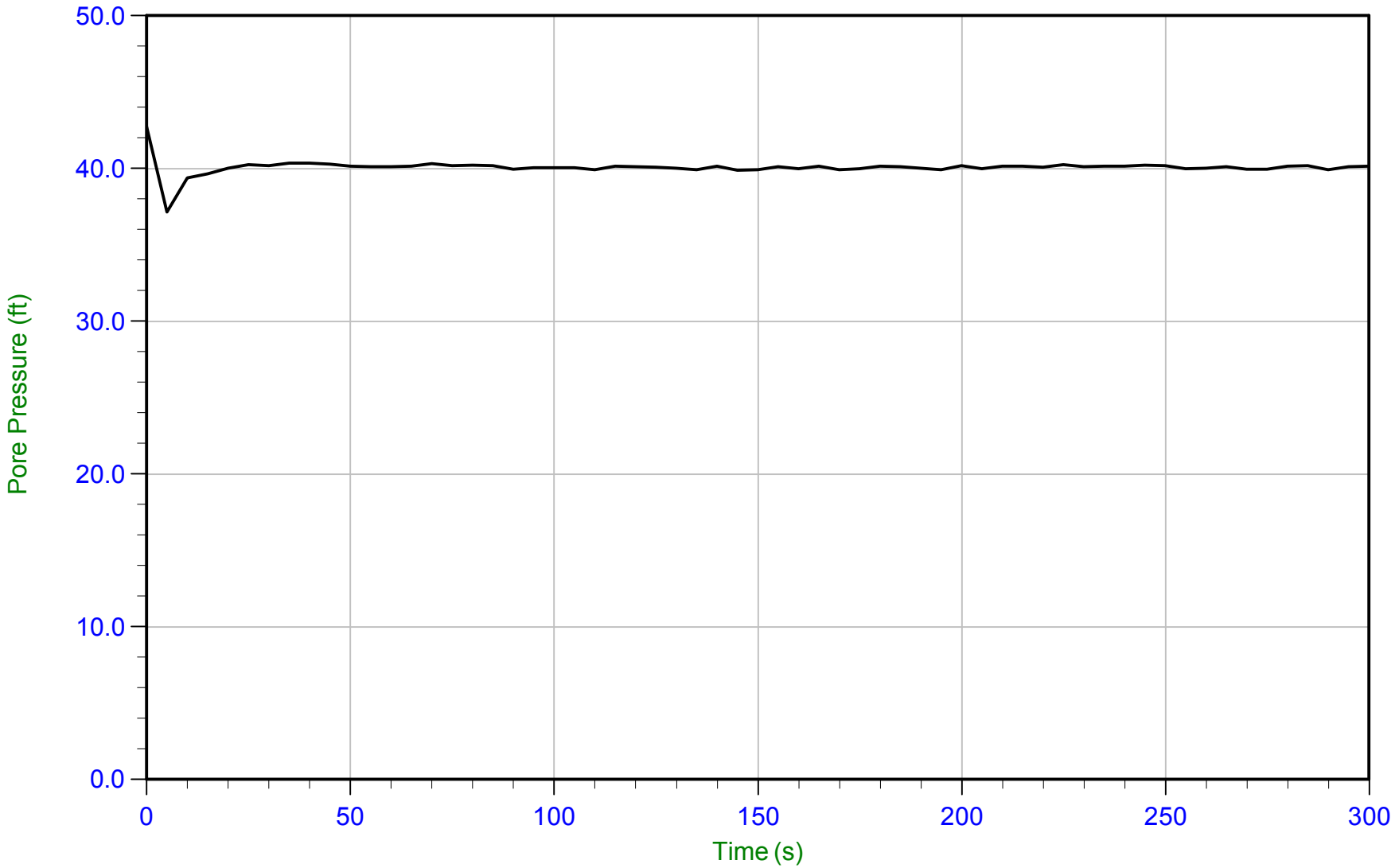
WT: 3.549 m / 11.644 ft
Ueq: 39.7 ft

CONETEC

AECOM

Job No: 15-53081
Date: 10-Sep-2015 14:10:27
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C015
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP15.PPD
Depth: 15.950 m / 52.329 ft
Duration: 300.0 s

U Min: 37.2 ft
U Max: 42.8 ft

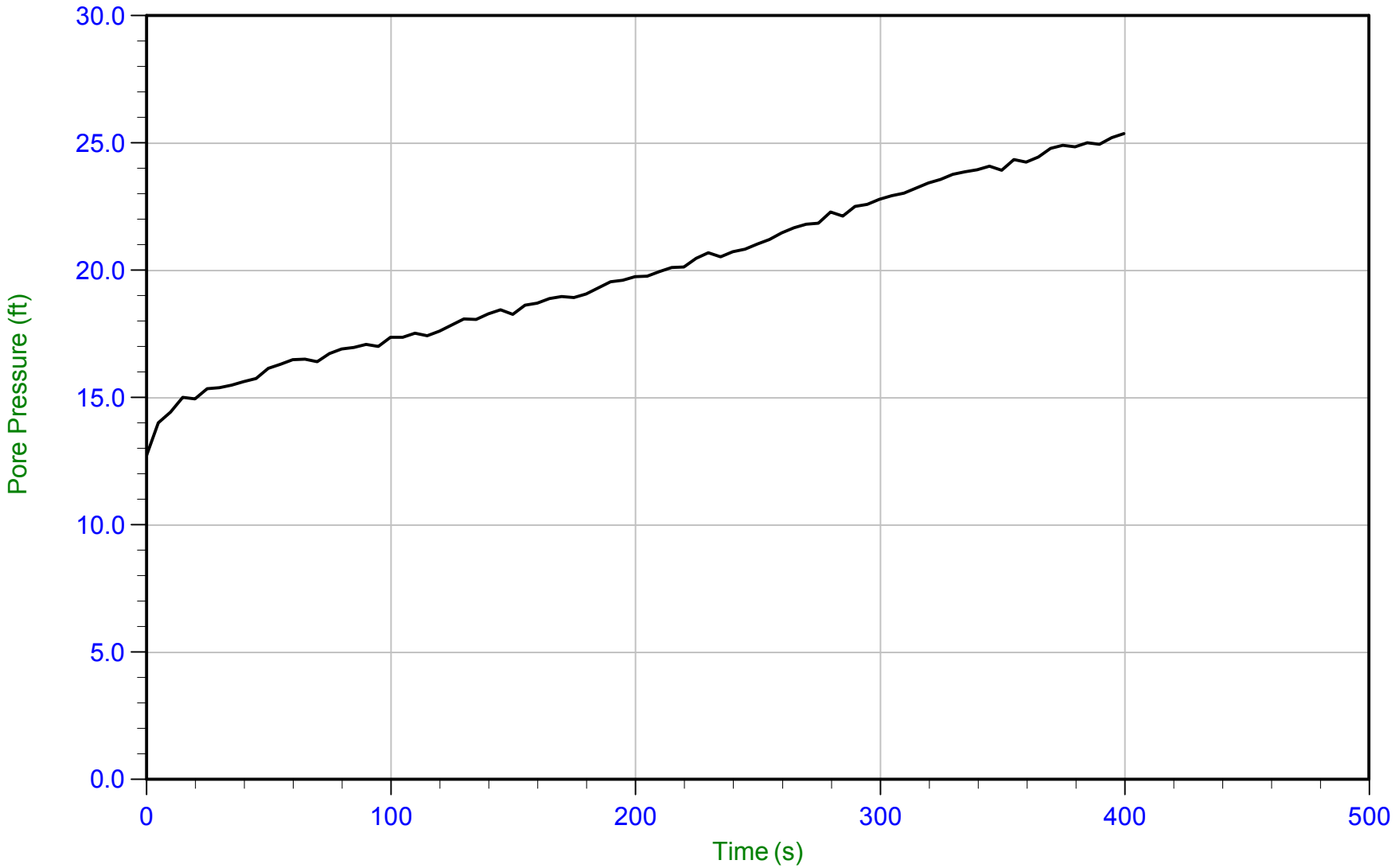
WT: 3.678 m / 12.067 ft
Ueq: 40.3 ft

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 13:54:48
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C017
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP17.PPD
Depth: 1.700 m / 5.577 ft
Duration: 400.0 s

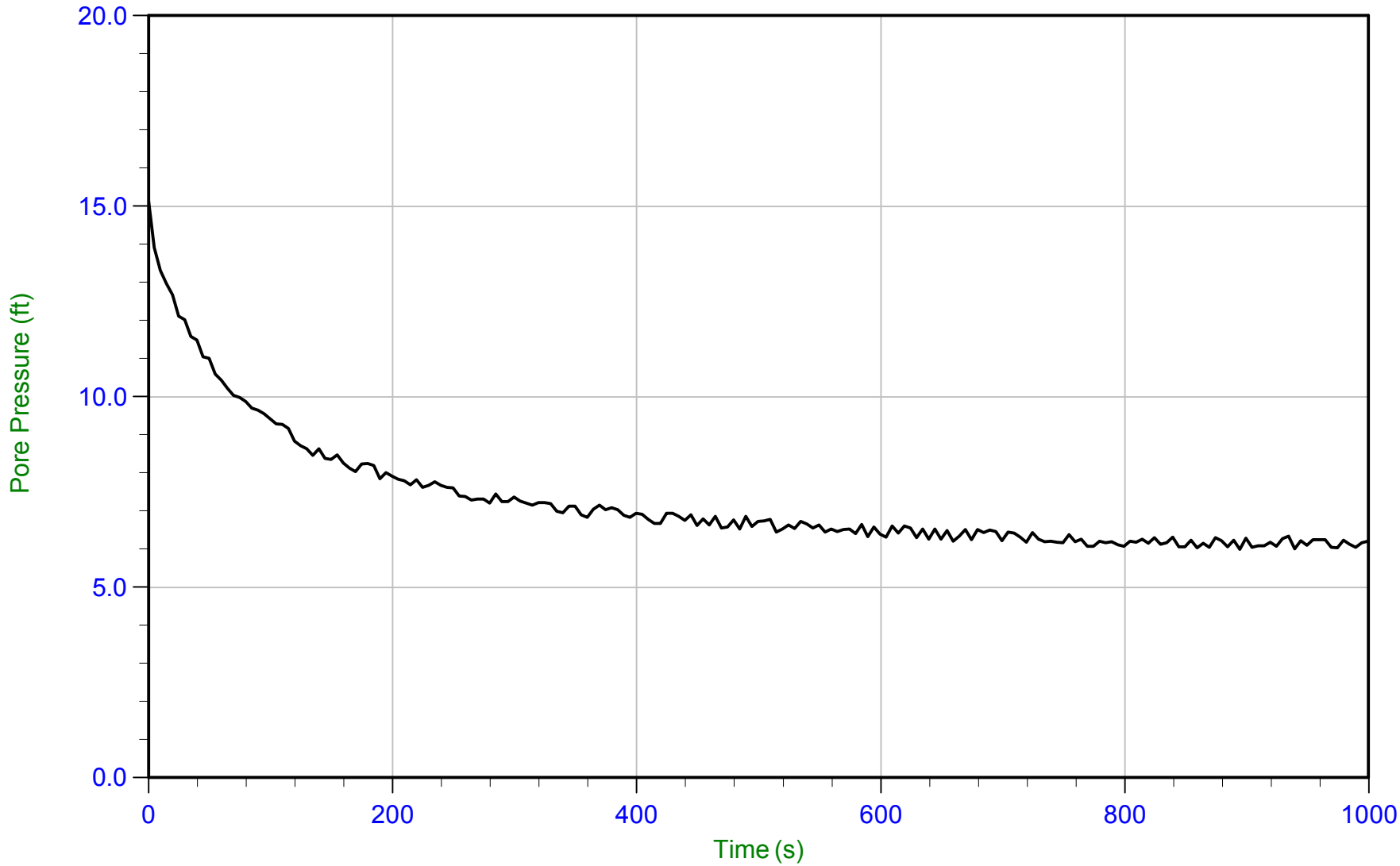
U Min: 12.7 ft
U Max: 25.4 ft

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 13:54:48
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C017
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP17.PPD
Depth: 4.750 m / 15.584 ft
Duration: 1000.0 s

U Min: 6.0 ft
U Max: 15.1 ft

WT: 3.674 m / 12.054 ft
Ueq: 3.5 ft
U(50): 9.33 ft

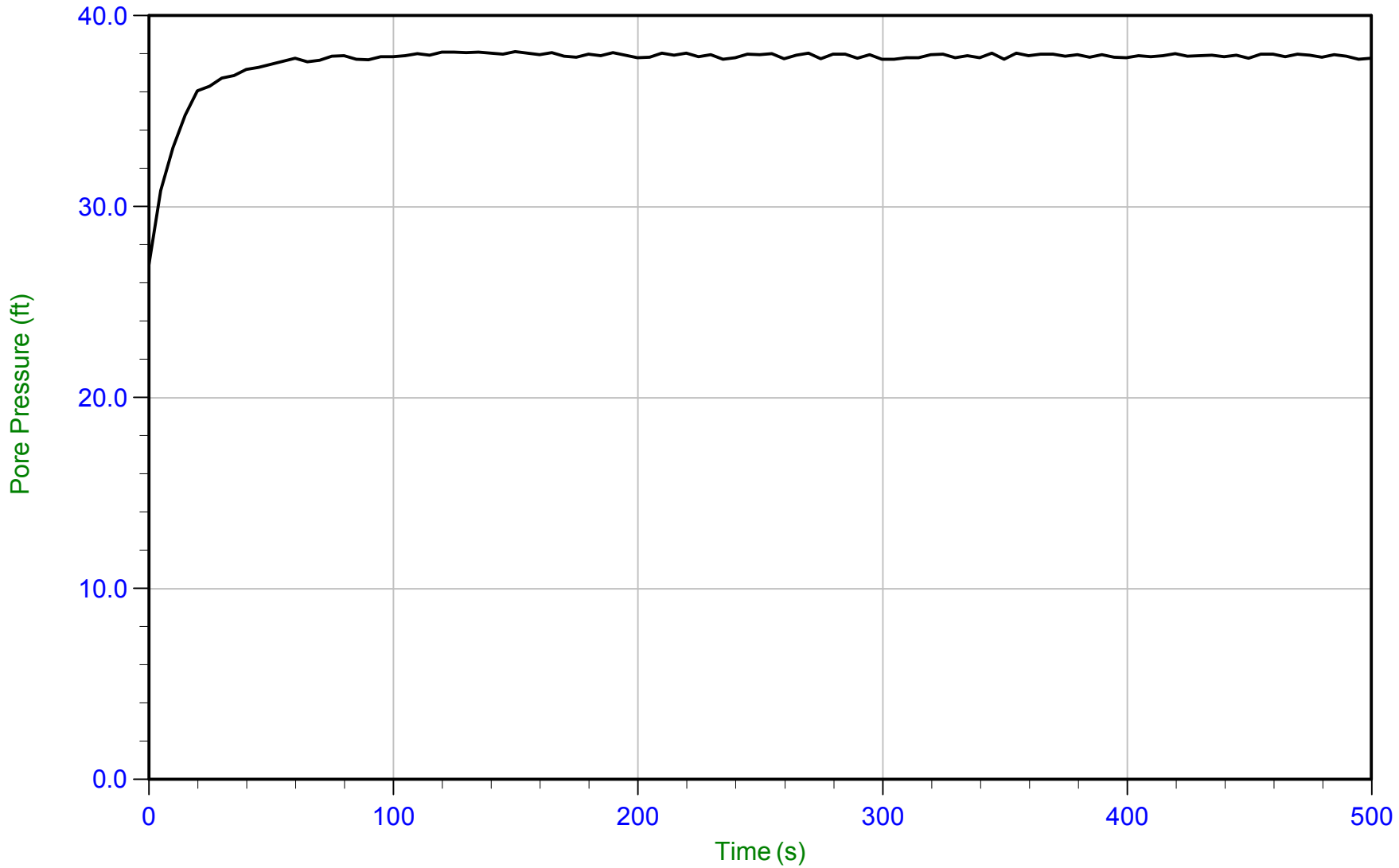
T(50): 103.5 s
Ir: 100
Ch: 6.8 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 13:54:48
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C017
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP17.PPD
Depth: 15.450 m / 50.688 ft
Duration: 500.0 s

U Min: 27.0 ft
U Max: 38.1 ft

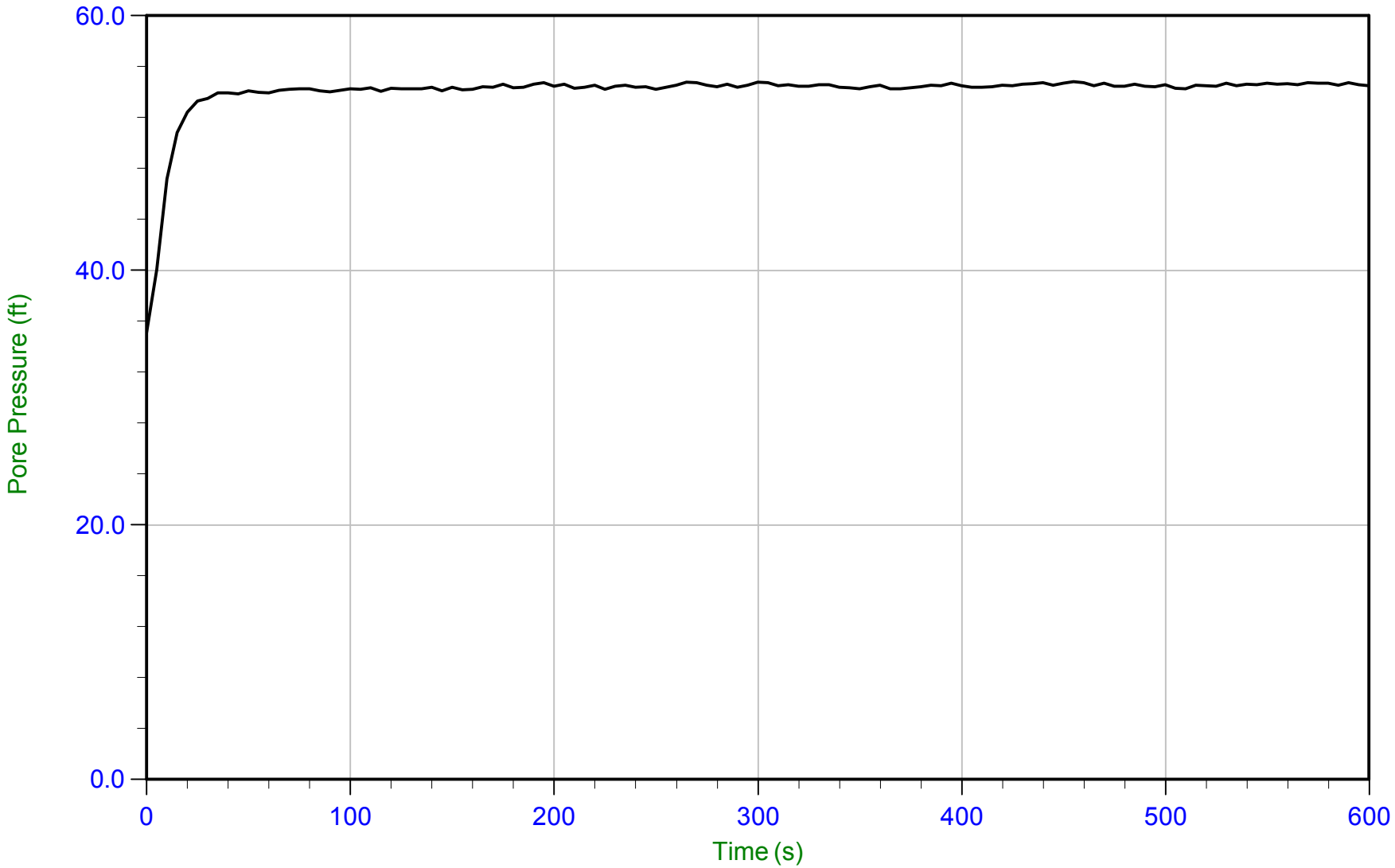
WT: 3.852 m / 12.638 ft
Ueq: 38.1 ft

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 13:54:48
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C017
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP17.PPD
Depth: 20.250 m / 66.436 ft
Duration: 600.0 s

U Min: 35.1 ft
U Max: 54.8 ft

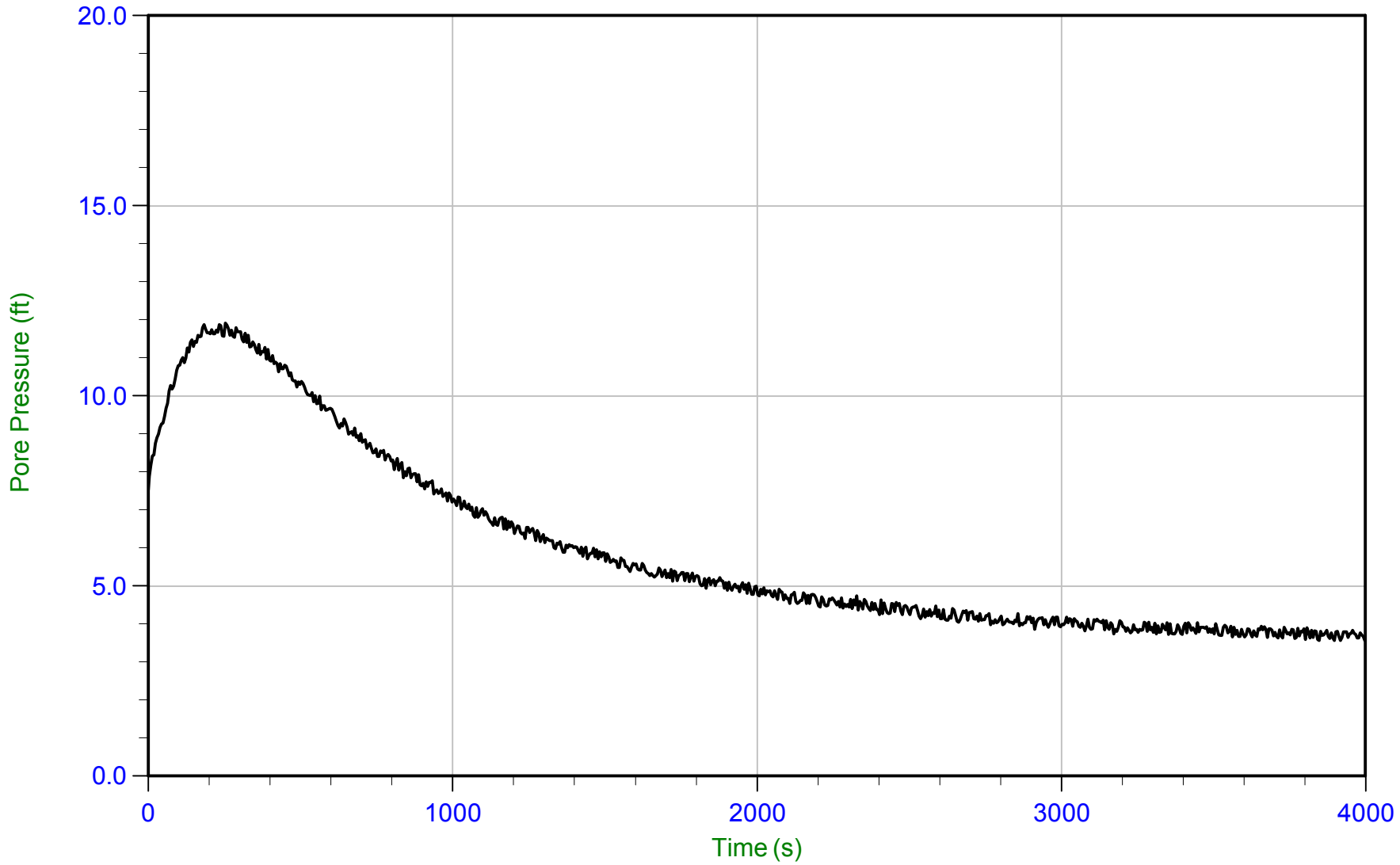
WT: 3.674 m / 12.054 ft
Ueq: 54.4 ft

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 09:45:05
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C019
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP19.PPD
Depth: 4.500 m / 14.764 ft
Duration: 4000.0 s

U Min: 3.6 ft
U Max: 11.9 ft

WT: 3.515 m / 11.532 ft
Ueq: 3.2 ft
U(50): 7.57 ft

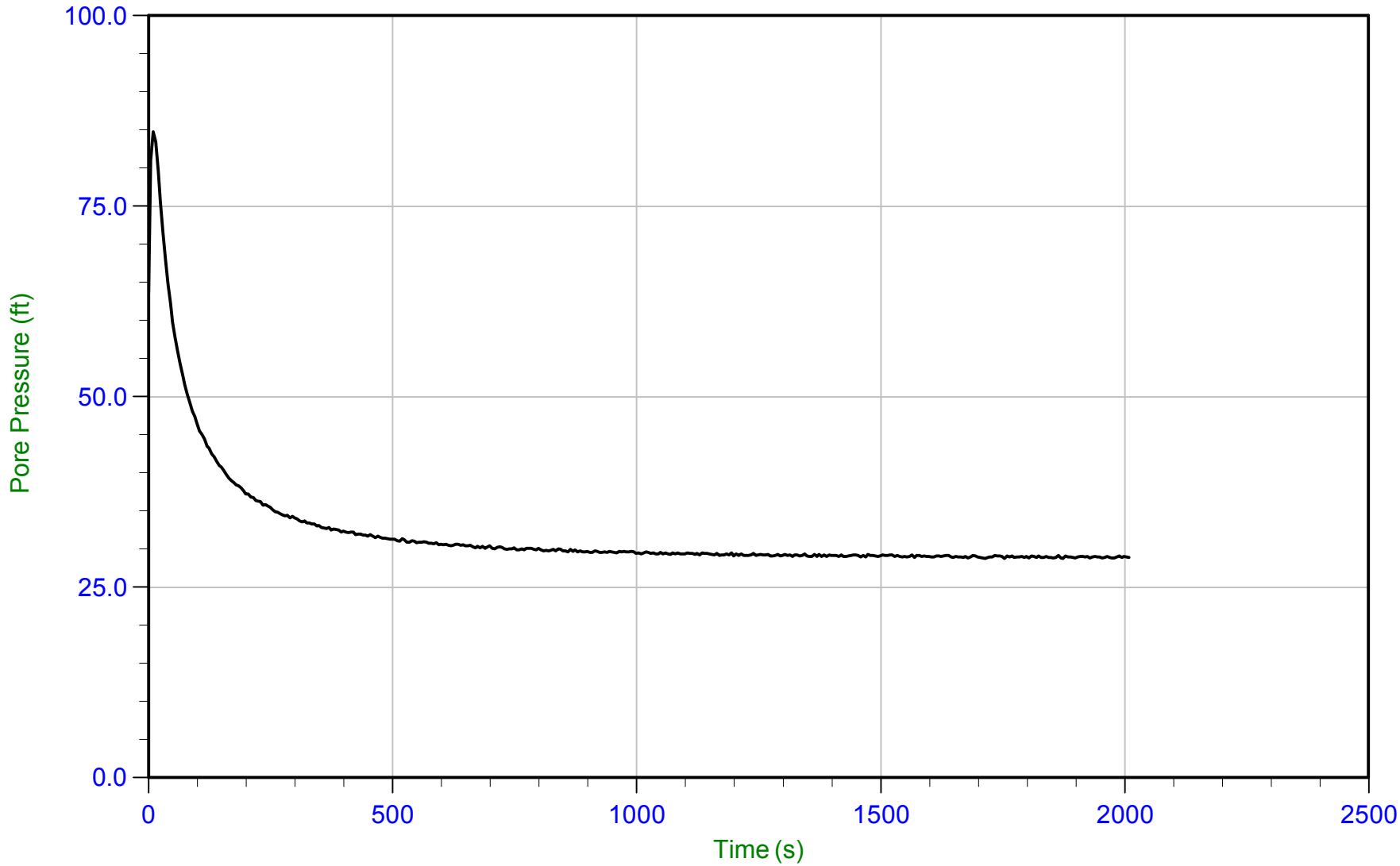
T(50): 654.3 s
Ir: 100
Ch: 1.1 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 09:45:05
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C019
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP19.PPD
Depth: 12.300 m / 40.354 ft
Duration: 2010.0 s

U Min: 28.8 ft
U Max: 84.8 ft

WT: 3.510 m / 11.516 ft
Ueq: 28.8 ft
U(50): 56.81 ft

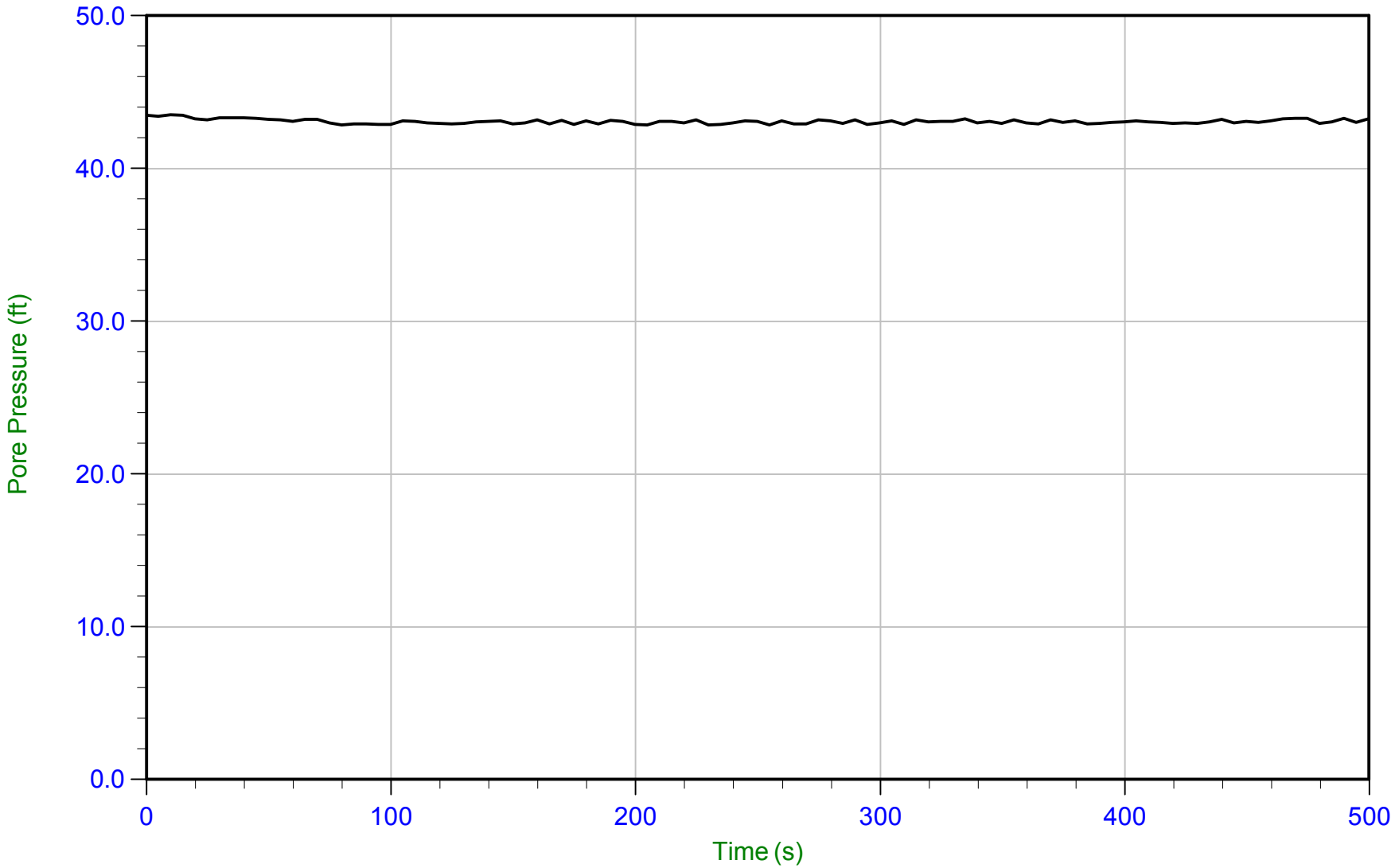
T(50): 47.7 s
Ir: 100
Ch: 14.7 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 09:45:05
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C019
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP19.PPD
Depth: 16.700 m / 54.789 ft
Duration: 500.0 s

U Min: 42.8 ft
U Max: 43.5 ft

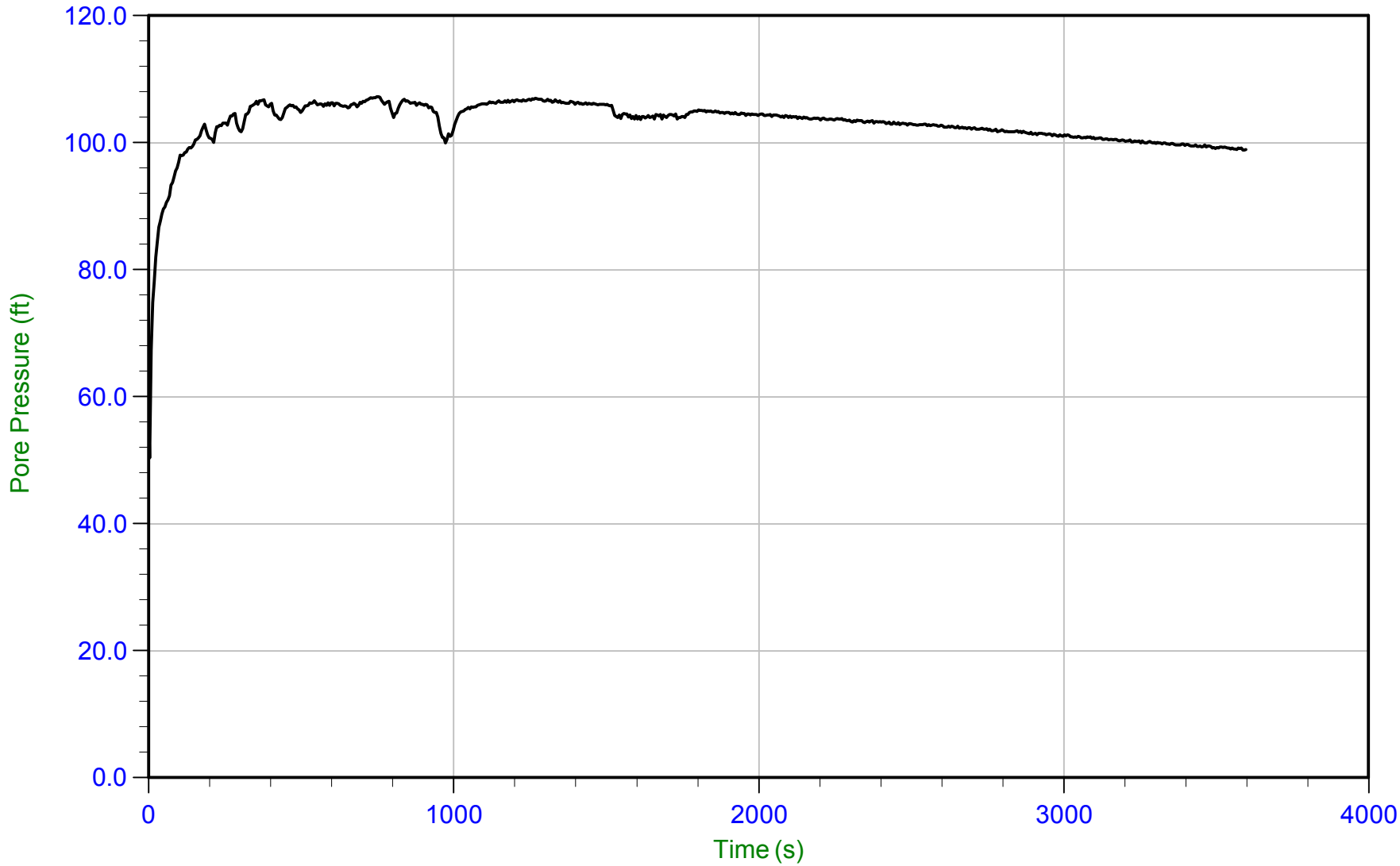
WT: 3.515 m / 11.532 ft
Ueq: 43.3 ft

CONETEC

AECOM

Job No: 15-53081
Date: 09-Sep-2015 09:45:05
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C019
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP19.PPD
Depth: 19.150 m / 62.827 ft
Duration: 3600.0 s

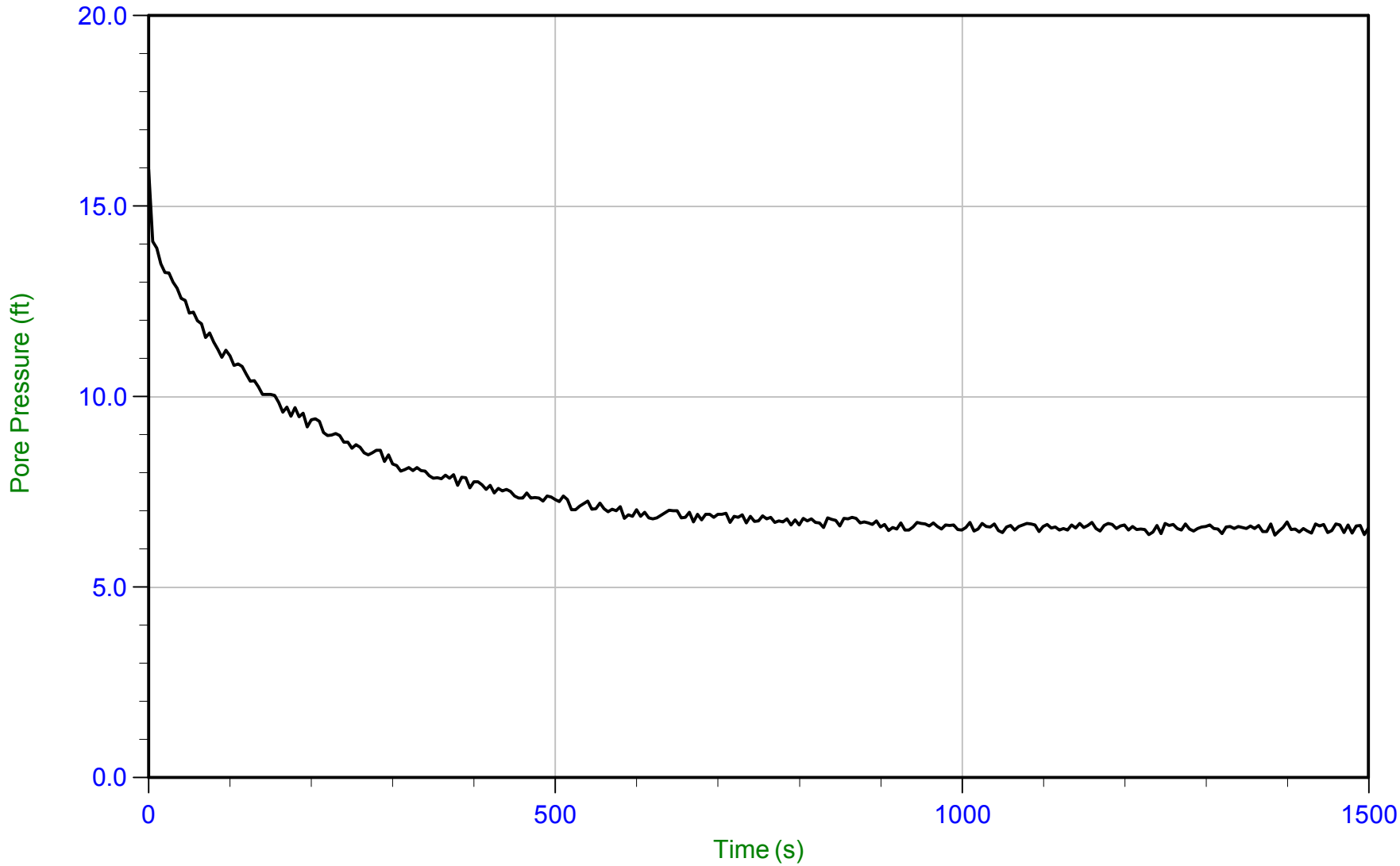
U Min: 50.4 ft
U Max: 107.3 ft

CONETEC

AECOM

Job No: 15-53081
Date: 01-Sep-2015 13:06:56
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C021A
Cone: AD340
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP21A.PPD
Depth: 5.100 m / 16.732 ft
Duration: 1500.0 s

U Min: 6.4 ft
U Max: 16.0 ft

WT: 3.136 m / 10.289 ft
Ueq: 6.4 ft
U(50): 11.20 ft

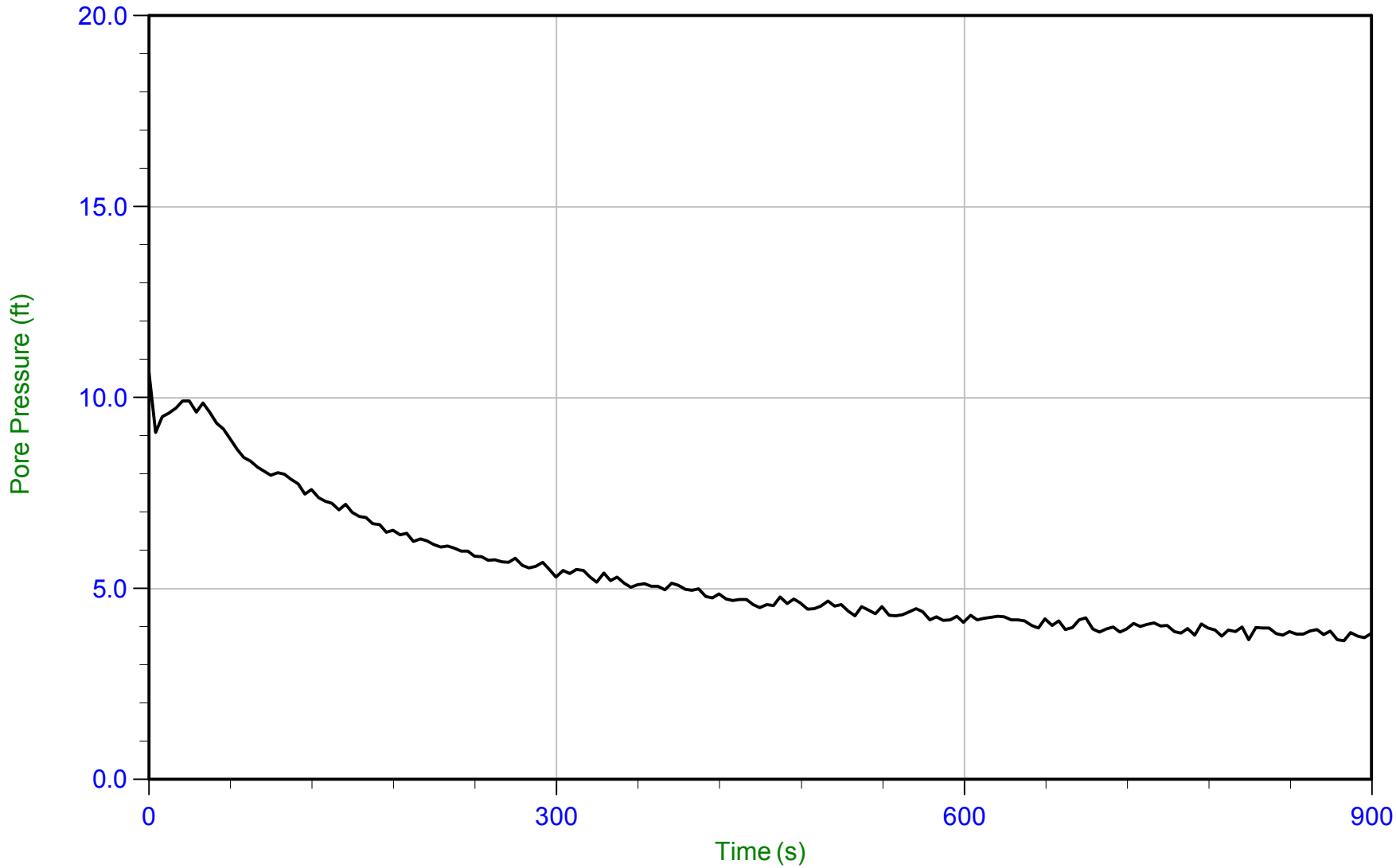
T(50): 86.0 s
Ir: 100
Ch: 8.2 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 01-Sep-2015 13:06:56
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C021A
Cone: AD340
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP21A.PPD
Depth: 7.850 m / 25.754 ft
Duration: 900.0 s

U Min: 3.6 ft
U Max: 10.7 ft

WT: 7.119 m / 23.356 ft
Ueq: 2.4 ft
U(50): 6.53 ft

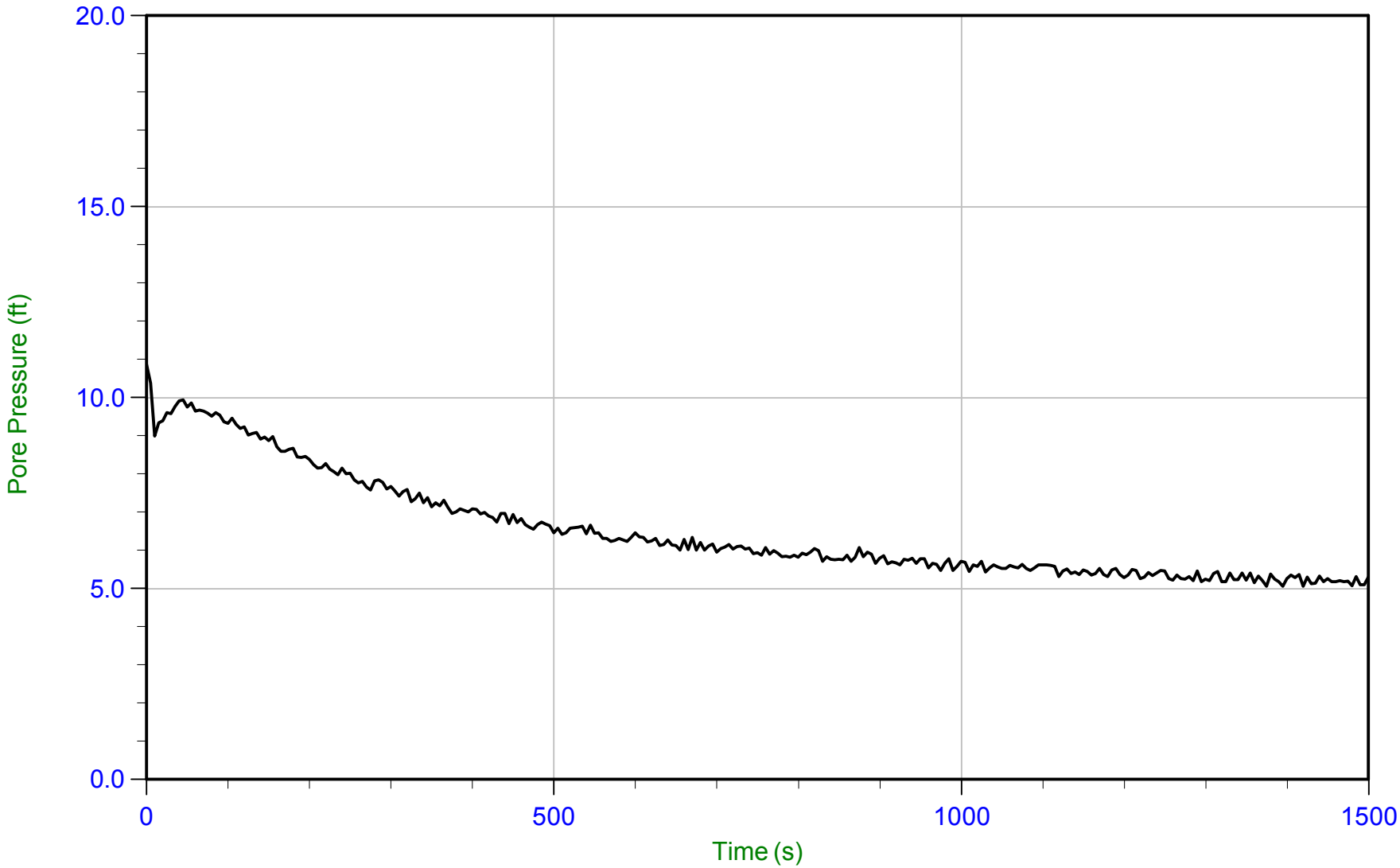
T(50): 173.7 s
Ir: 100
Ch: 4.0 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 01-Sep-2015 13:06:56
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C021A
Cone: AD340
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP21A.PPD
Depth: 9.900 m / 32.480 ft
Duration: 1500.0 s

U Min: 5.1 ft
U Max: 10.9 ft

WT: 8.507 m / 27.910 ft
Ueq: 4.6 ft
U(50): 7.72 ft

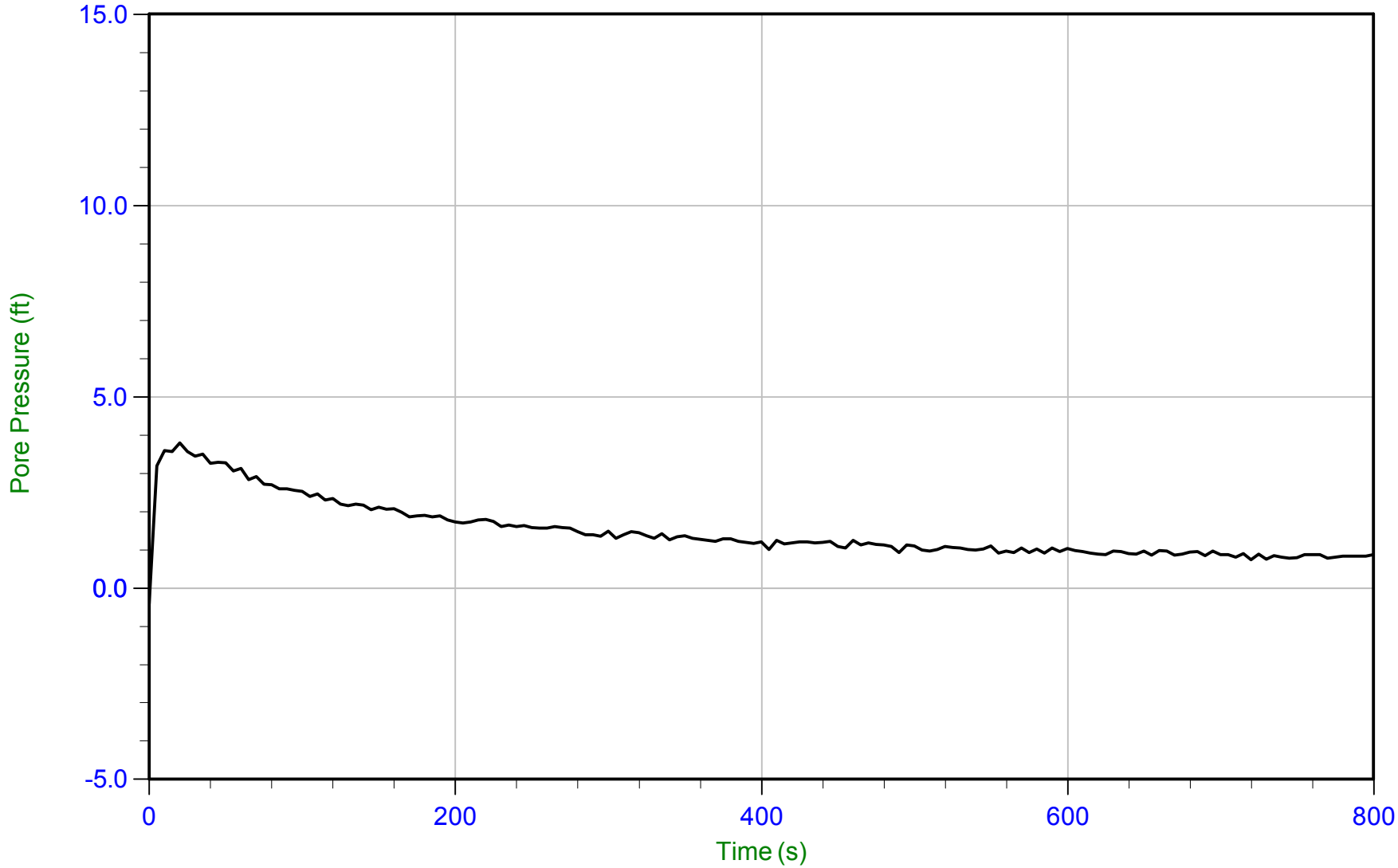
T(50): 267.8 s
Ir: 100
Ch: 2.6 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 01-Sep-2015 13:08:18
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C022
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP22.PPD
Depth: 2.350 m / 7.710 ft
Duration: 800.0 s

U Min: -0.4 ft
U Max: 3.8 ft

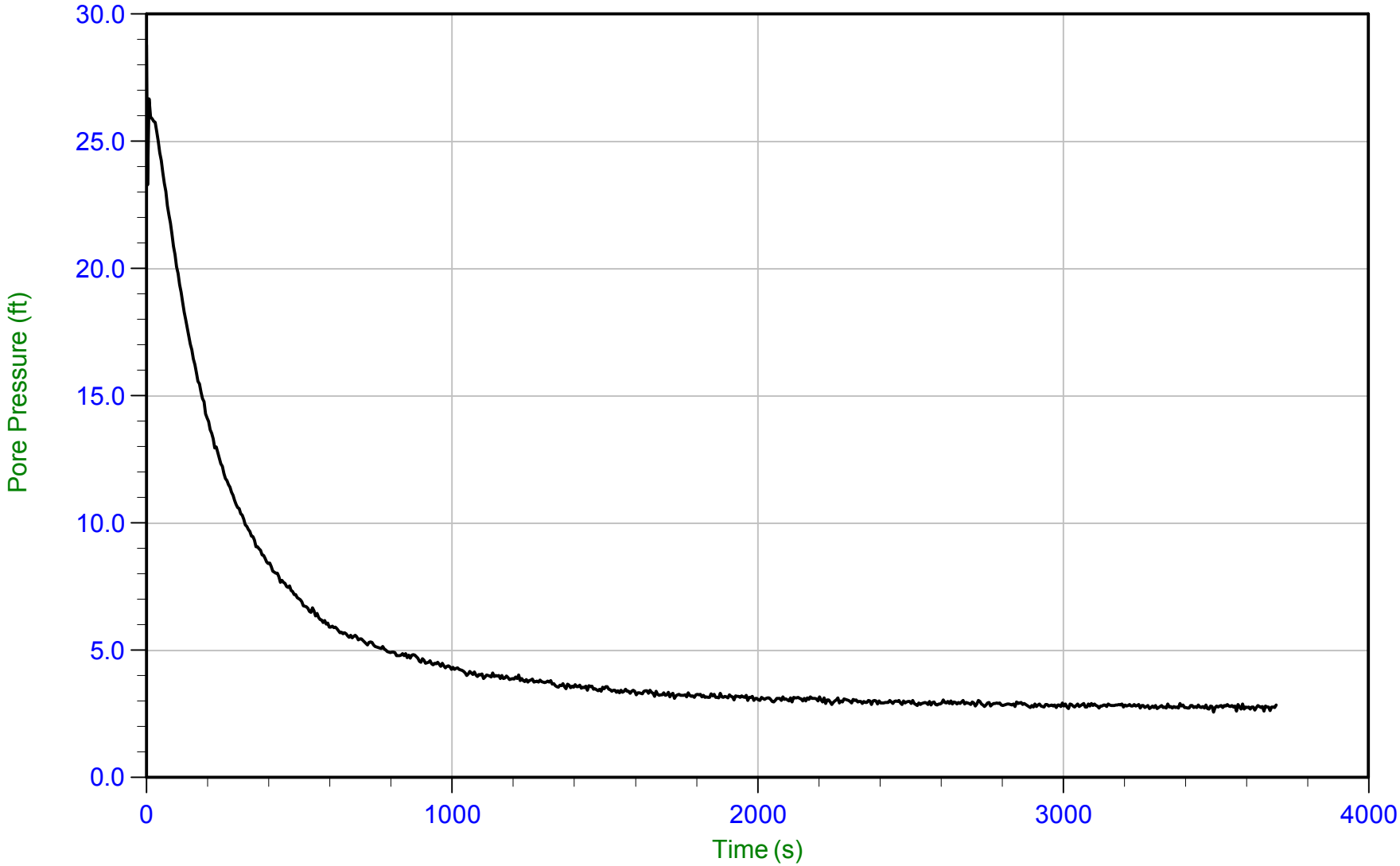
WT: 2.116 m / 6.942 ft
Ueq: 0.8 ft

CONETEC

AECOM

Job No: 15-53081
Date: 01-Sep-2015 13:08:18
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C022
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP22.PPD
Depth: 4.200 m / 13.779 ft
Duration: 3700.0 s

U Min: 2.6 ft
U Max: 28.8 ft

WT: 3.412 m / 11.194 ft
Ueq: 2.6 ft
U(50): 15.69 ft

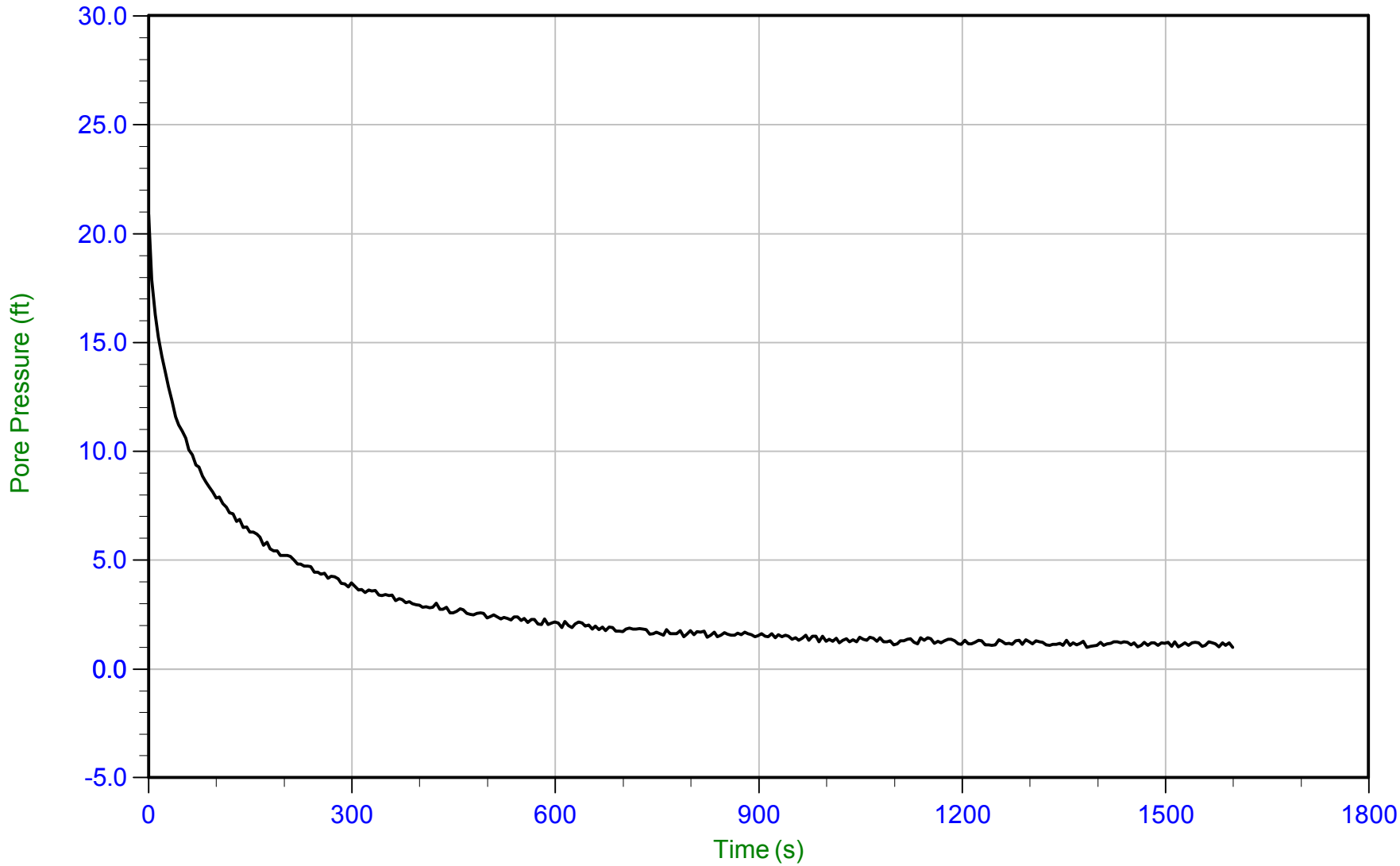
T(50): 168.3 s
Ir: 100
Ch: 4.2 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 02-Sep-2015 12:42:36
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C023
Cone: 340
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP23.PPD
Depth: 3.450 m / 11.319 ft
Duration: 1600.0 s

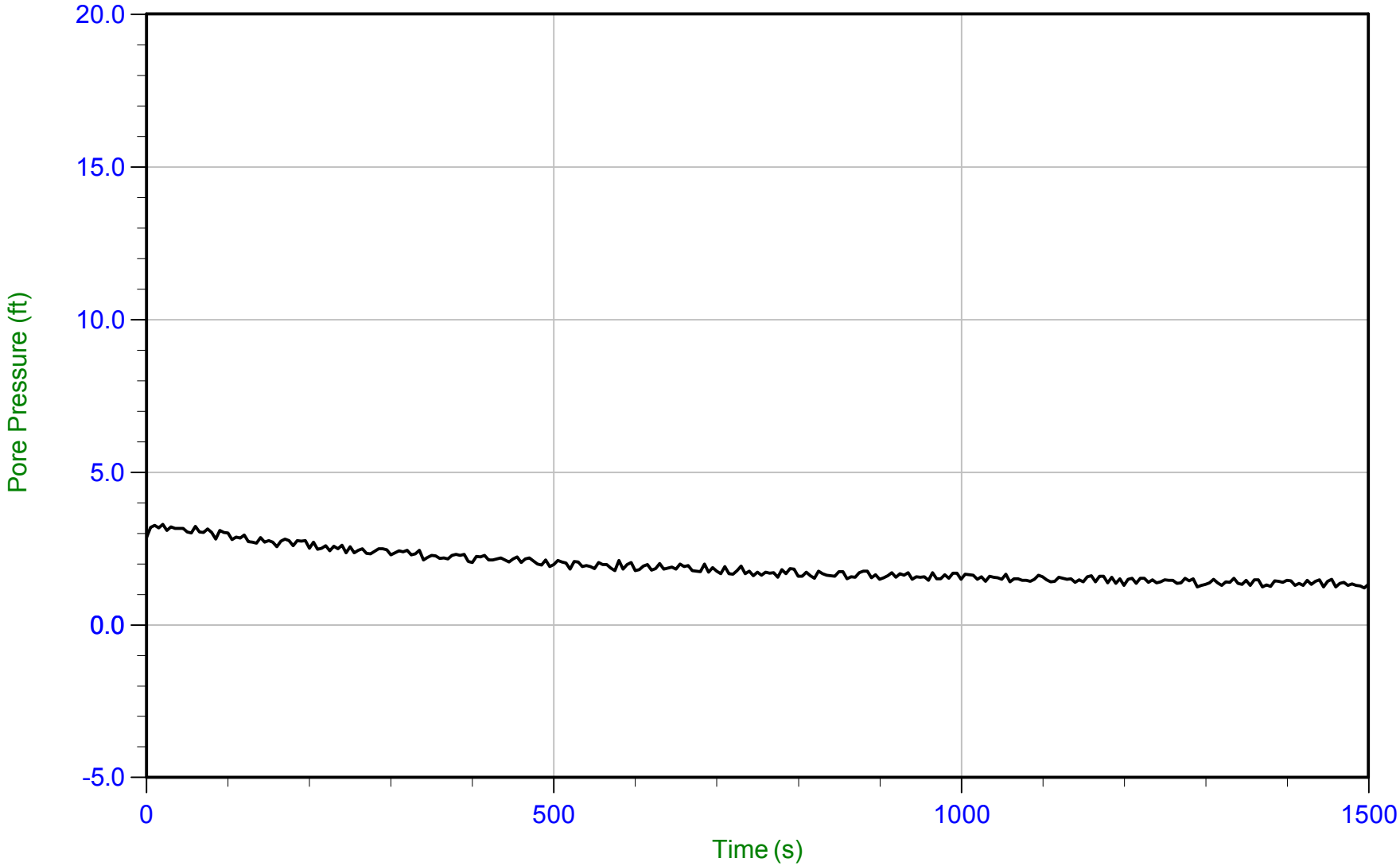
U Min: 1.0 ft
U Max: 20.9 ft

CONETEC

AECOM

Job No: 15-53081
Date: 02-Sep-2015 08:19:07
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C025
Cone: 340
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP25.PPD
Depth: 4.450 m / 14.600 ft
Duration: 1500.0 s

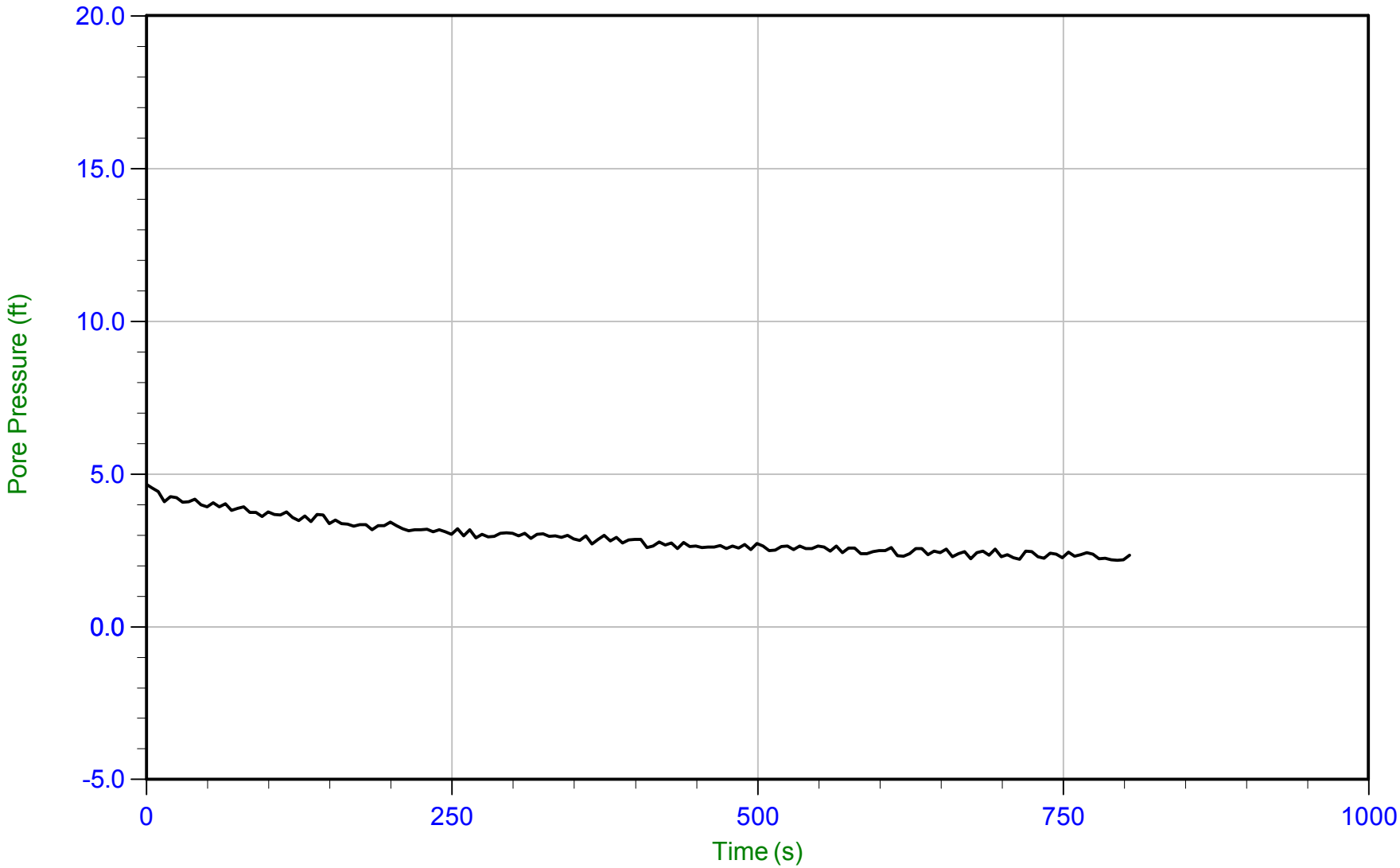
U Min: 1.2 ft
U Max: 3.3 ft

CONETEC

AECOM

Job No: 15-53081
Date: 02-Sep-2015 08:19:07
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C025
Cone: 340
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP25.PPD
Depth: 7.250 m / 23.786 ft
Duration: 805.0 s

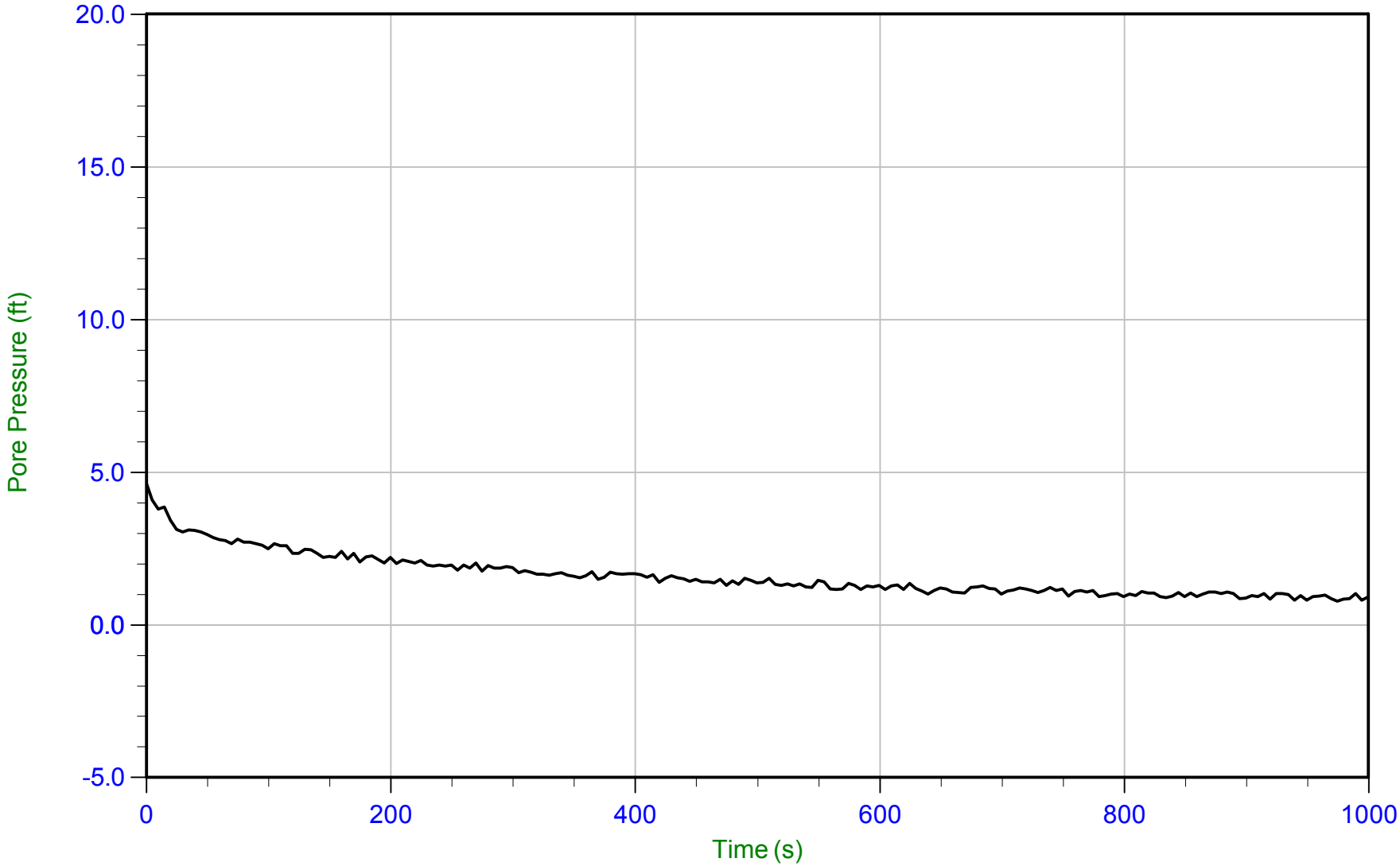
U Min: 2.2 ft
U Max: 4.7 ft

CONETEC

AECOM

Job No: 15-53081
Date: 02-Sep-2015 08:19:07
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C025
Cone: 340
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP25.PPD
Depth: 9.150 m / 30.019 ft
Duration: 1000.0 s

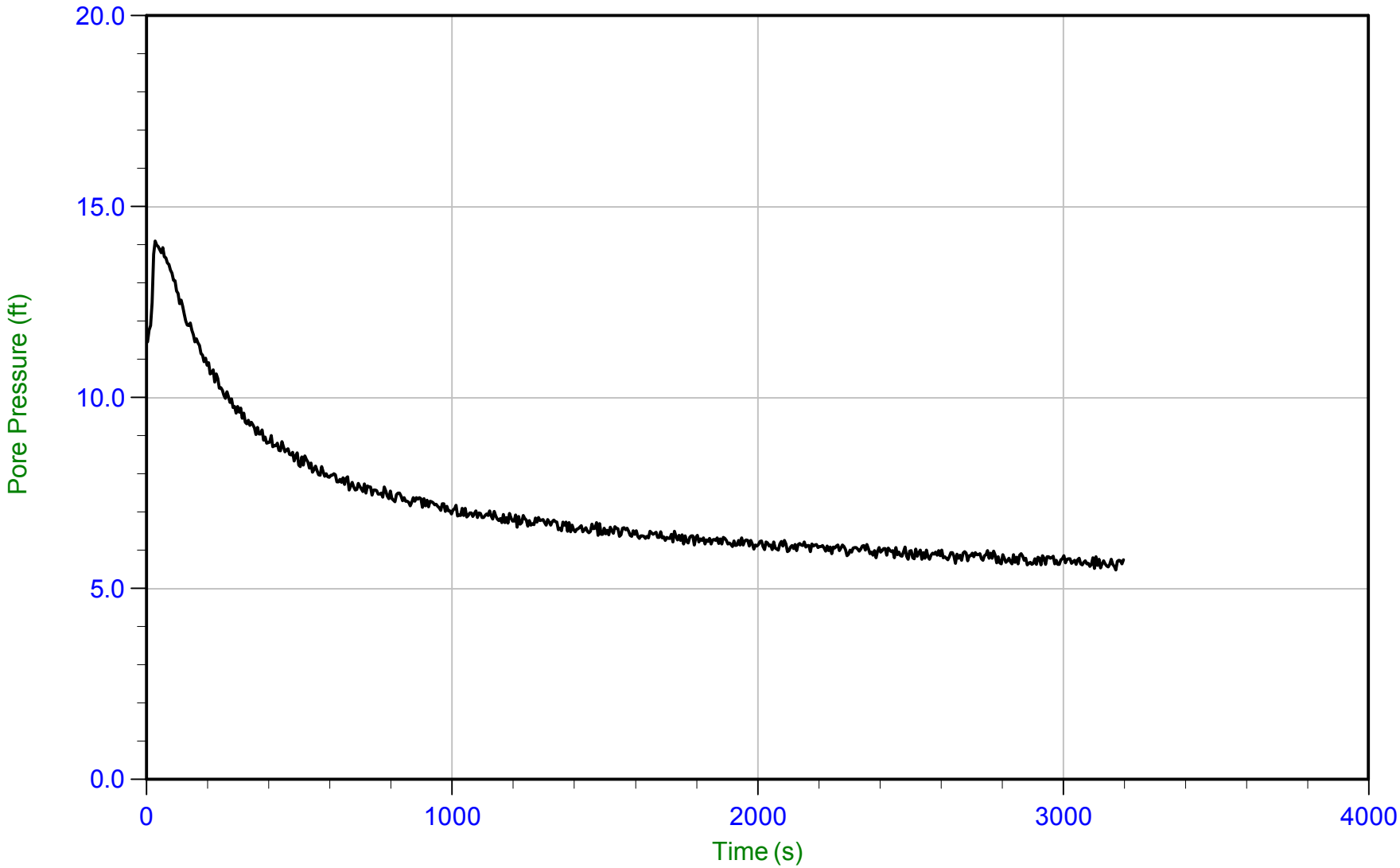
U Min: 0.8 ft
U Max: 4.6 ft

CONETEC

AECOM

Job No: 15-53081
Date: 02-Sep-2015 08:19:07
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C025
Cone: 340
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP25.PPD
Depth: 14.400 m / 47.244 ft
Duration: 3200.0 s

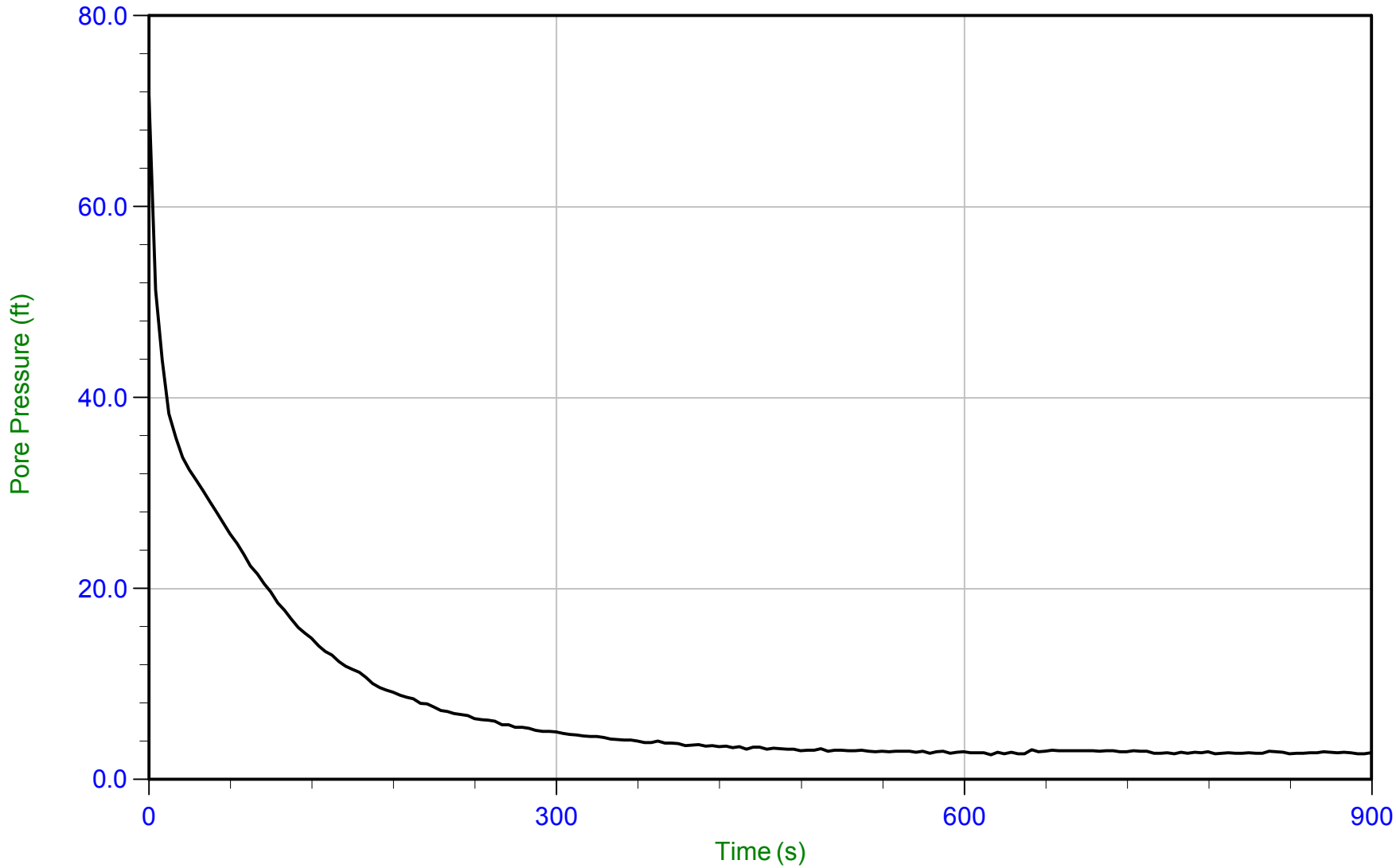
U Min: 5.5 ft
U Max: 14.1 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 11:32:02
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C026
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP26.PPD
Depth: 1.300 m / 4.265 ft
Duration: 900.0 s

U Min: 2.6 ft
U Max: 71.5 ft

WT: 0.478 m / 1.568 ft
Ueq: 2.7 ft
U(50): 37.11 ft

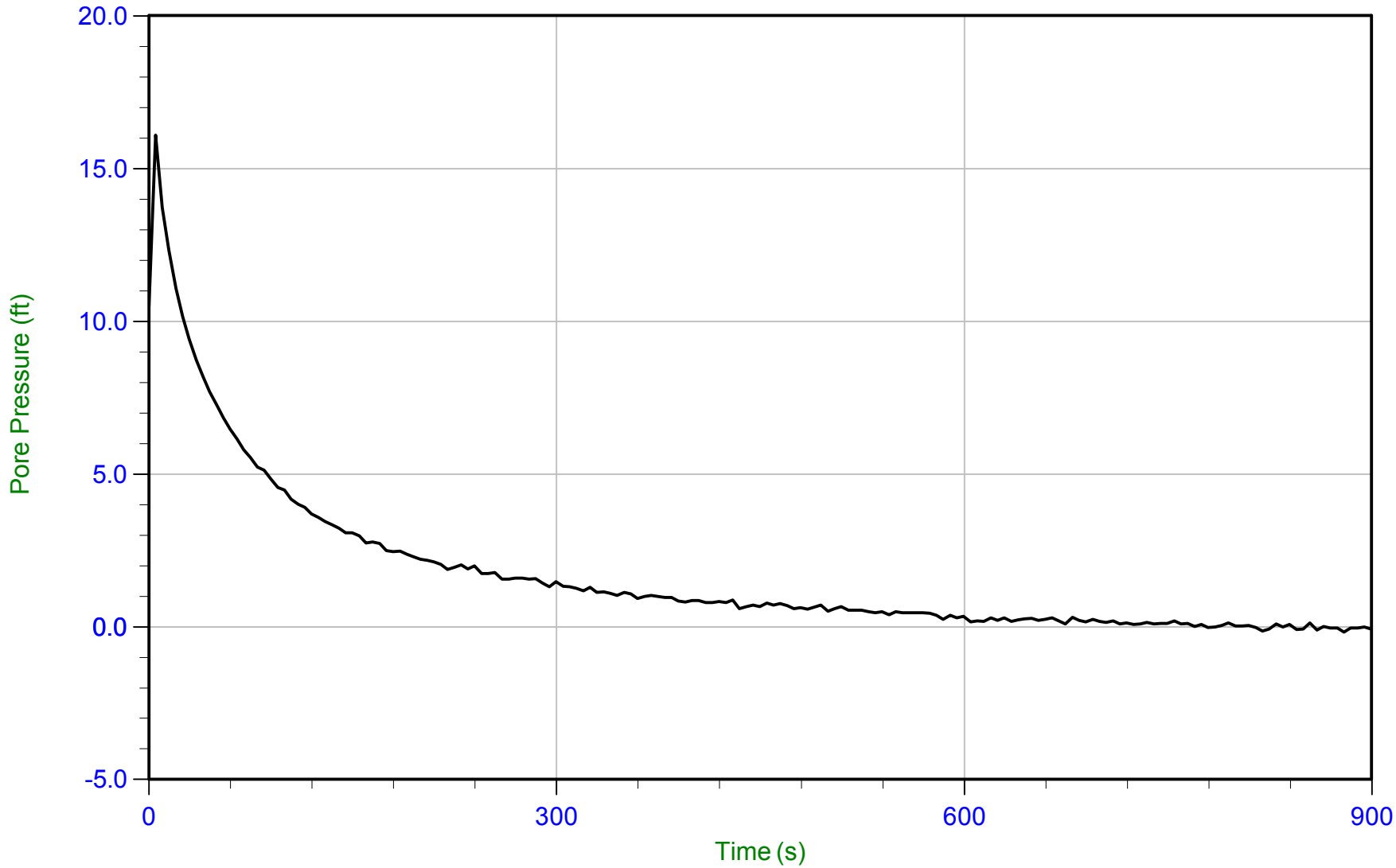
T(50): 17.4 s
Ir: 100
Ch: 40.4 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 11:32:02
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C026
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP26.PPD
Depth: 4.600 m / 15.092 ft
Duration: 900.0 s

U Min: -0.2 ft
U Max: 16.1 ft

WT: 4.600 m / 15.092 ft
Ueq: -0.0 ft
U(50): 8.05 ft

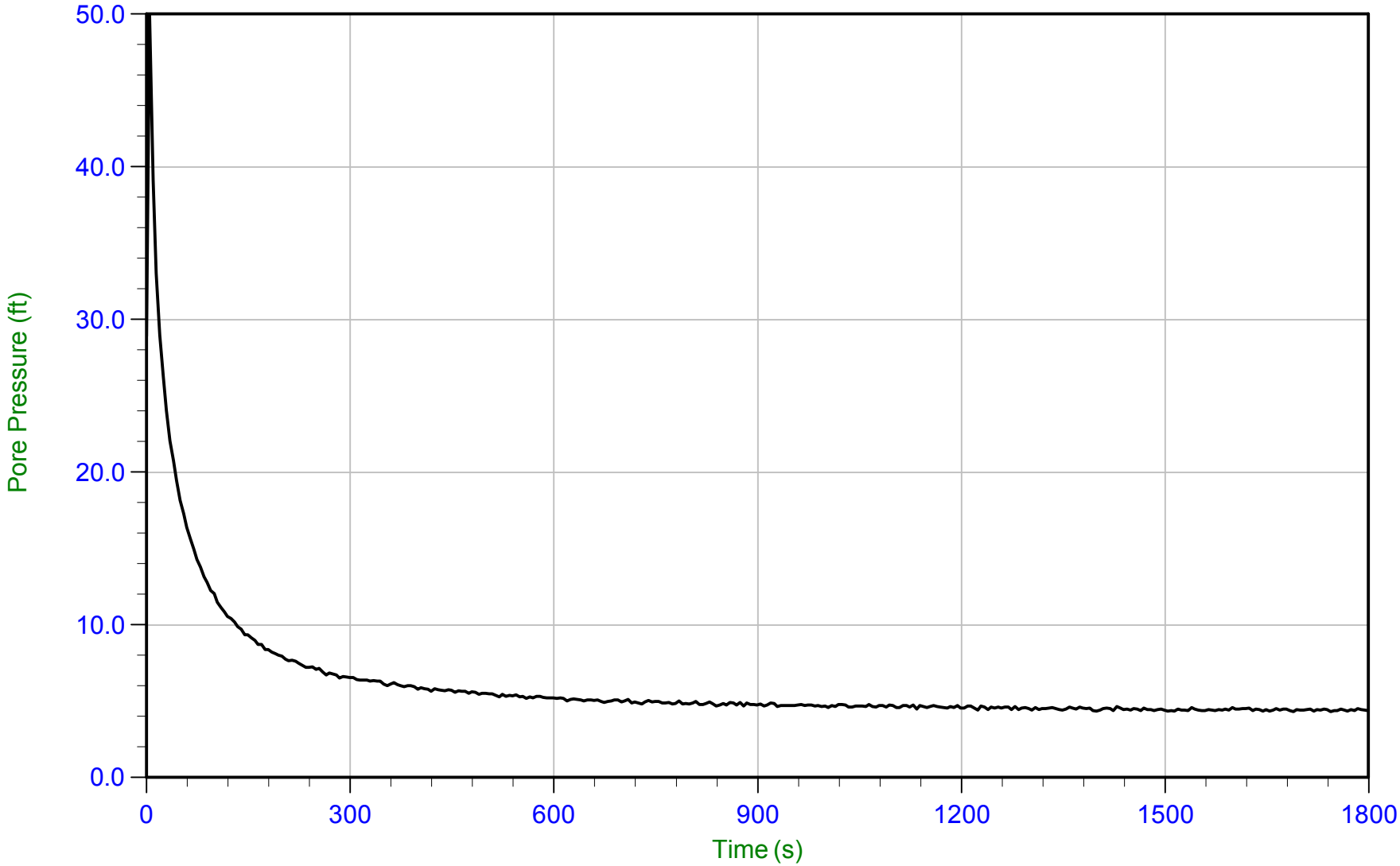
T(50): 36.4 s
Ir: 100
Ch: 19.3 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 11:32:02
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C026
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP26.PPD
Depth: 9.150 m / 30.019 ft
Duration: 1800.0 s

U Min: 4.3 ft
U Max: 50.0 ft

WT: 7.837 m / 25.712 ft
Ueq: 4.3 ft
U(50): 27.14 ft

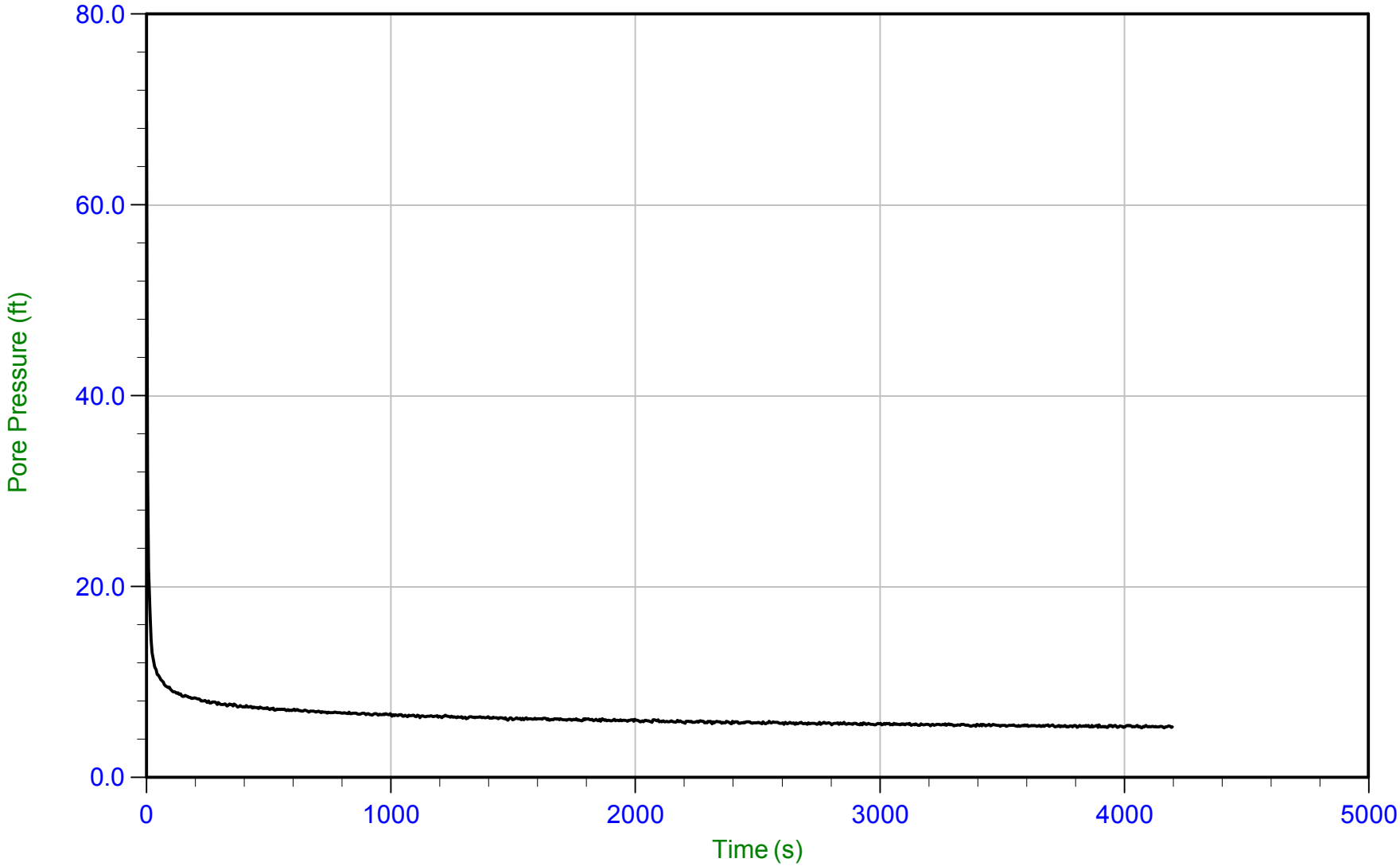
T(50): 18.4 s
Ir: 100
Ch: 38.2 sq cm/min

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 09:01:03
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C027
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP27.PPD
Depth: 5.350 m / 17.552 ft
Duration: 4200.0 s

U Min: 5.2 ft
U Max: 68.7 ft

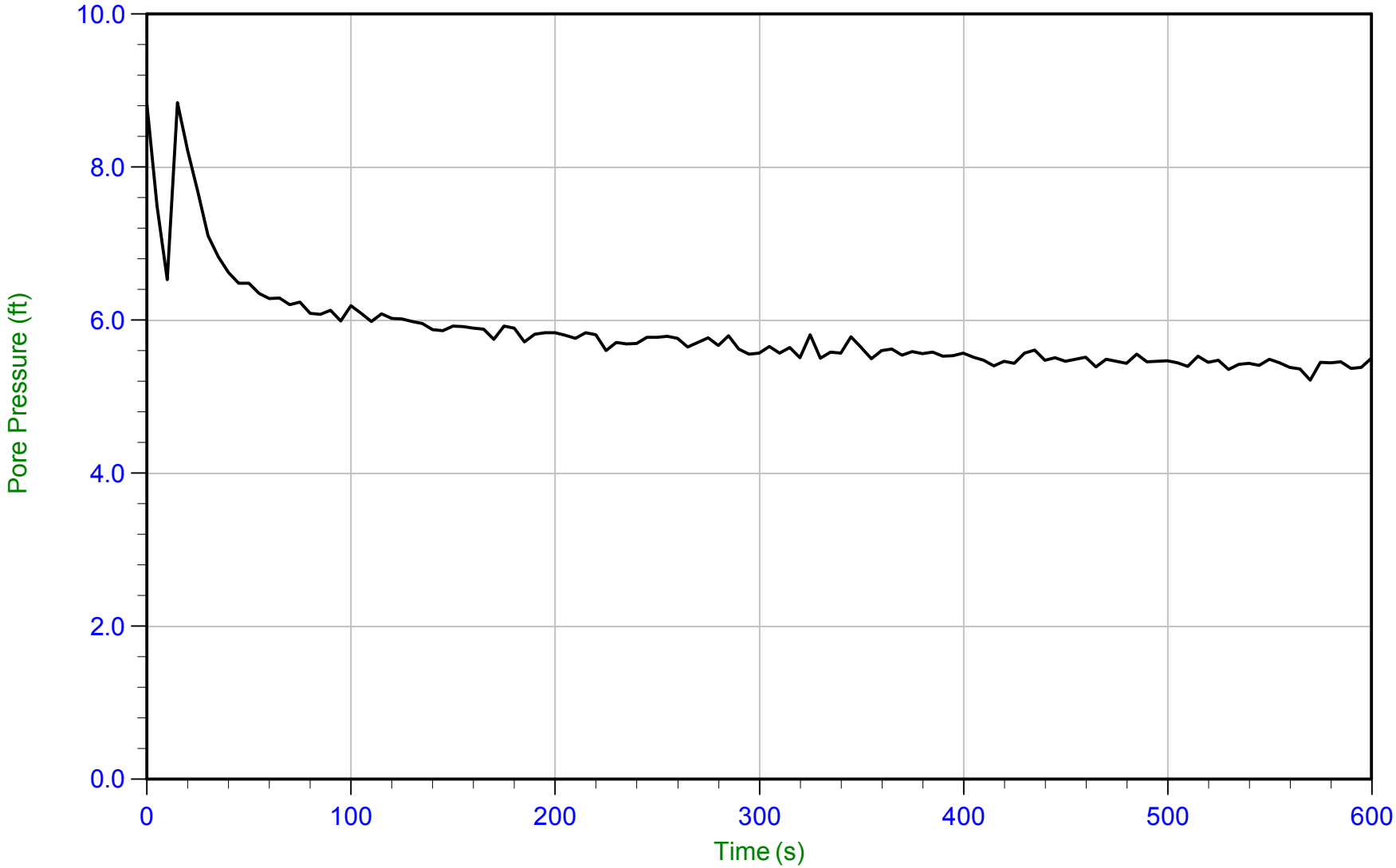
WT: 4.368 m / 14.331 ft
Ueq: 3.2 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 09:01:03
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C027
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP27.PPD
Depth: 6.000 m / 19.685 ft
Duration: 600.0 s

U Min: 5.2 ft
U Max: 8.8 ft

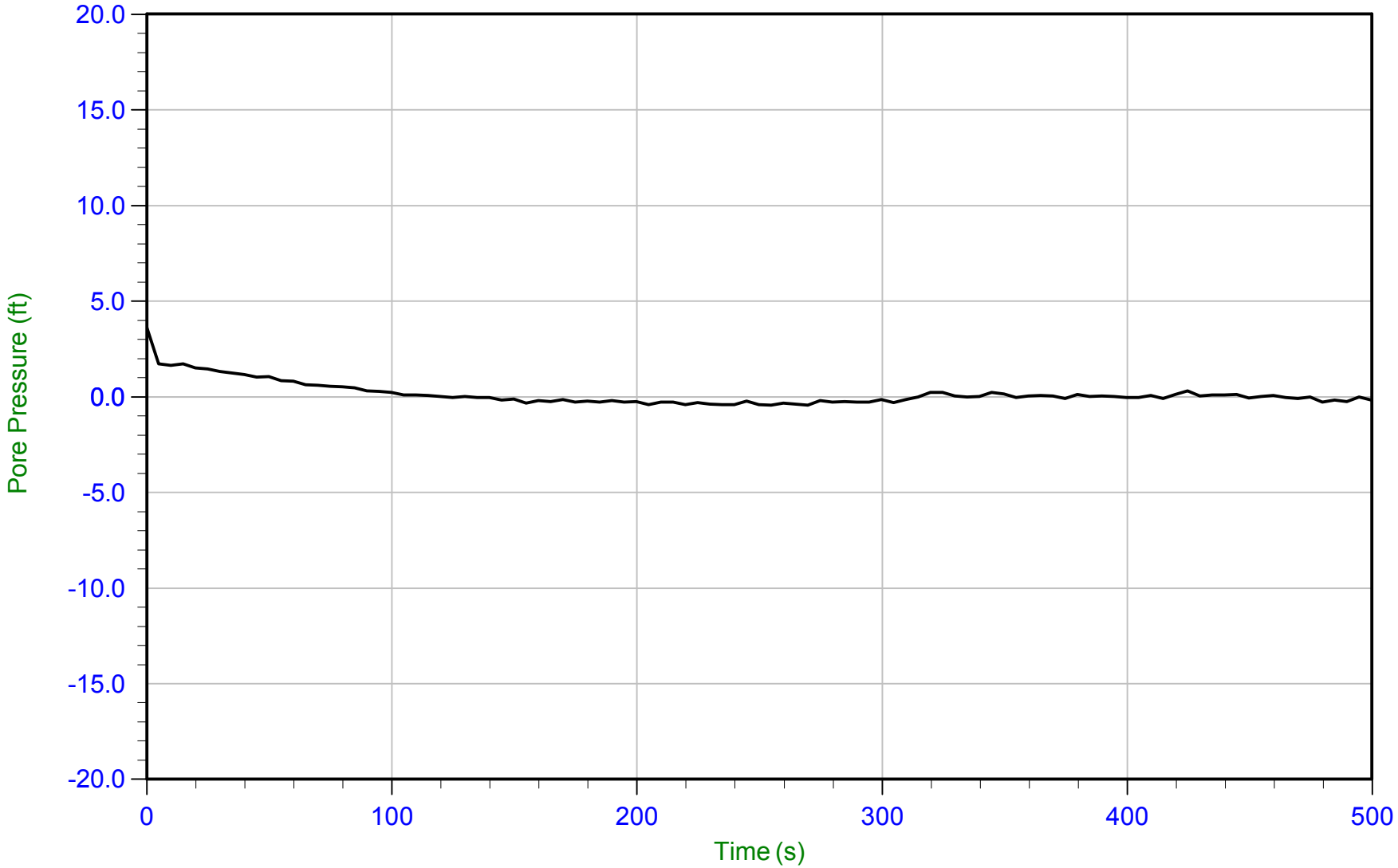
WT: 4.368 m / 14.331 ft
Ueq: 5.4 ft

CONETEC

AECOM

Job No: 15-53081
Date: 03-Sep-2015 09:01:03
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C027
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_SP27.PPD
Depth: 9.150 m / 30.019 ft
Duration: 500.0 s

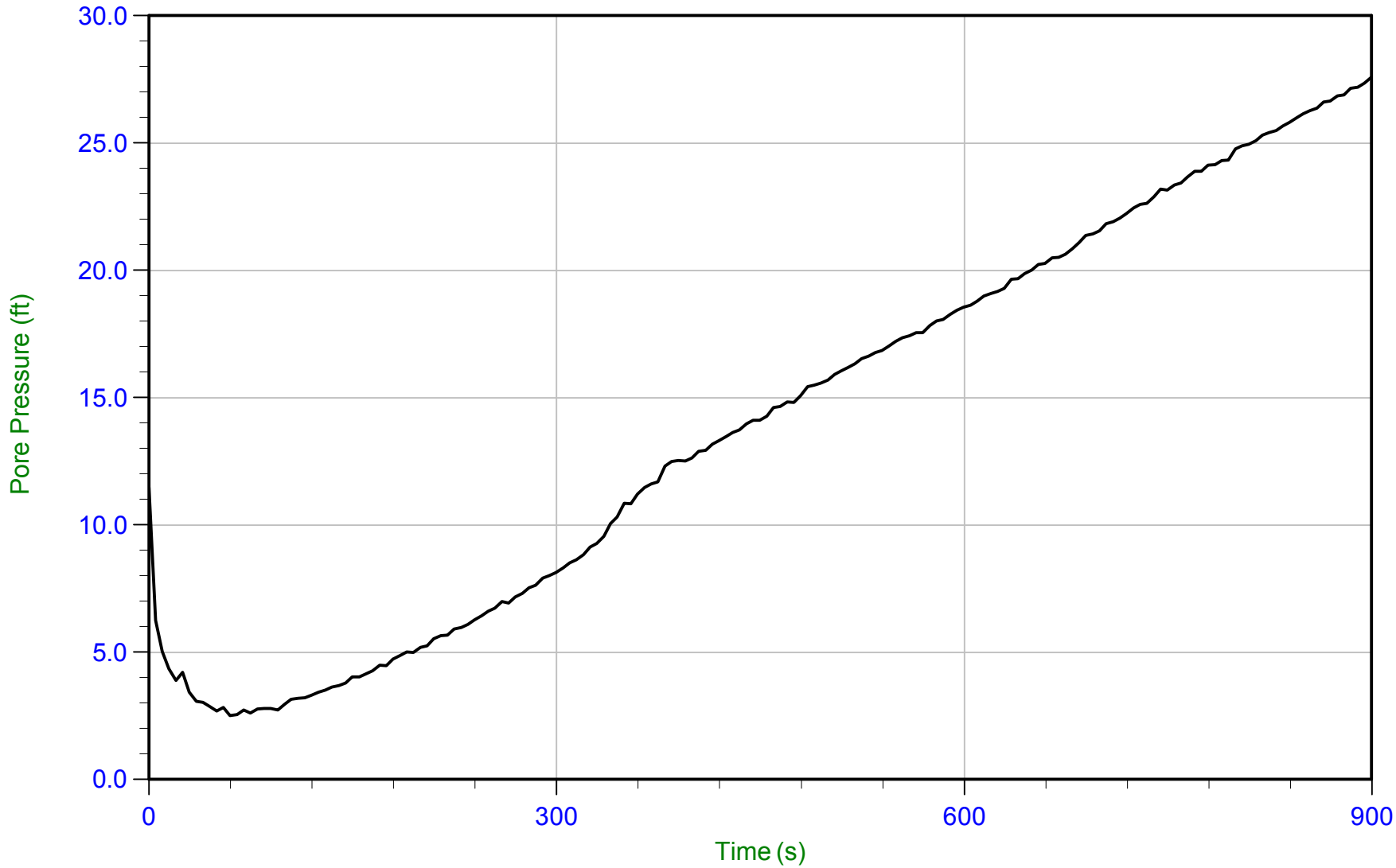
U Min: -0.4 ft
U Max: 3.6 ft

CONETEC

AECOM

Job No: 15-53081
Date: 01-Sep-2015 15:44:33
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C029
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP29.PPD
Depth: 3.050 m / 10.006 ft
Duration: 900.0 s

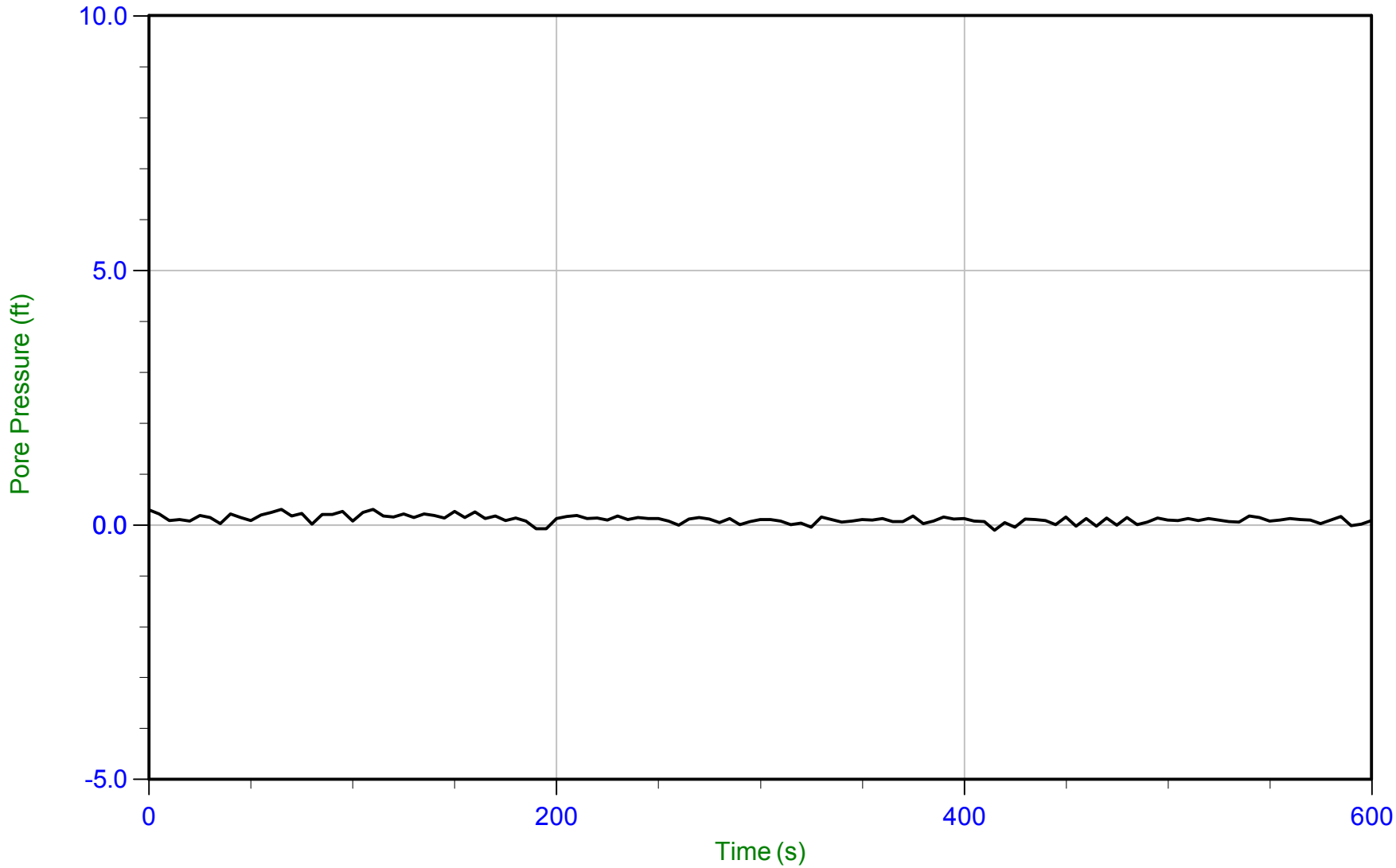
U Min: 2.5 ft
U Max: 27.6 ft

CONETEC

AECOM

Job No: 15-53081
Date: 01-Sep-2015 15:44:33
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C029
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP29.PPD
Depth: 6.450 m / 21.161 ft
Duration: 600.0 s

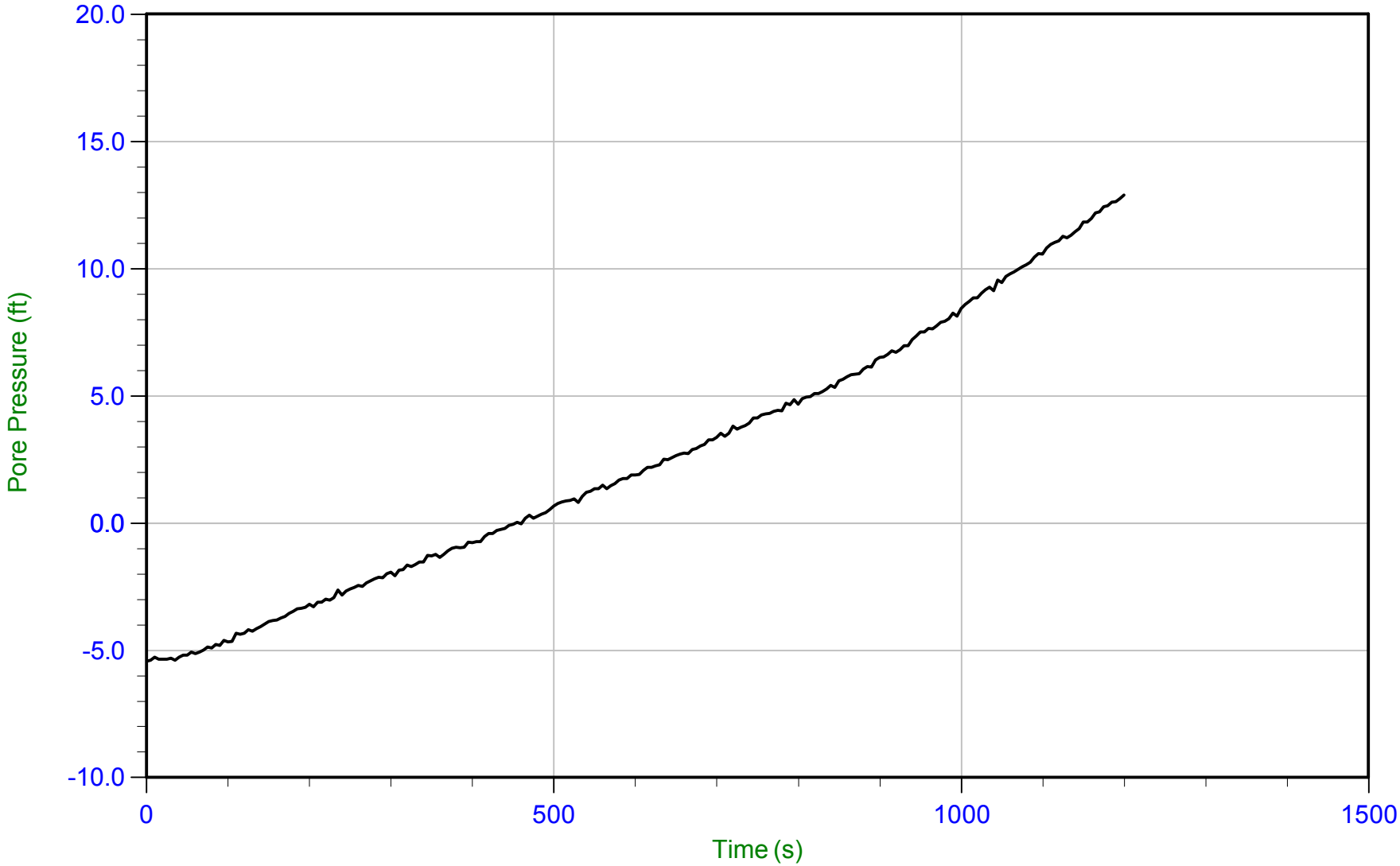
U Min: -0.1 ft
U Max: 0.3 ft

CONETEC

AECOM

Job No: 15-53081
Date: 02-Sep-2015 10:27:31
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C032
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP32.PPD
Depth: 3.050 m / 10.006 ft
Duration: 1200.0 s

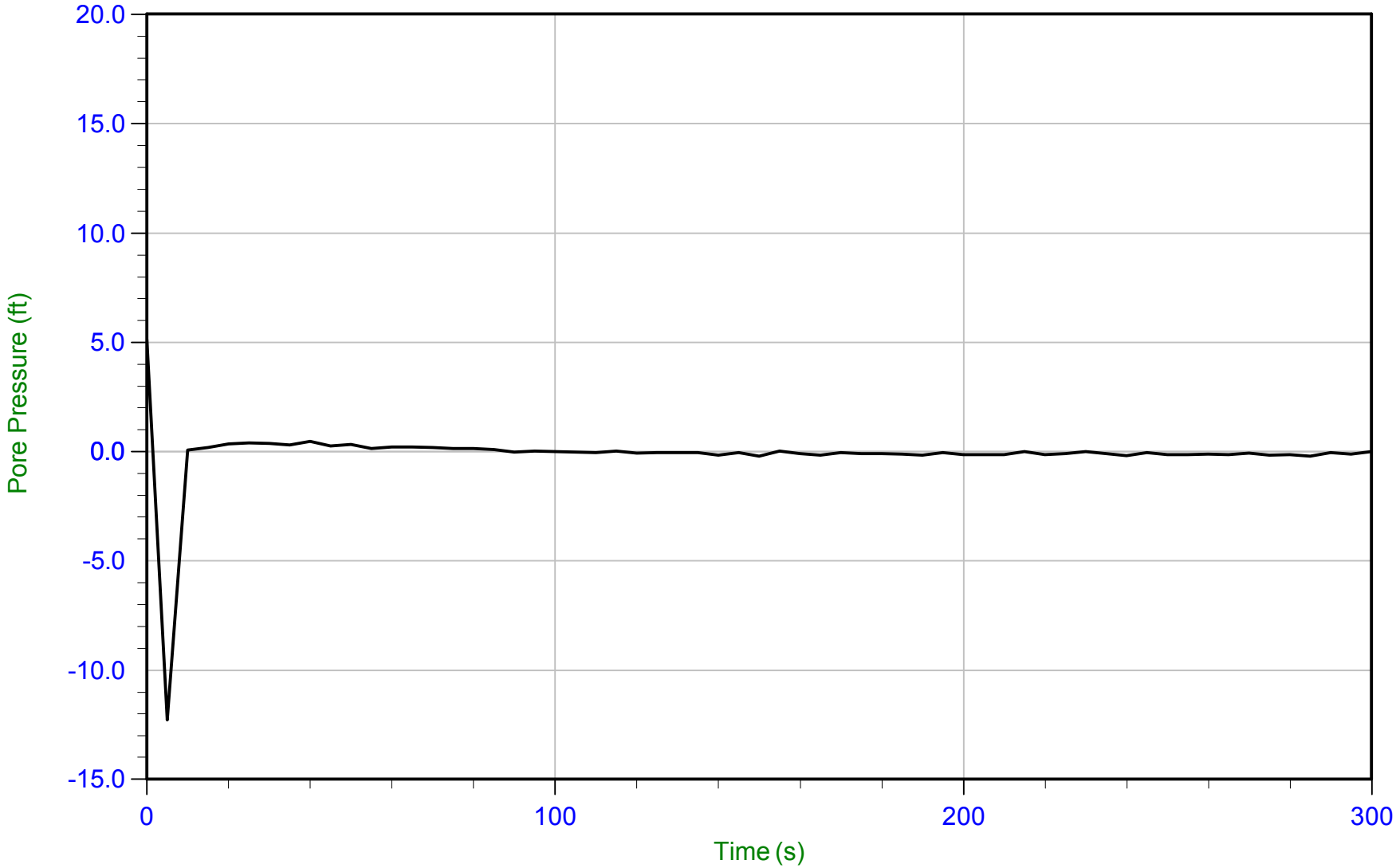
U Min: -5.4 ft
U Max: 12.9 ft

CONETEC

AECOM

Job No: 15-53081
Date: 02-Sep-2015 10:27:31
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C032
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP32.PPD
Depth: 3.750 m / 12.303 ft
Duration: 300.0 s

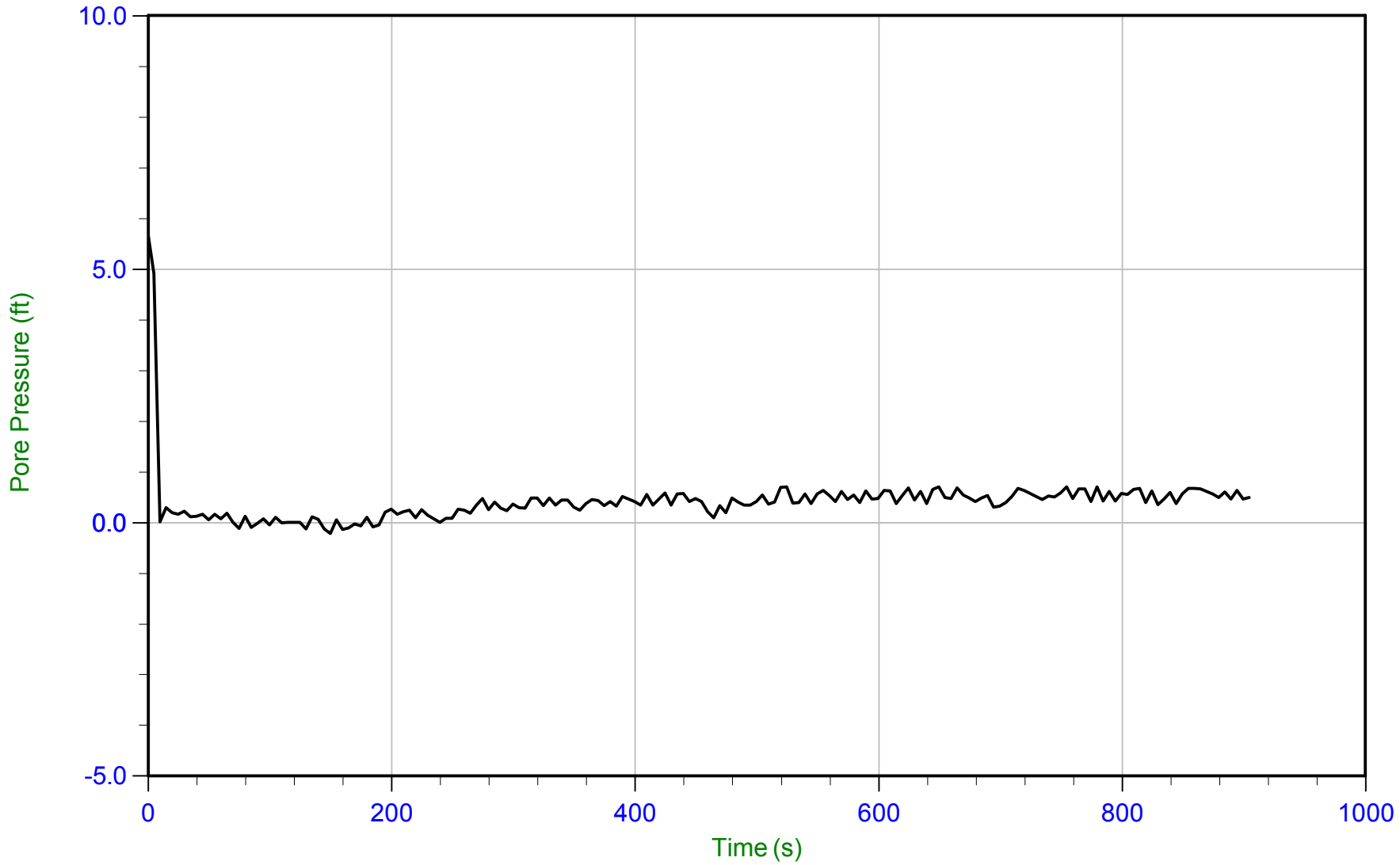
U Min: -12.3 ft
U Max: 5.1 ft

CONETEC

AECOM

Job No: 15-53081
Date: 02-Sep-2015 15:55:12
Site: Hennepin Power Station, Hennepin, Il

Sounding: HEN-C038A
Cone: 301
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP38A.PPD
Depth: 2.800 m / 9.186 ft
Duration: 905.0 s

U Min: -0.2 ft
U Max: 5.7 ft

WT: 2.629 m / 8.625 ft
Ueq: 0.6 ft

APPENDIX D

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B001	S-1	0.0'-1.5'	POSSIBLE FILL: REDDISH BROWN SANDY LEAN CLAY - ROOTS AND BRICK NOTED	CL	7.6										
HEN-B001	S-2	2.5'-4.0'	DARK BROWN SANDY LEAN CLAY	CL	13.1										
HEN-B001	S-3	5.0'-7.5'	DARK BROWN LEAN CLAY WITH SAND	CL	19.0										
HEN-B001	S-4	7.5'-9.5'	BROWN AND GRAY LEAN CLAY WITH SAND - SAND SEAMS NOTED	CL	17.4							21	14	7	
HEN-B001	S-5	10.0'-11.5'	BROWN AND DARK BROWN SANDY LEAN CLAY	CL	16.8										
HEN-B001	S-6	15.0'-16.5'	GRAY LEAN CLAY	CL	44.8										
HEN-B001	S-7	20.0'-22.0'	GRAY ORGANIC LEAN CLAY - SHELL NOTED	CL	37.0							38	22	16	
HEN-B001	S-8	25.0'-26.5'	GRAYISH BROWN LEAN CLAY	CL	30.6										
HEN-B001	S-9	30.0'-31.5'	BROWN LEAN CLAY	CL	36.6										
HEN-B001	S-10	35.0'-36.5'	DARK GRAY LEAN CLAY - ORGANICS NOTED	CL	39.8										
HEN-B001	S-11	40.0'-41.5'	DARK GRAY FAT CLAY	CH	43.3							59	30	29	
HEN-B001	S-12	45.0'-46.5'	GRAY SANDY LEAN CLAY	CL	31.5										
HEN-B001	S-13	50.0'-51.5'	GRAY SAND WITH GRAVEL	SP	18.6										
HEN-B001	S-14	55.0'-56.5'	BROWN AND GRAY SILTY SAND WITH GRAVEL	SM	7.4										
HEN-B002	S-1	0.0-1.5'	FILL: BROWN SANDY LEAN CLAY	CL	5.7										
HEN-B002	S-2	2.5'-4.0'	BROWN POORLY GRADED SAND WITH CLAY	SP-SC	6.8										2.68
HEN-B002	S-3	5.5'-6.5'	GRAY SANDY LEAN CLAY	CL	15.0										
HEN-B002	S-4	7.5'-9.0'	BROWN SILT WITH CLAY	ML	9.3							20	14	6	
HEN-B002	S-6	15.0'-16.5'	BROWN POORLY GRADED SAND WITH SILT AND GRAVEL	SP-SM	15.7		22.7	65.7	7.2	4.4	11.6				
HEN-B002	S-7A	20.0'-20.8'	BROWN CLAYEY SAND	SC	7.4										
HEN-B002	S-7B	20.8'-21.5'	GRAY SILTY LEAN CLAY	CL-ML	47.1										
HEN-B002	S-8	25.0'-27.0'	DARK GRAY LEAN CLAY WITH SAND AND GRAVEL - FLY ASH NOTED	OL	24.6							41	23	18	
HEN-B002	S-9	30.0'-31.5'	GRAYISH BROWN LEAN CLAY	CL	32.0										
HEN-B002	S-10	35.0'-37.0'	GRAY LEAN CLAY	CL	31.7							46	21	25	
HEN-B002	S-11	40.0'-41.5'	BROWN AND GRAY LEAN CLAY	CL	57.9										
HEN-B002	S-12A	45.0'-46.0'	DARK GRAY LEAN CLAY - ORGANICS NOTED	CL	57.9										
HEN-B002	S-12B	46.0'-46.5'	GRAY CLAYEY SILT	CL-ML	43.1										
HEN-B002	S-13	50.0'-51.5'	BROWN AND GRAY SILTY SAND	SM	21.2										
HEN-B002	S-14	55.0'-56.5'	BROWN POORLY GRADED SAND WITH SILT AND GRAVEL	SP-SM	15.3		16.8	71.3			11.9				
HEN-B002	S-15	60.0'-61.5'	GRAY GRAVEL	GP	4.0										

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B003	S-1	0.0'-1.5'	GRAY SILTY LEAN CLAY	CL	70.4										
HEN-B003	S-2	2.5'-4.0'	GRAY CLAYEY SILT	CL-ML	42.9										
HEN-B003	S-3	5.0'-6.5'	GRAY CLAYEY SILT	CL-ML	49.5										
HEN-B003	S-4	7.5'-9.0'	GRAY SILTY LEAN CLAY	CL	48.5										
HEN-B003	S-5	10.0'-12.0'	BLACK ORGANIC CLAY WITH SAND - WOOD NOTED	OL	38.5										
HEN-B003	S-6	15.0'-16.5'	BROWN TO GRAY LEAN CLAY	CL	36.8										
HEN-B003	S-7	20.0'-21.5'	GRAYISH BROWN LEAN CLAY	CL	32.2										
HEN-B003	S-8	25.0'-27.5'	DARK GRAY LEAN CLAY	CL	32.1							45	21	24	
HEN-B003	S-9	30.0'-31.5'	DARK GRAY LEAN CLAY	CL	66.3										
HEN-B003	S-10	35.0'-36.5'	GRAY LEAN CLAY	CL	44.4										
HEN-B003	S-11	40.0'-41.5'	BROWN AND GRAY SANDY SILT	ML	30.3										
HEN-B003	S-12	45.0'-46.5'	CLAYEY SAND WITH SILT	SC	15.6										
HEN-B003	S-13	50.0'-51.5'	BROWN CLAYEY SAND WITH GRAVEL	SC	7.7										
HEN-B004	S-1	0.0'-0.5'	FILL: SILTY SAND - CLAY LENSES NOTED	SM	8.9										
HEN-B004	S-1A	0.5'-1.5'	BROWN SILTY SAND WITH GRAVEL - CLAY LENSES NOTED	SM	6.8										
HEN-B004	S-2	2.5'-4.0'	BROWN, TAN AND GRAY POORLY GRADED GRAVEL WITH SAND	GP	2.9										2.746
HEN-B004	S-3	5.0'-6.5'	BROWN SANDY LEAN CLAY WITH GRAVEL	CL	6.3										
HEN-B004	S-4	7.5'-9.0'	GRAY SILTY SAND	SM	22.2										
HEN-B004	S-5	10.0'-12.0'	BROWN BLACK AND GRAY SANDY SILT WITH GRAVEL	ML	36.8							32	35	NP	
HEN-B004	S-6	15.0'-16.5'	DARK BROWN SANDY LEAN CLAY	CL	14.9										
HEN-B004	S-7	20.0'-22.0'	VERY DARK GRAY LEAN CLAY - ORGANICS NOTED	CL	29.7							45	23	22	
HEN-B004	S-8	25.0'-26.5'	GRAY LEAN CLAY	CL	32.0										
HEN-B004	S-9	30.0'-32.0'	BROWN AND GRAY LEAN CLAY	CL	33.5							43	22	21	
HEN-B004	S-10	35.0'-36.5'	GRAYISH BROWN LEAN CLAY WITH SAND	CL	19.5										
HEN-B004	S-11	40.0'-41.5'	DARK BROWN LEAN CLAY	CL	10.9										
HEN-B004	S-12	45.0'-46.5'	BROWN CLAYEY SAND WITH SILT AND GRAVEL	SC	7.2										
HEN-B005	S-1	4.0'-6.0'	DARK GRAY TO BROWN CLAYEY SILT WITH SAND	CL-ML	28.5										
HEN-B005	S-2	7.5'-9.5'	BLACK TO VERY DARK GRAY ORGANIC CLAY	OL	59.5										
HEN-B005	S-4	12.5'-14.5'	DARK GRAY LEAN CLAY WITH SAND AND FLY ASH	CL	53.0		0.0	16.2	51.2	32.6	83.8	43	24	19	
HEN-B005	S-5	14.5'-16.0'	DARK GRAY LEAN CLAY WITH GRAVEL	CL	16.3										
HEN-B005	S-3	10.0'-12.5'	GRAY ORGANIC CLAY WITH SAND	OL	41.4										
HEN-B005	S-6	20.0'-21.5'	BROWN AND GRAY CLAYEY GRAVEL WITH SAND	GC	7.8										
HEN-B005	S-7	25.0'-27.0'	BROWN CLAYEY GRAVEL	GC	7.2										

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B006	S-1	0.0'-1.5'	FILL: BROWN SILTY SAND WITH GRAVEL	SM	4.4										
HEN-B006	S-2	2.5'-4.0'	BROWN AND LIGHT BROWN POORLY GRADED SAND WITH GRAVEL	SP	6.8										2.665
HEN-B006	S-3	5.0'-6.5'	BROWN SILTY SAND - CLAY LENSES NOTED	SM	5.9										
HEN-B006	S-4	7.5'-9.0'	POSSIBLE FILL: DARK BROWN SANDY LEAN CLAY	CL	7.1										
HEN-B006	S-5	10.0'-11.5'	BROWN SILTY SAND	SM	14.6										
HEN-B006	S-6	15.0'-16.5'	BROWN SILTY SAND	SM	13.8		0.8	62.3	23.1	13.8	36.9				
HEN-B006	S-7	20.0'-21.5'	BROWN GRAVELLY SAND	SP-SM	7.9										
HEN-B006	S-8	25.0'-26.5'	BROWN GRAVELLY SAND	SP-SC	8.2										
HEN-B006	S-9	30.0'-31.5'	LIGHT BROWN SILTY GRAVEL WITH SAND	GM	15.2		42.4	38.3	12.1	7.2	19.3				
HEN-B006	S-10	35.0'-36.5'	BROWN GRAVELLY LEAN CLAY WITH SAND	CL	10.7										
HEN-B006	S-11	40.0'-41.5'	BROWN GRAVELLY SAND	SP	9.1										
HEN-B007	S-1	3.5'-5.0'	FILL: GRAY SILTY SAND - ASPHALT NOTED	SM	31.2										
HEN-B007	S-2	5.0'-5.5'	GRAYISH BROWN TO DARK GRAY SILTY SAND WITH CLAY	SM	36.2										
HEN-B007	S-2A	5.5'-6.5'	GRAY GRAVELLY LEAN CLAY WITH SAND	CL	7.1										
HEN-B007	S-3	7.5'-9.0'	GRAYISH BROWN CLAYEY GRAVEL WITH SAND	GC	6.0										
HEN-B007	S-4	10.0'-11.0'	BROWN POORLY GRADED GRAVEL WITH CLAY	GP-GC	17.6										
HEN-B007	S-4A	11.0'-11.5'	BROWN CLAYEY GRAVEL WITH SAND	GC	9.5										
HEN-B007	S-5	12.5'-14.5'	BROWN CLAYEY SAND WITH SILT	SC	10.2										
HEN-B007	S-6	15.0'-16.5'	BROWN GRAVEL WITH POORLY GRADED SAND AND SILT	GP	11.1		59.2	28.9	7.2	4.7	11.9				
HEN-B007	S-7	20.0'-21.5'	BROWN CLAYEY SAND WITH GRAVEL	SC	11.3										
HEN-B008	S-1	0.0'-1.5'	POSSIBLE FILL: GRAY FLY ASH - WOODCHIPS NOTED		34.5										
HEN-B008	S-2	2.5'-4.0'	GRAY FLY ASH		44.7										
HEN-B008	S-3	5.0'-6.5'	DARK GRAY TO BLACK SANDY SILT	ML	49.0		1.5	41.0	47.9	9.6	57.5				
HEN-B008	S-4	7.5'-9.5'	MULTI STRATA SAMPLE: TOP, FLY ASH - MIDDLE, FLY ASH LEAN CLAY WITH SAND MIX - BOTTOM, BROWN SANDY CLAY		43.4										
HEN-B008	S-5	10.0'-11.5'	BROWN AND DARK BROWN LEAN CLAY	CL	16.2										
HEN-B008	S-6	15.0'-16.5'	BROWN POORLY GRADED SAND WITH GRAVEL	SP	9.8										
HEN-B008	S-7	20.0'-21.5'	BROWN POORLY GRADED GRAVEL WITH SILT AND SAND	GP-GM	7.4		54.4	33.9			11.7				

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B009	S-1	0.0'-1.5'	FILL: DARK BROWN SILTY SAND	SM	10.6										
HEN-B009	S-2	2.5'-4.0'	DARK GRAY AND BLACK SILT WITH SAND AND GRAVEL	ML	11.3										
HEN-B009	S-3	5.0'-6.5'	GRAY SILTY SAND	SM	15.5										
HEN-B009	S-4	8.0'-9.0'	DARK BROWN SILT WITH SAND	ML	10.0										2.672
HEN-B009	S-5	10.0'-11.5'	DARK BROWN AND BROWN LEAN CLAY WITH SILT AND SAND	CL	17.7										
HEN-B009	S-6	15.0'-16.5'	BROWN SILTY SAND WITH GRAVEL	SM	7.3										
HEN-B009	S-7	20.0'-21.5'	BROWN CLAYEY SAND WITH GRAVEL	SC	7.7										
HEN-B009	S-8	25.0'-26.5'	BROWN SILTY SAND	SM	20.1		0.4	76.9			22.7				
HEN-B009	S-9	30.0'-31.5'	BROWN POORLY GRADED SAND	SP	20.9										
HEN-B009	S-10A	35.0'-35.5'	BROWN SILTY LEAN CLAY	CL	27.7										
HEN-B009	S-10B	35.5'-36.0'	BROWN SILTY LEAN CLAY	CL	26.4										
HEN-B009	S-10C	36.0'-36.5'	BROWN SILTY LEAN CLAY	CL	25.9										
HEN-B009	S-11	40.0'-41.5'	BROWN SILTY SAND	SM	27.2		0.0	70.3			29.7				
HEN-B009	S-12A	45.0'-45.5'	BROWN SILTY LEAN CLAY	CL	24.4										
HEN-B009	S-12B	45.5'-46.5'	BROWN SILTY SAND	SM	26.4										
HEN-B009	S-13	50.0'-51.5'	BROWN AND DARK BROWN CLAYEY SAND WITH GRAVEL	SC	10.3										
HEN-B010	S-1	0.0'-1.5'	POSSIBLE FILL: BROWN, GRAYISH BROWN AND GRAY SAND WITH GRAVEL	SP-SM	3.6										
HEN-B010	S-2A	2.5'-3.5'	BROWN SANDY CLAY	CL	11.2										
HEN-B010	S-2B	3.5'-4.0'	BROWN, GRAY AND DARK GRAY POORLY GRADED SAND WITH GRAVEL	SP	7.6										
HEN-B010	S-3	5.0'-6.5'	DARK GRAY FLY ASH		26.6										
HEN-B010	S-4	7.5'-9.0'	BROWN AND DARK BROWN SILTY SAND	SM	28.3		1.3	77.9			20.8				2.723
HEN-B010	S-5	10.0'-11.5'	VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL		29.8							29	33	NP	
HEN-B010	S-6	15.0'-16.5'	DARK BROWN LEAN CLAY	CL	19.7										
HEN-B010	S-7	20.0'-21.5'	BROWN TO DARK BROWN POORLY GRADED SAND WITH SILT AND GRAVEL	SP-SM	14.2		24.8	61.0	9.3	4.9	14.2				
HEN-B010	S-8	25.0'-26.5'	BROWN POORLY GRADED SAND	SP	10.4										
HEN-B010	S-9	30.0'-31.5'	BROWN GRAVELLY SAND	SP	9.1										
HEN-B010	S-10	35.0'-36.5'	BROWN POORLY GRADED SAND	SP	20.3										
HEN-B010	S-11	40.0'-41.5'	BROWN SILTY SAND WITH GRAVEL	SM	16.2		8.2	67.9			23.9				
HEN-B011	S-1	0.0'-1.5	POSSIBLE FILL: DARK BROWN POORLY GRADED SAND - ROOTS NOTED	SP	10.5										
HEN-B011	S-2	2.5'-4.0'	RUST BROWN SANDY LEAN CLAY	CL	12.7							22	15	7	2.693
HEN-B011	S-3	5.0'-6.5'	BROWN POORLY GRADED SAND	SP	15.2										
HEN-B011	S-4	7.5'-9.0'	BROWN AND DARK BROWN POORLY GRADED SAND	SP	19.8										
HEN-B011	S-5	10.0'-11.5'	BROWN POORLY GRADED SAND	SP	13.2										
HEN-B011	S-6	15.0'-16.5'	BROWN SILTY GRAVEL WITH SAND	GM	7.3		47.4	36.6			16.0				
HEN-B011	S-7	20.0'-21.5'	BROWN AND GRAYISH BROWN POORLY GRADED GRAVEL	GP	6.3										

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B012	S-1	0.0'-1.5'	DARK BROWN SILTY SAND WITH GRAVEL - CLAY LENSES NOTED	SM	4.5										
HEN-B012	S-2	2.5'-4.0'	LIGHT BROWN AND LIGHT GRAY SILTY GRAVEL WITH SAND	GM	4.9		47.5	33.4	11.1	8.0	19.1				
HEN-B012	S-3	5.0'-6.5'	BROWN SANDY LEAN CLAY WITH GRAVEL	CL	7.7										
HEN-B012	S-4	8.0'-9.0'	BROWN SILTY LEAN CLAY WITH SAND	CL	9.0										
HEN-B012	S-5	10.0'-11.5'	DARK BROWN LEAN CLAY WITH SILT AND SAND - SILT AND SAND SEAM NOTED	CL	14.3							23	14	9	
HEN-B012	S-6	15.0'-16.5'	DARK GRAY SILTY SAND	SM	45.4										
HEN-B012	S-7	20.0'-22.0'	VERY DARK GRAY LEAN CLAY - ORGANICS NOTED	CL	38.1		0.0	2.7	38.5	58.8	97.3				
HEN-B012	S-8	25.0'-26.5'	DARK GRAY LEAN CLAY	CL	22.5										
HEN-B012	S-9	30.0'-32.0'	BROWN AND GRAYISH BROWN LEAN CLAY WITH SAND	CL	26.0							30	15	15	
HEN-B012	S-10	35.0'-36.5'	GRAYISH BROWN LEAN CLAY	CL	26.2										
HEN-B012	S-11	40.0'-41.5'	BROWN SILTY SAND WITH GRAVEL	SM	4.4										
HEN-B012	S-12	45.0'-46.5'	BROWN SILTY SAND WITH GRAVEL	SM	11.3										
HEN-B014	S-1	0.0'-1.5'	FILL: DARK BROWN AND GRAYISH BROWN SILTY SAND WITH GRAVEL	SM	7.0										
HEN-B014	S-2	2.5'-4.0'	FILL: DARK BROWN SILTY SAND WITH GRAVEL - ORGANIC CLAY AND BRICK NOTED	SM	7.0										
HEN-B014	S-3	5.5'-6.5'	GREENISH GRAY CLAYEY SILT WITH SAND	CL-ML	39.2										
HEN-B014	S-4	7.5'-9.0'	DARK GRAY FLY ASH		36.8		1.1	32.1	58.1	8.7	66.8				
HEN-B014	S-5A	10.0'-11.0'	DARK GRAY FLY ASH WITH SAND		34.2										
HEN-B014	S-5B	11.0'-11.5'	DARK GRAY FLY ASH		43.4										
HEN-B014	S-6A	15.0'-16.0'	DARK GRAY FLY ASH		61.1										
HEN-B014	S-6B	16.0'-16.5'	DARK GRAY LEAN CLAY - ORGANICS NOTED	CL	29.8										
HEN-B014	S-7	20.0'-21.5'	GRAYISH BROWN AND DARK GRAY LEAN CLAY - ORGANICS NOTED	CL	33.7										
HEN-B014	S-8	25.0'-27.0'	BROWN AND GRAY LEAN CLAY	CL	32.4							43	20	23	
HEN-B014	S-9	30.0'-31.5'	GRAYISH BROWN AND DARK GRAY LEAN CLAY - ORGANICS NOTED	CL	38.1										
HEN-B014	S-10	35.0'-37.0'	VERY DARK BROWNISH GRAY ORGANIC SILT	OH	63.4							70	38	32	
HEN-B014	S-11	40.0'-41.5'	DARK GRAY PEAT	PT	77.8										
HEN-B014	S-12	45.0'-46.5'	GRAY POORLY GRADED SAND WITH SILT	SP-SM	22.6		4.3	86.4	5.1	4.2	9.3				
HEN-B014	S-13	50.0'-51.5'	GRAY SILTY SAND	SM	13.2										
HEN-B014	S-14	55.0'-56.5'	GRAYISH BROWN SILTY SAND WITH GRAVEL	SM	8.1										
HEN-B014	S-15	60.0'-61.5'	BROWN AND GRAYISH BROWN SILTY SAND WITH CLAY AND GRAVEL	SM	14.4										

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B015	S-1	0.5'-1.5'	BROWN AND GRAY SANDY LEAN CLAY	CL	18.4										
HEN-B015	S-2	2.5'-4.0'	DARK GRAY LEAN CLAY	CL	2.9										
HEN-B015	S-3	5.0'-6.5'	BROWN TO GRAY LEAN CLAY	CL	35.7										
HEN-B015	S-4	7.5'-9.5'	BLACK AND DARK GRAY ORGANIC LEAN CLAY WITH SAND AND GRAVEL	OL	131.9							48	25	23	
HEN-B015	S-5	10.0'-11.5'	DARK BROWN TO GRAY LEAN CLAY	CL	32.3										
HEN-B015	S-6	15.0'-16.5'	BROWN AND GRAY LEAN CLAY	CL	32.1										
HEN-B015	S-7	20.0'-21.5'	GRAY LEAN CLAY	CL	41.6										
HEN-B015	S-8	25.0'-27.0'	BLACK ORGANIC SILT WITH SAND	OH	67.8							74	37	37	
HEN-B015	S-9	30.0'-31.5'	GRAY AND DARK GRAY CLAYEY SAND WITH SILT	SC	40.1										
HEN-B015	S-10	35.0'-36.5'	GRAY POORLY GRADED SAND WITH SILT	SP-SM	24.5										
HEN-B015	S-11	40.0'-41.5'	BROWN CLAYEY SAND WITH GRAVEL	SC	8.7										
HEN-B015	S-12	45.0'-46.5'	GRAY AND BROWN POORLY GRADED GRAVEL WITH SILT AND SAND	GP-GM	10.9		49.3	40.5	7.1	3.1	10.2				
HEN-B016	S-1	0.0'-1.5'	POSSIBLE FILL: DARK BROWN SANDY LEAN CLAY - GRAVEL AND BRICK NOTED	CL	7.1										
HEN-B016	S-2	2.5'-4.5'	BROWN SANDY LEAN CLAY	CL	6.3										
HEN-B016	S-3	5.0'-6.5'	DARK BROWN AND BROWN SILTY SAND WITH GRAVEL		10.1		31.5	45.2	13.0	10.3	23.3				
HEN-B016	S-4	7.5'-9.0'	BROWN SANDY LEAN CLAY WITH GRAVEL	CL	7.3										
HEN-B016	S-5	10.0'-11.5'	DARK GRAY FLY ASH WITH SAND		29.8										
HEN-B016	S-6	15.0'-16.5'	DARK GRAY LEAN CLAY - ORGANICS NOTED	CL	31.8										
HEN-B016	S-7	20.0'-22.0'	VERY DARK GRAY CLAY WITH SAND AND GRAVEL - ORGANICS AND ASH NOTED	CL	35.2							38	21	17	
HEN-B016	S-8	25.0'-26.5'	GRAY LEAN CLAY	CL	32.7										
HEN-B016	S-9	30.0'-31.5'	GRAYISH BROWN LEAN CLAY	CL	32.9										
HEN-B016	S-10	35.0'-37.0'	DARK GRAY LEAN CLAY WITH SAND - FLY ASH AND ORGANICS NOTED	CL	22.3							41	23	18	
HEN-B016	S-11	40.0'-41.5'	DARK GRAY ORGANIC CLAY	OL	48.8										
HEN-B016	S-12	45.0'-46.5'	GRAY LEAN CLAY	CL	42.3										
HEN-B016	S-13	51.0'-51.5'	GRAY POORLY GRADED SAND	SP	26.4										
HEN-B016	S-14	55.0'-56.5'	GRAY TO BROWN POORLY GRADED SAND	SP	18.7										
HEN-B016	S-15	60.0'-61.5'	DARK GRAY LEAN CLAY WITH SILT	CL	51.9							55	34	21	
HEN-B016	S-16	65.0'-66.5'	BROWN LEAN CLAY	CL	38.9										
HEN-B016	S-17	70.0'-71.5'	BROWNISH GRAY GRAVEL WITH SILT AND SAND	GP-GM	10.4		52.4	35.5	9.0	3.1	12.1				
HEN-B016	S-18	75.0'-76.5'	GRAYISH BROWN GRAVELLY SAND	SP	6.5										

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B017	S-1	0.0'-1.5'	FILL: SILTY LEAN CLAY WITH SAND	CL	20.6										
HEN-B017	S-2	2.5'-4.0'	DARK BROWN SILTY SAND WITH CLAY	SM	24.1										
HEN-B017	S-3	5.0'-7.0'	VERY DARK GRAY LEAN CLAY WITH SAND	CL	36.7							39	21	18	
HEN-B017	S-4	7.5'-9.0'	GRAY TO BROWN ORGANIC CLAY	OL	35.4										
HEN-B017	S-5	10.0'-11.5'	GRAYISH BROWN LEAN CLAY - ORGANICS NOTED	CL	31.4										
HEN-B017	S-6	15.0'-17.0'	BROWN AND GRAY LEAN CLAY	CL	34.1							45	24	21	
HEN-B017	S-7	20.0'-21.5'	BROWN LEAN CLAY - ORGANICS NOTED	CL	34.8										
HEN-B017	S-8	25.0'-26.5'	BROWN AND GRAY LEAN CLAY	CL	31.7										
HEN-B017	S-9	30.0'-32.0'	DARK BROWNISH GRAY ORGANIC CLAY WITH SAND - SAND SEAMS AND SHELL NOTED	OL	50.0							60	35	25	
HEN-B017	S-10	35.0'-36.5'	GRAY LEAN CLAY	CL	41.8										
HEN-B017	S-11	40.5'-41.5'	GRAY CLAYEY SAND WITH SILT	SC	24.0										
HEN-B017	S-12	45.0'-46.5'	DARK GRAY SAND WITH SILT	SM	19.2		0.0	91.9	4.1	4.0	8.1				
HEN-B017	S-13	50.0'-51.5'	GRAY LEAN CLAY - ORGANICS NOTED	CL	46.8										
HEN-B017	S-14	55.0'-56.5'	GRAYISH BROWN LEAN CLAY - ORGANICS NOTED	CL	40.9										
HEN-B017	S-15	60.0'-61.5'	GRAY SILTY SAND WITH GRAVEL	SM	9.7										
HEN-B017	S-16	65.0'-66.5'	BROWN SILTY SAND WITH GRAVEL	SM	7.2										
HEN-B018	S-1	0.0'-1.5'	FILL: BROWN SILTY SAND WITH GRAVEL	SM	6.7										
HEN-B018	S-2A	2.5'-3.5'	BROWN SANDY LEAN CLAY	CL	10.2										
HEN-B018	S-2B	3.5'-4.0'	BROWN SILTY LEAN CLAY WITH GRAVEL	CL	9.7										
HEN-B018	S-3	5.0'-6.5'	BROWN, TAN AND GRAY SILT WITH CLAY AND GRAVEL	ML	9.3										2.7
HEN-B018	S-4	7.5'-9.0'	DARK GRAY FLY ASH WITH SAND		62.5										
HEN-B018	S-5	10.0'-12.0'	GRAY TO VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL		44.3										
HEN-B018	S-6	15.0'-16.5'	DARK GRAY ORGANIC CLAY	CL	41.1										
HEN-B018	S-7	20.0'-21.5'	GRAYISH BROWN LEAN CLAY	CL	30.0										
HEN-B018	S-8	25.0'-27.0'	DARK BROWNISH GRAY LEAN CLAY	CL	31.8							43	22	21	
HEN-B018	S-9	30.0'-31.5'	GRAYISH BROWN LEAN CLAY	CL	33.0										
HEN-B018	S-10	35.0'-36.5'	DARK BROWN ORGANIC CLAY	OL	58.1										
HEN-B018	S-11	40.0'-42.0'	DARK BROWN AND GRAY ORGANIC CLAY WITH SAND - SAND SEAMS AND SHELL NOTED	OL	40.5							27	20	7	
HEN-B018	S-12	45.0'-46.5'	DARK GRAY LEAN CLAY	CL	37.6										
HEN-B018	S-13	50.0'-51.5'	GRAY POORLY GRADED SAND	SP	21.5										
HEN-B018	S-14	55.0'-56.5'	GRAY AND BROWN SILTY SAND	SM	16.8		0.0	79.1			20.9				
HEN-B018	S-15	60.0'-61.5'	GRAYISH BROWN AND DARK GRAY LEAN CLAY - ORGANICS NOTED	CL	49.2										
HEN-B018	S-16	65.0'-66.5'	BROWN AND GRAY SILTY SAND WITH GRAVEL	SM	10.5										
HEN-B018	S-17	70.0'-71.5'	GRAY SILTY SAND WITH GRAVEL	SM	10.6										

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B019	S-1	4.0'-4.3'	GRAYISH BROWN GRAVELLY SAND	SP	9.9										
HEN-B019	S-1A	4.3'-5.8'	BROWN AND GRAY LEAN CLAY	CL	34.8										
HEN-B019	S-2	7.5'-9.5'	DARK BROWN LEAN CLAY WITH SAND	CL	33.0							41	22	19	
HEN-B019	S-3	10.0'-11.5'	BROWN LEAN CLAY	CL	35.5										
HEN-B019	S-4	12.5'-14.5'	GRAY AND BROWN LEAN CLAY	CL	34.5							45	24	21	
HEN-B019	S-5	14.5'-16.0'	BROWN TO GRAY LEAN CLAY	CL	31.1										
HEN-B019	S-6	20.0'-22.0'	BROWN AND GRAY LEAN CLAY	CL	33.9							38	22	16	
HEN-B019	S-7	25.0'-27.0'	VERY DARK GRAY ORGANIC SILT WITH SAND - SHELL NOTED	ML	44.5							34	26	8	
HEN-B019	S-8	30.0'-31.5'	DARK GRAY SANDY LEAN CLAY	CL	30.9										
HEN-B019	S-9	35.0'-36.0'	GRAY SANDY LEAN CLAY	CL	39.1										
HEN-B019	S-9A	36.0'-36.5	GRAY CLAYEY SAND	SC	22.5										
HEN-B019	S-10	40.0'-41.5'	BROWN AND GRAY SILTY SAND	SM	20.2		0.5	76.1			23.4				
HEN-B019	S-11	45.0'-46.5'	BROWN TO GRAY LEAN CLAY	CL	42.6										
HEN-B019	S-12	50.0'-51.5'	GRAY LEAN CLAY WITH SILT	CL	43.7							46	29	17	
HEN-B019	S-13	54.0'-55.5'	GRAYISH BROWN GRAVELLY SAND	SP	12.6										
HEN-B020	S-1	0.0'-1.5'	BROWN AND DARK BROWN LEAN CLAY WITH SILT AND GRAVEL	CL	4.9							25	17	8	
HEN-B020	S-2	2.5'-4.0'	BROWN GRAVELLY SAND - CLAY LENSES NOTED	SP	5.5										
HEN-B020	S-3	5.0'-6.5'	BROWN SILT WITH CLAY, SAND AND GRAVEL	ML	12.6										2.672
HEN-B020	S-4	7.5'-9.0'	BROWN SANDY LEAN CLAY	CL	11.4										
HEN-B020	S-5	9.5'-11.5	BROWN SANDY LEAN CLAY WITH GRAVEL	CL	14.2							30	17	13	
HEN-B020	S-6	15.0'-16.5'	BROWN GRAVEL	GP											
HEN-B020	S-7	20.0'-21.4'	BROWN AND REDDISH BROWN SILTY SAND WITH GRAVEL	SM	8.5		33.5	48.9	10.6	7.0	17.6				
HEN-B020	S-8	25.0'-26.5'	BROWN CLAYEY SAND WITH GRAVEL	SC	9.1										
HEN-B020	S-9	30.0'-31.5'	BROWN AND LIGHT BROWN GRAVELLY SAND	SP	9.3										
HEN-B020	S-10	35.0'-36.5'	BROWN CLAYEY SAND WITH GRAVEL	SC	10.8										
HEN-B020	S-11	40.0'-41.5'	BROWN CLAYEY SAND WITH GRAVEL	SC	8.3										

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B021	S-1	0.0'-0.5'	FILL: BROWN AND DARK BROWN SANDY LEAN CLAY WITH ROOT HAIRS	CL	7.3										
HEN-B021	S-2	2.5'-4.0'	BROWN SANDY LEAN CLAY	CL	16.5										
HEN-B021	S-3	5.0'-6.0'	BROWN LEAN CLAY WITH SAND AND GRAVEL	CL	15.7										
HEN-B021	S-4A	7.5'-8.3'	BROWN LEAN CLAY	CL	13.1										
HEN-B021	S-4B	8.3'-8.5'	BROWN SILTY SAND WITH GRAVEL	SM	2.9										
HEN-B021	S-5	10.0'-11.5'	BROWN CLAYEY SAND WITH GRAVEL	SC	9.0										
HEN-B021	S-6	15.0'-16.5'	BROWN LEAN CLAY WITH SAND - ROOTS NOTED	CL	16.7							22	14	8	
HEN-B021	S-7	20.0'-21.5'	DARK GRAY FLY ASH		34.9										
HEN-B021	S-8	22.0'-24.0'	DARK GRAY VARVED FLY ASH		31.9		1.7	20.0	60.8	17.5	78.3				
HEN-B021	S-9	25.0'-26.5'	GRAY AND DARK GRAY FLY ASH		41.6										
HEN-B021	S-10	30.0'-31.5'	GRAY FLY ASH		48.8										
HEN-B021	S-11	35.0'-36.5'	DARK GRAY AND BLACK SILTY SAND WITH CLAY	SM	20.3		0.9	44.3	31.6	23.2	54.8				
HEN-B021	S-12	40.0'-41.5'	BROWN CLAYEY SAND	SC	17.1										
HEN-B022	S-1	0.0'-1.5'	GRAY FLY ASH		37.4										
HEN-B022	S-2	2.5'-4.5'	VERY DARK GRAY VARVED FLY ASH		26.8							36	42	NP	
HEN-B022	S-3A	5.0'-6.3'	GRAY FLY ASH		37.0										
HEN-B022	S-3B	6.3'-6.5'	GRAY FLY ASH		21.8										
HEN-B022	S-4	7.5'-9.0'	VERY DARK GRAY VARVED FLY ASH WITH SAND - SAND SEAMS NOTED		34.2		1.4	26.4	57.3	14.9	72.2				
HEN-B022	S-5	10.0'-11.5'	GRAY SILTY SAND	SM	31.5										
HEN-B022	S-6	15.0'-16.5'	FILL: BLACK POORLY GRADED SAND - CINDERS NOTED	SP-SM	7.2										
HEN-B022	S-7	20.0'-21.5'	REDDISH BROWN SANDY LEAN CLAY	CL	18.3							26	16	10	

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B023	S-1	0.0'-1.5'	FILL: BROWN AND DARK BROWN SILTY SAND WITH GRAVEL	SM	5.3										
HEN-B023	S-2	2.5'-4.0'	BROWN AND TAN SILTY SAND WITH GRAVEL	SM	6.5		31.7	44.3	12.2	11.8	24.0				
HEN-B023	S-3	5.0'-6.5'	FILL: BROWN AND DARK BROWN SILT WITH CLAY, SAND AND GRAVEL	ML	8.3										2.701
HEN-B023	S-5A	10.0'-11.0'	BROWN AND GRAY SILTY LEAN CLAY WITH SAND	CL	15.9										
HEN-B023	S-5B	11.0'-11.5'	POSSIBLE FILL: BROWN TO DARK BROWN LEAN CLAY	CL	21.6										
HEN-B023	S-6	15.0'-16.5'	BROWN SILTY SAND WITH GRAVEL - SILT POCKETS NOTED	SM	3.3										
HEN-B023	S-7	20.0'-21.5'	DARK GRAY AND BLACK SILTY SAND AND FLY ASH - CINDERS NOTED	SM	25.5		7.2	44.9	39.9	8.0	47.9				
HEN-B023	S-8	25.0'-26.5'	GRAY FLY ASH		38.9										
HEN-B023	S-9	27.0'-29.0'	VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL		27.1										
HEN-B023	S-10	30.0'-31.5'	DARK GRAY FLY ASH		35.6										
HEN-B023	S-11	35.0'-36.5'	DARK GRAY FLY ASH WITH SAND AND CINDERS		18.6		23.3	51.4	20.6	4.7	25.3				
HEN-B023	S-12	40.0'-41.5'	DARK GRAY SILTY SAND	SM	14.4										
HEN-B023	S-13	45.0'-46.5'	BROWN AND GRAY LEAN CLAY	CL	19.8										
HEN-B023	S-14	50.0'-51.0'	LIGHT BROWN POORLY GRADED GRAVEL WITH SAND AND SILT	GP-GM	10.2		48.7	38.5	7.8	5.0	12.8				
HEN-B023	S-15	55.0'-56.5'	BROWN POORLY GRADED SAND WITH SILT AND GRAVEL	SP-SM	15.2										
HEN-B023	S-16	60.0'-61.5'	BROWN POORLY GRADED SAND WITH SILT AND GRAVEL	SP-SM	9.7										
HEN-B023	S-17	65.0'-66.5'	BROWN SILTY SAND	SM	15.1										
HEN-B023	S-18	70.0'-71.5'	BROWN SILTY SAND WITH CLAY	SM	19.3										
HEN-B023	S-19	75.0'-76.5'	BROWN SILTY SAND WITH GRAVEL	SM	9.6										
HEN-B023	S-4	7.5'-9.0'	BROWN POORLY GRADED GRAVEL WITH SAND AND CLAY	GP-GC	8.0										

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B024	S-1	0.0'-1.5'	FILL: GRAYISH BROWN SILTY SAND WITH GRAVEL - ASPHALT AND CONCRETE NOTED	SM	6.2										
HEN-B024	S-2	2.5'-4.0'	BROWN AND GRAY SAND WITH SILT, CLAY AND GRAVEL	SM	6.7										2.756
HEN-B024	S-3A	5.0'-5.8'	BROWN SILTY SAND WITH CLAY	SM	9.9										
HEN-B024	S-3B	5.8'-6.5'	BROWN LEAN CLAY WITH SAND AND GRAVEL	CL	8.5										
HEN-B024	S-4	7.0'-8.5'	DARK BROWN SANDY LEAN CLAY	CL	11.3										
HEN-B024	S-4	7.5'-9.0'	BROWN SILTY SAND WITH GRAVEL	SM	7.5										
HEN-B024	S-5	10.0'-11.5'	BROWN LEAN CLAY WITH GRAVEL	CL	10.0										
HEN-B024	S-6	15.0'-16.5'	BLACK FLY ASH WITH CINCERS AND SAND		16.4		14.8	62.8	19.4	3.0	22.4				
HEN-B024	S-7	20.0'-20.3'	DARK GRAY CLAYEY SAND	SC	16.3										
HEN-B024	S-8	25.0'-26.5'	BROWN CLAYEY SILT	CL-ML	47.3										
HEN-B024	S-9	26.5'-28.5'	DARK GRAY ORGANIC CLAY WITH SAND	0H	48.2							58	23	35	
HEN-B024	S-10	30.0'-31.5'	GRAY LEAN CLAY	CL	53.6										
HEN-B024	S-11	35.0'-36.5'	GRAY FLY ASH		47.4										
HEN-B024	S-12	40.0'-41.5'	BROWN AND GRAY CLAYEY SAND WITH GRAVEL	SC	13.0										
HEN-B024	S-13	45.0'-46.5'	BROWN AND DARK BROWN SILTY GRAVEL WITH SAND	GM	11.0		48.6	34.4	11.1	5.9	17.0				
HEN-B024	S-14	50.0-51.5	BROWN AND DARK BROWN LEAN CLAY WITH SAND AND GRAVEL	CL	11.2										
HEN-B024	S-16	60.0'-61.5'	BROWN POORLY GRADED SAND	SP	15.7										
HEN-B024	S-17	62.5'-62.7'	BROWN AND GRAY GRAVELLY SAND	SP	2.9										
HEN-B025	S-1	0.0'-1.5'	FILL: BROWN POORLY GRADED SAND WITH SILT AND GRAVEL	SP	6.2										
HEN-B025	S-2	2.5'-4.0'	BROWN LEAN CLAY WITH SILT AND SAND	CL	10.1										2.708
HEN-B025	S-3	5.0'-6.5'	BROWN AND GRAY SILTY GRAVEL WITH SAND	GM	4.3		37.3	35.4	18.6	8.7	27.3				
HEN-B025	S-4	7.5'-9.0'	GRAY FLY ASH		22.6										
HEN-B025	S-5	10.0'-11.5'	GRAY LEAN CLAYEY SILT WITH SAND AND GRAVEL	CL-ML	31.1										
HEN-B025	S-6	11.5'-14.0'	VERY DARK GRAY FLY ASH WITH SAND		31.9		16.8	10.7	52.3	20.2	72.5	38	38	NP	
HEN-B025	S-7	15.0'-16.5'	GRAY FLY ASH		31.1										
HEN-B025	S-8	20.0'-21.5'	GRAY SILTY LEAN CLAY WITH SAND	CL	46.7										
HEN-B025	S-9	25.0'-27.0'	VERY DARK GRAY TO GRAY FLY ASH WITH SAND		36.1							32	34	NP	
HEN-B025	S-10	27.0'-28.5'	GRAY CLAYEY SILT	CL-ML	38.9										
HEN-B025	S-11	30.0'-31.5'	GRAY CLAYEY SILT	CL-ML	44.8										
HEN-B025	S-12	35.0'-36.5'	GRAY FLY ASH - CLAY LENSES NOTED		38.3										
HEN-B025	S-13	40.0'-41.5'	GRAY FLY ASH WITH CLAY		42.9										
HEN-B025	S-14	45.0'-46.5'	GRAY FLY ASH		58.6										
HEN-B025	S-15	50.0'-51.5'	GRAY FLY ASH		66.7										
HEN-B025	S-16	55.0'-56.5'	GRAY SANDY LEAN CLAY	CL	19.1										

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B026	S-1	4.0'-4.5'	GRAY POORLY GRADED SAND	SP	13.7										
HEN-B026	S-1A	4.5'-5.5'	GRAY AND GRAYISH BROWN SANDY LEAN CLAY	CL	15.5										
HEN-B026	S-2	7.5'-9.0'	GRAYISH BROWN LEAN CLAY WITH GRAVEL	CL	24.0										
HEN-B026A	S-1	10.0'-11.5'	BROWN TO GRAY SANDY LEAN CLAY WITH GRAVEL	CL	11.1										
HEN-B026A	S-2	13.5'-15.0'	BROWN SILTY SAND WITH GRAVEL	SM	19.2		32.6	33.8	18.4	15.2	33.6				
HEN-B026A	S-3	16.5'-18.5'	BROWN SANDY LEAN CLAY WITH GRAVEL	CL	11.9										
HEN-B026A	S-4	20.0'-21.5'	BROWN CLAYEY GRAVEL WITH SAND	GC	10.6										
HEN-B026A	S-5	25.0'-26.5'	BROWN SANDY GRAVEL WITH SILT	GP-GM	17.2										
HEN-B027	S-1	7.0'-7.5'	BROWN SANDY GRAVEL WITH SILT	GP-GM	15.7										
HEN-B027	S-1A	7.5'-9.0'	DARK GRAY LEAN CLAY - ORGANICS NOTED	CL	41.5										
HEN-B027	S-2	10.0'-12.0'	GRAY LEAN CLAY WITH SAND AND GRAVEL	CL	36.3										
HEN-B027	S-3	12.0'-13.5'	GRAYISH BROWN LEAN CLAY WITH SAND AND GRAVEL	CL	16.3										
HEN-B027	S-4	15.0'-16.5'	BROWN LEAN CLAY WITH GRAVEL	CL	26.4										
HEN-B027	S-5	20.0'-21.5'	BROWN LEAN CLAY WITH GRAVEL	CL	13.2										
HEN-B027	S-6	25.0'-26.5'	BROWN TO GREENISH GRAY SILTY LEAN CLAY WITH SAND	CL	9.7										
HEN-B027	S-7	30.0'-31.5'	BROWN SANDY GRAVEL WITH SILT	GP-GM	11.2										
HEN-B029	S-1	0.0'-1.5'	BROWN POORLY GRADED SAND	SP	4.7										
HEN-B029	S-2	2.5'-4.0'	DARK BROWN SANDY LEAN CLAY	CL	14.7										
HEN-B029	S-3	5.0'-7.0'	BROWN LEAN CLAY WITH SAND AND GRAVEL	CL	10.8							22	15	7	
HEN-B029	S-4	7.0'-8.5'	DARK BROWN LEAN CLAY	CL	14.8										
HEN-B029	S-5	10.0'-12.0'	VERY DARK BROWN AND GRAY SLIGHTLY ORGANIC LEAN CLAY WITH SAND AND GRAVEL	CL	16.7							31	17	14	
HEN-B029	S-6	15.0'-16.5'	POSSIBLE FILL: BROWN TO DARK BROWN LEAN CLAY	CL	21.7										
HEN-B029	S-7	20.0'-21.5'	BROWN TO GRAY SILTY LEAN CLAY	CL	11.5										
HEN-B029	S-8	25.0'-26.5'	BROWN SILTY LEAN CLAY WITH SAND	CL	8.8										
HEN-B029	S-9	30.0'-30.9'	BROWN SILTY LEAN CLAY WITH SAND	CL	12.7										
HEN-B029	S-10	35.0'-36.5'	LIGHT BROWN POORLY GRADED GRAVEL WITH SAND AND CLAY	GP-GC	13.8		61.0	26.0			13.0				
HEN-B029	S-11	40.0'-41.5'	BROWN SILTY SAND WITH CLAY	SM	4.6										

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B030	S-1A	0.0'-1.5'	FILL: DARK BROWN AND BROWN SANDY LEAN CLAY WITH GRAVEL	CL	7.0										
HEN-B030	S-2	2.5'-4.0'	BROWN AND LIGHT BROWN SILTY SAND WITH GRAVEL	SM	6.4		34.0	45.7	11.0	9.3	20.3				
HEN-B030	S-3	5.0'-6.5'	FILL: BROWN AND GRAY LEAN CLAY WITH SILT, SAND AND GRAVEL	CL	11.5										2.746
HEN-B030	S-4	7.5'-9.0'	BROWN LEAN CLAY	CL	17.1										
HEN-B030	S-5	10.0'-11.0'	DARK BROWNISH GRAY FLY ASH AND LEAN CLAY MIXTURE WITH SAND		18.1										
HEN-B030	S-6	15.0'-16.5'	LIGHT BROWN AND TAN WELL GRADED GRAVEL WITH SAND	GW	17.6		81.4	14.8			3.8				
HEN-B030	S-7	21.5'	DARK BROWN AND BLACK ORGANIC CLAY WITH GRAVEL - WOOD NOTED	OL	23.9										
HEN-B030	S-8	25.0'-26.5'	BROWN SILTY SAND WITH GRAVEL	SM	11.2										
HEN-B030	S-10	35.0'-36.5'	BROWN CLAYEY SAND WITH GRAVEL	SC	8.9										
HEN-B030	S-11	40.0'-41.5'	BROWN CLAYEY SAND	SC	9.0										
HEN-B032	S-1A	0.0'-1.0'	BROWN AND GRAYISH BROWN CLAYEY SAND	SC	2.7										
HEN-B032	S-1B	1.0'-1.5'	FILL: BROWN SANDY LEAN CLAY	CL	7.9										
HEN-B032	S-2	2.5'-4.0'	FILL: DARK BROWN SANDY LEAN CLAY	SC	9.7										
HEN-B032	S-3	5.0'-7.0'	DARK BROWNISH GRAY LEAN CLAY WITH SAND AND GRAVEL	CL	14.0							35	18	17	
HEN-B032	S-4	7.5'-9.0'	DARK BROWN LEAN CLAY	CL	16.7										
HEN-B032	S-5	10.0'-11.5'	DARK BROWN AND DARK GRAY LEAN CLAY WITH GRAVEL	CL	16.2										
HEN-B032	S-6	15.0'-16.5'	BROWN AND GRAYISH BROWN SILTY SAND WITH GRAVEL	SM	8.2										
HEN-B032	S-7	20.0'-21.5'	BROWN SILTY SAND WITH GRAVEL	SM	11.1		30.5	43.6	13.4	12.5	25.9				
HEN-B032	S-8	25.0'-26.5'	BROWN SILTY SAND WITH GRAVEL AND CLAY	SM	9.1										
HEN-B032	S-9	30.0'-31.5'	BROWN LEAN CLAY WITH SAND AND GRAVEL	CL	10.6										
HEN-B032	S-10	35.0'-36.5'	BROWN SILTY SAND WITH GRAVEL	SM	5.5										
HEN-B032	S-11	40.0'-41.3'	BROWN AND GRAYISH BROWN SILTY LEAN CLAY WITH SAND AND GRAVEL	CL	10.9										
HEN-B034	S-1A	0.0'-0.5'	BROWN SILTY SAND WITH GRAVEL	SM	4.2										
HEN-B034	S-1B	0.5'-1.5	POSSIBLE FILL: DARK BROWN LEAN CLAY	CL	9.1										
HEN-B034	S-2	2.5'-4.0'	DARK BROWN LEAN CLAY WITH SILT AND SAND	CL	14.2										2.704
HEN-B034	S-3A	5.0'-5.5'	BROWN SILTY SAND	SM	15.9										
HEN-B034	S-3B	5.5'-6.5'	BROWN GRAVELLY SAND	SP	1.4										
HEN-B034	S-4	7.5'-9.0'	BROWN AND GRAYISH BROWN SILTY SAND WITH GRAVEL	SM	2.5										
HEN-B034	S-5	10.0'-11.5'	BROWN AND LIGHT BROWN POORLY GRADED GRAVEL WITH SILT AND	GP-GM	11.2		60.1	27.0	7.7	5.2	12.9				
HEN-B034	S-6	15.0'-16.5'	BROWN AND LIGHT BROWN POORLY GRADED GRAVEL WITH CLAY AND	GP-GC	9.1										2.808
HEN-B034	S-7	20.0'-21.5'	LIGHT BROWN SILTY SAND WITH GRAVEL	SM	12.5										
HEN-B034	S-9	30.0'-31.5'	BROWN, GRAY AND PINKISH BROWN POORLY GRADED GRAVEL	GP	13.6										
HEN-B034	S-10	35.0'-36.5'	LIGHT BROWN AND TAN POORLY GRADED GRAVEL WITH SAND AND SILT	GP-GM	10.9		82.8	11.3			5.9				
HEN-B034	S-11	40.0'-41.5'	BROWN POORLY GRADED GRAVEL WITH SILT AND SAND	GP-GM	1.5										

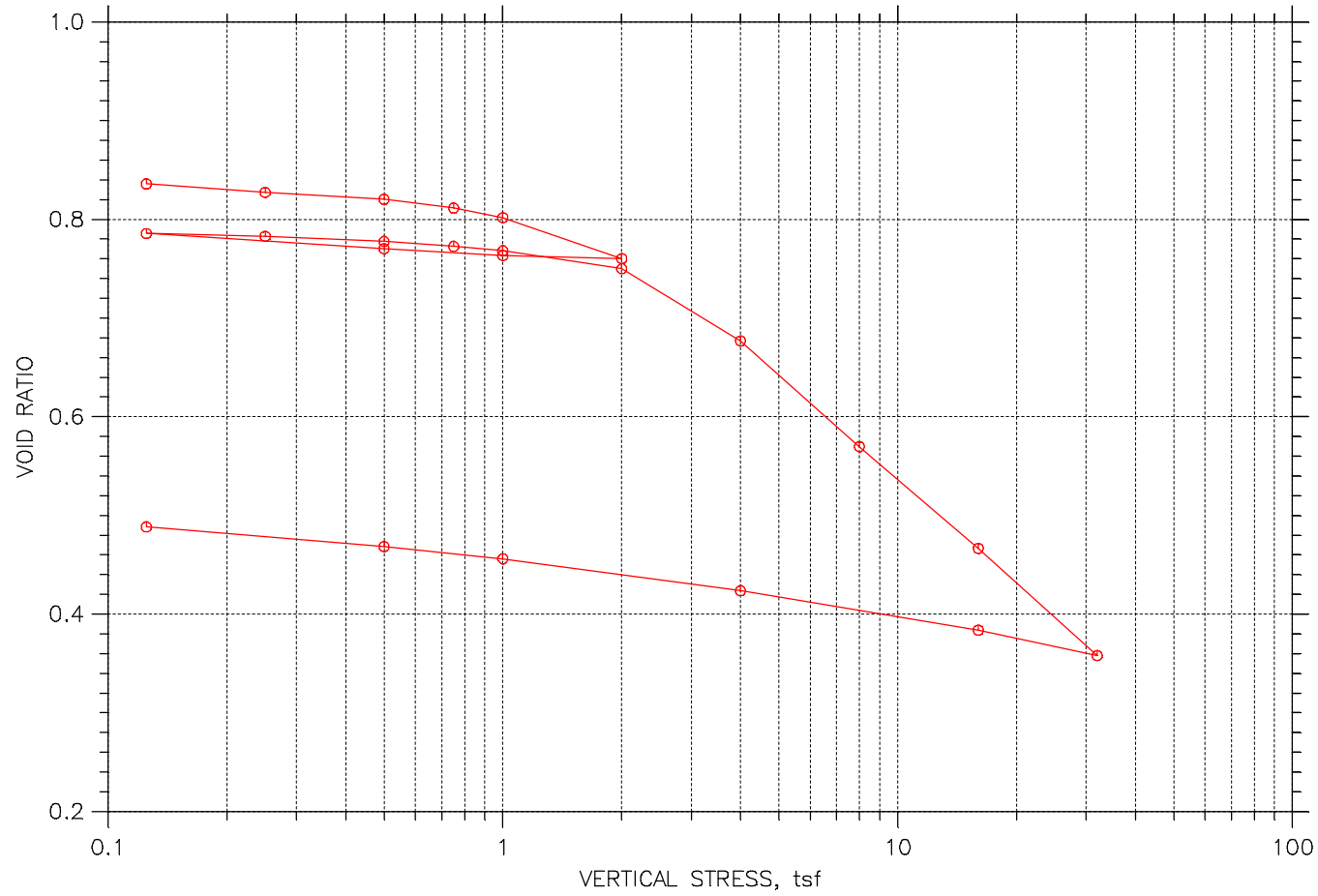
LABORATORY TESTING SUMMARY

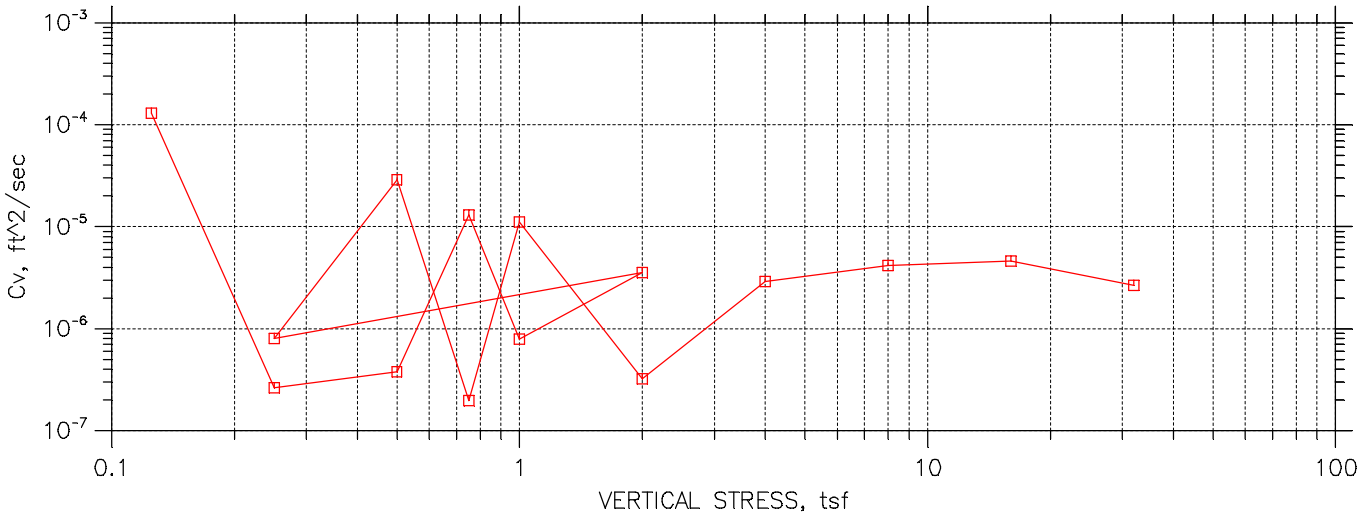
PROJECT NAME: Dynergy - Hennepin Site | PROJECT NUMBER: MR155233 | CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B037	S-1	0.0'-1.5'	DARK BROWN POORLY GRADED SAND	SP	3.2										
HEN-B037	S-2	2.5'-4.0'	BROWN POORLY GRADED SAND WITH SILT AND GRAVEL	SP-SM	4.6										2.685
HEN-B037	S-3	5.0'-6.5'	BROWN AND DARK BROWN SILTY SAND WITH GRAVEL	SM	4.0		41.3	51.0			7.7				
HEN-B037	S-4A	7.5'-8.0'	DARK BROWN CLAYEY SAND	SC	4.8										
HEN-B037	S-4B	8.0'-9.0'	DARK BROWN LEAN CLAY	CL	15.4										
HEN-B037	S-5	10.0'-11.5'	BROWN SILTY SAND WITH GRAVEL - CLAY LENSES NOTED	SM	9.3										
HEN-B037	S-6	15.0'-16.5'	BROWN AND LIGHT BROWN CLAYEY GRAVEL WIRTH SAND	GC	9.6		34.1	26.5	16.2	23.2	39.4				
HEN-B037	S-7	20.0'-21.5'	BROWN AND GRAYISH BROWN SILTY LEAN CLAY WITH SAND	CL	9.5										
HEN-B037	S-8	25.0'-26.5'	BROWN SILTY SAND WITH GRAVEL	SM	12.1										
HEN-B037	S-9A	30.0'-30.5'	LIGHT BROWN SILTY SAND WITH GRAVEL	SM	14.1										
HEN-B037	S-9B	30.5'-31.5'	BROWN SILTY LEAN CLAY	CL	20.5										
HEN-B037	S-10	35.0'-36.5'	BROWN SILTY SAND WITH GRAVEL	SM	7.6										
HEN-B037	S-11	40.0'-41.5'	BROWN SILTY GRAVEL	GM	14.2										
HEN-B038	S-1	0.0'-1.5'	FILL: BROWN SILTY SAND	SM	7.0										
HEN-B038	S-2A	2.5'-3.0'	BROWN SANDY LEAN CLAY	CL	9.8										
HEN-B038	S-2B	3.0'-4.0'	LIGHT BROWN SILTY SAND WITH GRAVEL	SM	2.7										
HEN-B038	S-3	5.0'-6.5'	TAN POORLY GRADED SAND WITH GRAVEL AND SILT	SP-SM	2.3		30.1	61.6	4.4	3.9	8.3				
HEN-B038	S-4A	8.1'-8.6'	FILL: BROWN LEAN CLAY WITH SAND	CL	44.1										
HEN-B038	S-4B	8.6'-9.0'	BROWN SILTY SAND WITH GRAVEL	SM	6.0										
HEN-B038	S-5A	10.0'-10.5'	BROWN SANDY LEAN CLAY	CL	4.5										
HEN-B038	S-5B	10.5-11.5'	GREENISH GRAY FAT CLAY	CH	18.8							55	23	32	
HEN-B038	S-6	15.0'-16.5'	BROWN POORLY GRADED GRAVEL WITH CLAY AND SILT	GP-GC	6.5										2.763
HEN-B038	S-7	20.0'-21.5'	BROWN AND GRAY GRAVELLY SAND	SP	4.6										

One-Dimensional Consolidation Tests
ASTM D 2435

ONE DIMENSIONAL CONSOLIDATION TEST
ASTM D2435





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	219		

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CONSOLIDATION TEST DATA

Terracon
Consulting Engineers & Scientists

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S-7
Sample No.: S-7
Test No.: HENB016S7

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/13/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: BCM
Depth: 30.0'-22.0'
Elevation: ----

Soil Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL
Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435

Estimated Specific Gravity: 2.72
Initial Void Ratio: 0.84
Final Void Ratio: 0.49

Liquid Limit: 38
Plastic Limit: 21
Plasticity Index: 17

Initial Height: 0.74 in
Specimen Diameter: 2.50 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	X-11	RING	RING	X-19
Wt. Container + Wet Soil, gm	310.43	192.3	183.59	145.61
Wt. Container + Dry Soil, gm	249.7	167.91	167.91	130.41
Wt. Container, gm	44.46	79.89	79.89	45.08
Wt. Dry Soil, gm	205.24	88.021	88.021	85.33
Water Content, %	29.59	27.71	17.81	17.81
Void Ratio	---	0.84	0.49	---
Degree of Saturation, %	---	89.65	99.22	---
Dry Unit Weight, pcf	---	92.25	114.09	---

CONSOLIDATION TEST DATA

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S-7
Sample No.: S-7
Test No.: HENB016S7

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/13/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: BCM
Depth: 30.0'-22.0'
Elevation: ----

Soil Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL
Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435

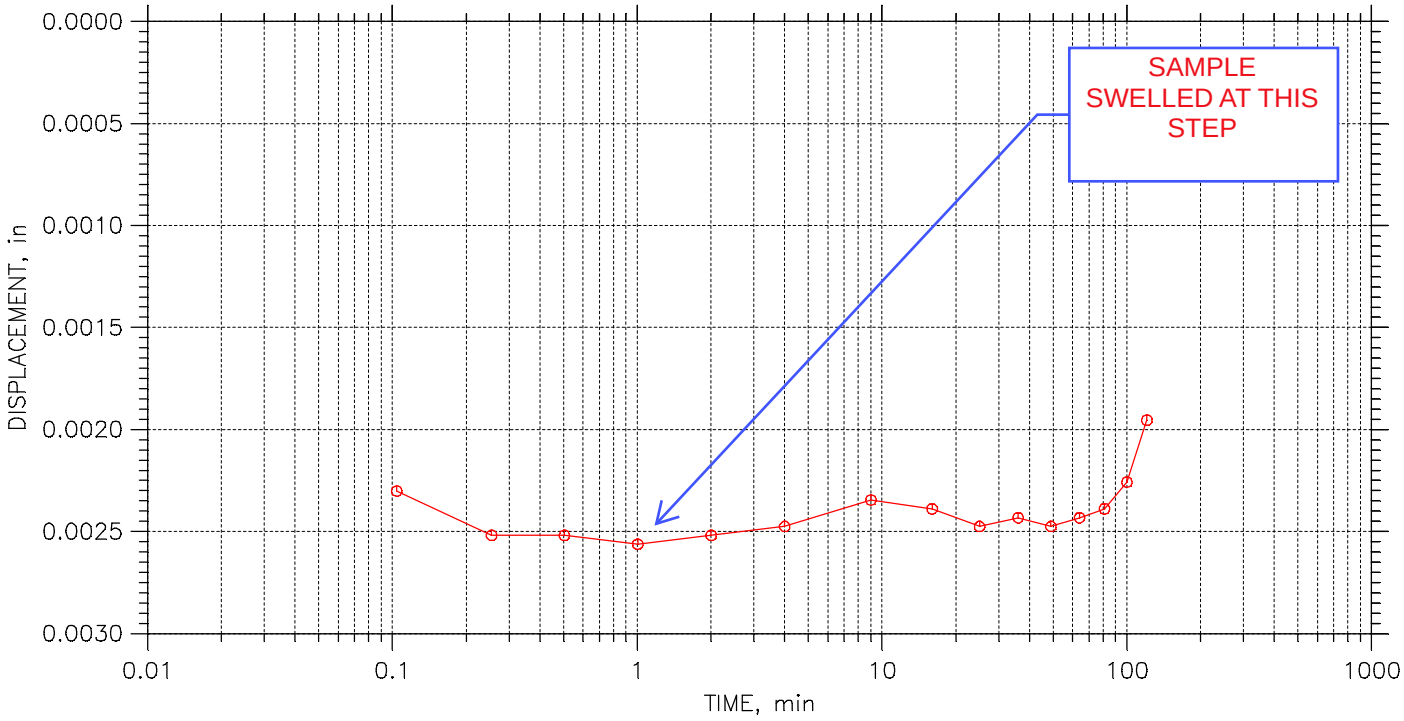
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting Sq.Rt. min	T50 Fitting Log min	Coefficient of Consolidation Sq.Rt. ft^2/sec	Coefficient of Consolidation Log ft^2/sec	Coefficient of Consolidation Ave. ft^2/sec
1	0.125	0.001955	0.836	0.26	0.0	0.0	1.29e-004	0.00e+000	1.29e-004
2	0.25	0.005429	0.827	0.73	11.9	0.0	2.63e-007	0.00e+000	2.63e-007
3	0.5	0.008253	0.820	1.11	8.2	0.0	3.77e-007	0.00e+000	3.77e-007
4	0.75	0.01181	0.811	1.59	0.2	0.0	1.30e-005	0.00e+000	1.30e-005
5	1	0.01581	0.802	2.13	3.8	0.0	7.94e-007	0.00e+000	7.94e-007
6	2	0.03249	0.760	4.37	1.5	0.2	2.00e-006	1.60e-005	3.56e-006
7	1	0.03123	0.763	4.20	0.1	0.0	2.83e-005	0.00e+000	2.83e-005
8	0.5	0.02849	0.770	3.83	0.1	0.0	3.01e-005	0.00e+000	3.01e-005
9	0.125	0.02224	0.786	2.99	3.6	0.0	8.17e-007	0.00e+000	8.17e-007
10	0.25	0.02341	0.783	3.15	3.7	0.0	8.03e-007	0.00e+000	8.03e-007
11	0.5	0.0255	0.778	3.43	0.1	0.0	2.87e-005	0.00e+000	2.87e-005
12	0.75	0.02754	0.772	3.70	14.9	0.0	1.96e-007	0.00e+000	1.96e-007
13	1	0.02932	0.768	3.94	0.3	0.0	1.11e-005	0.00e+000	1.11e-005
14	2	0.03666	0.750	4.93	8.9	0.0	3.24e-007	0.00e+000	3.24e-007
15	4	0.06615	0.677	8.90	0.9	0.0	2.90e-006	0.00e+000	2.90e-006
16	8	0.1094	0.570	14.72	1.0	0.2	2.54e-006	1.12e-005	4.14e-006
17	16	0.151	0.467	20.32	0.5	0.5	4.59e-006	4.58e-006	4.58e-006
18	32	0.1949	0.358	26.23	1.0	0.4	1.95e-006	4.19e-006	2.66e-006
19	16	0.1845	0.384	24.82	0.1	0.0	1.70e-005	0.00e+000	1.70e-005
20	4	0.1684	0.424	22.66	0.2	0.0	8.35e-006	0.00e+000	8.35e-006
21	1	0.1553	0.456	20.89	3.7	0.0	5.18e-007	0.00e+000	5.18e-007
22	0.5	0.1504	0.468	20.23	19.6	12.7	1.01e-007	1.57e-007	1.23e-007
23	0.125	0.1423	0.488	19.14	14.5	0.0	1.40e-007	0.00e+000	1.40e-007

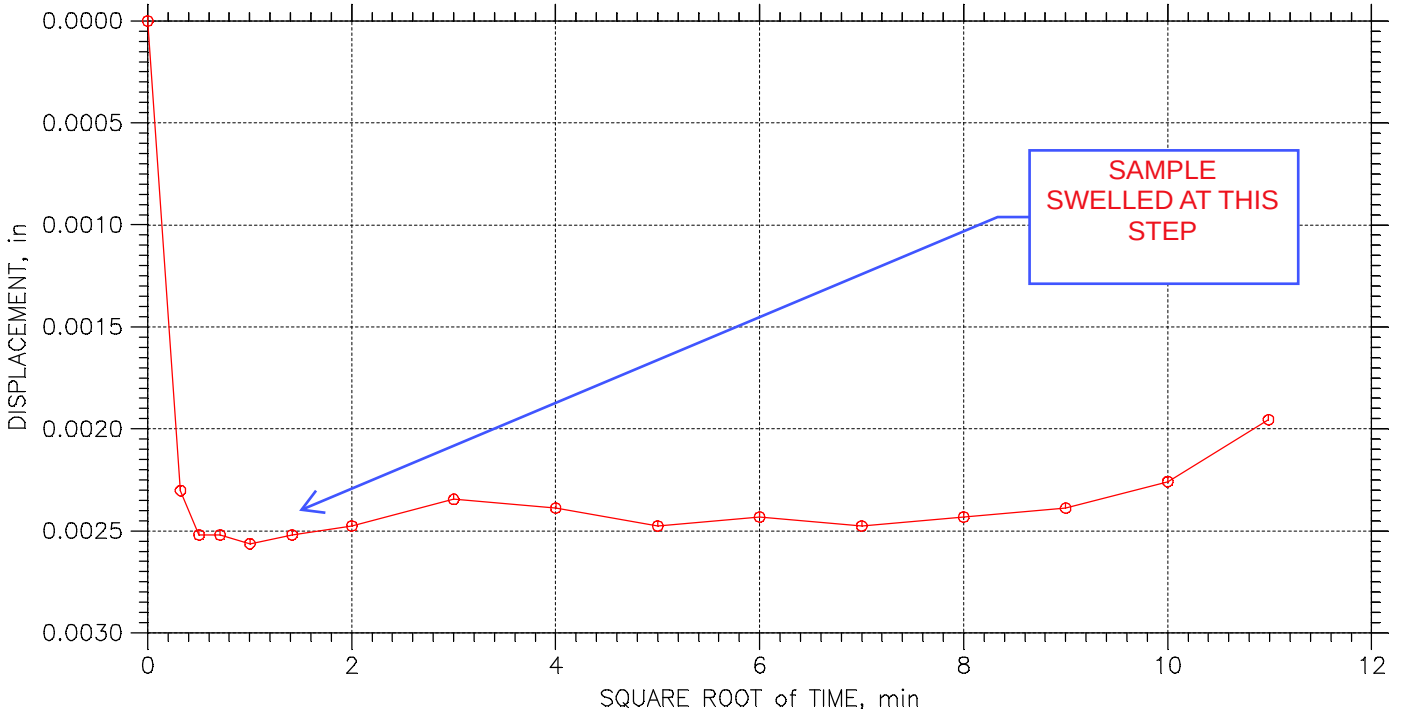
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 23

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	222		

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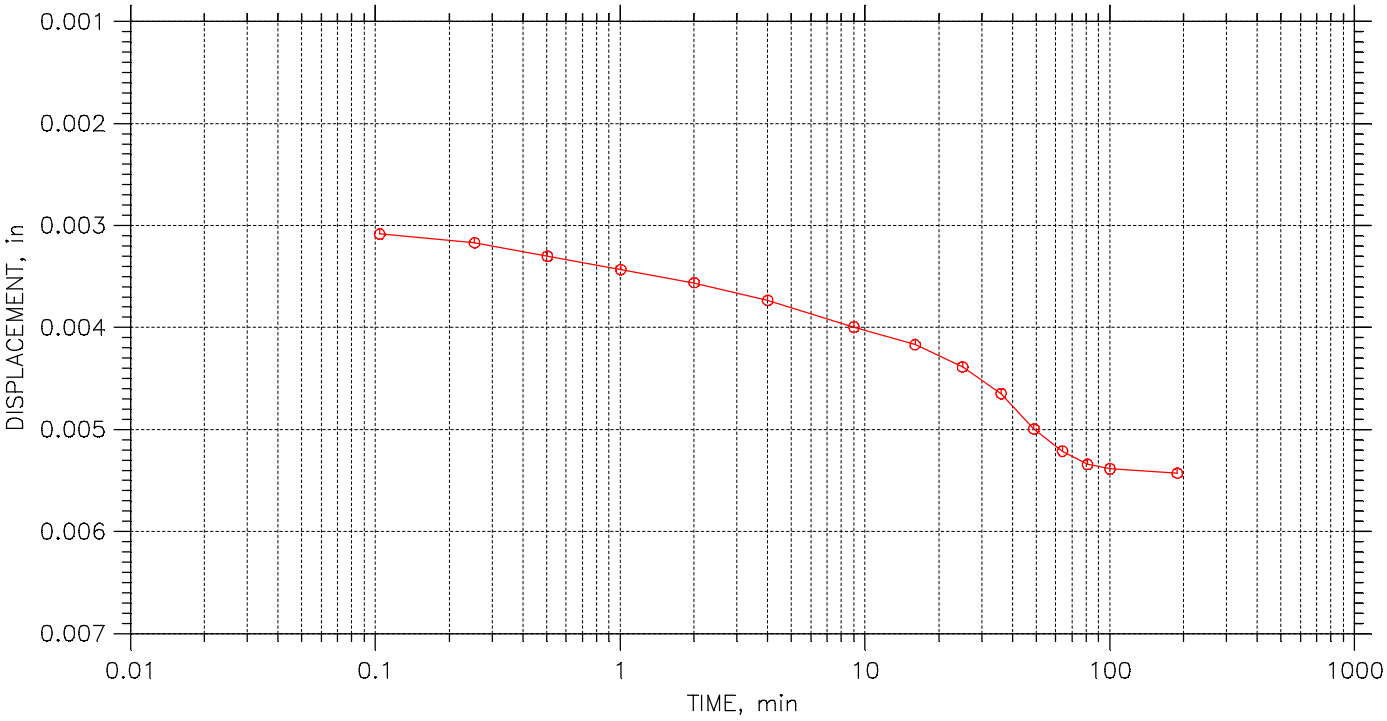
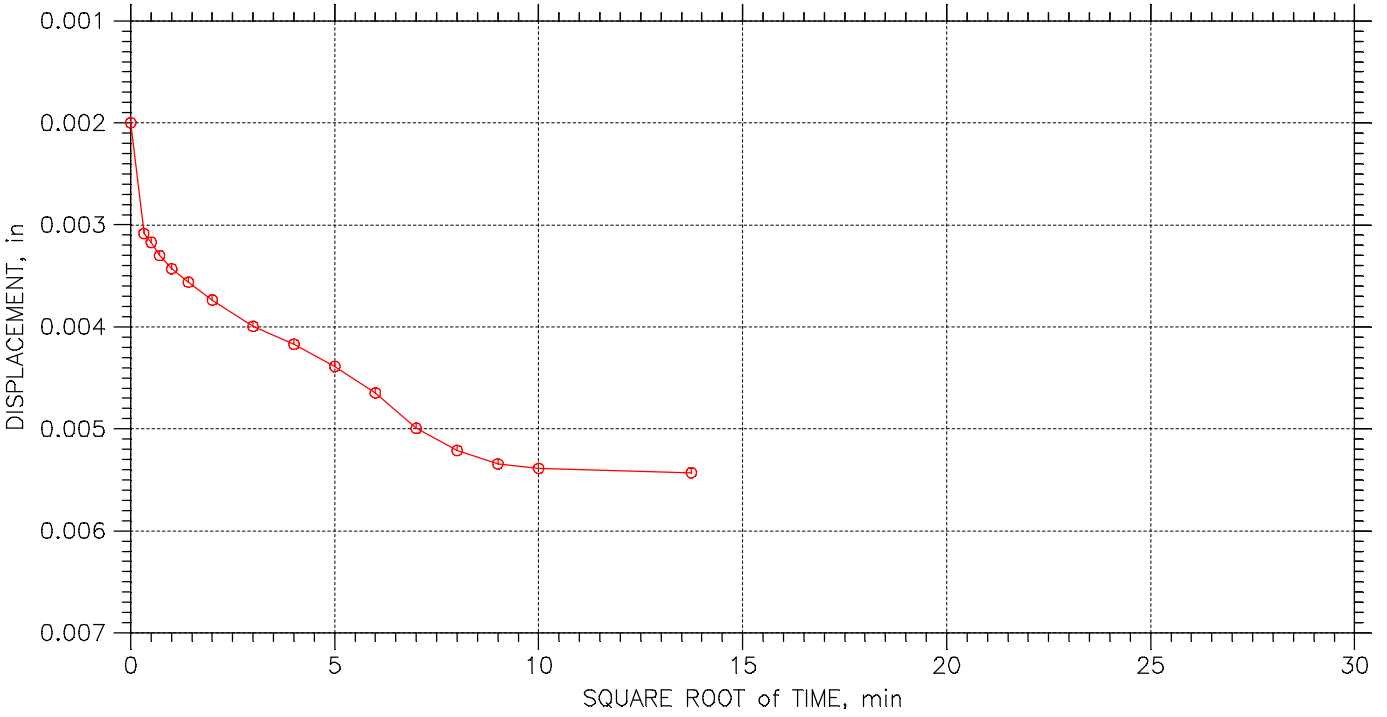
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 23

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	223		

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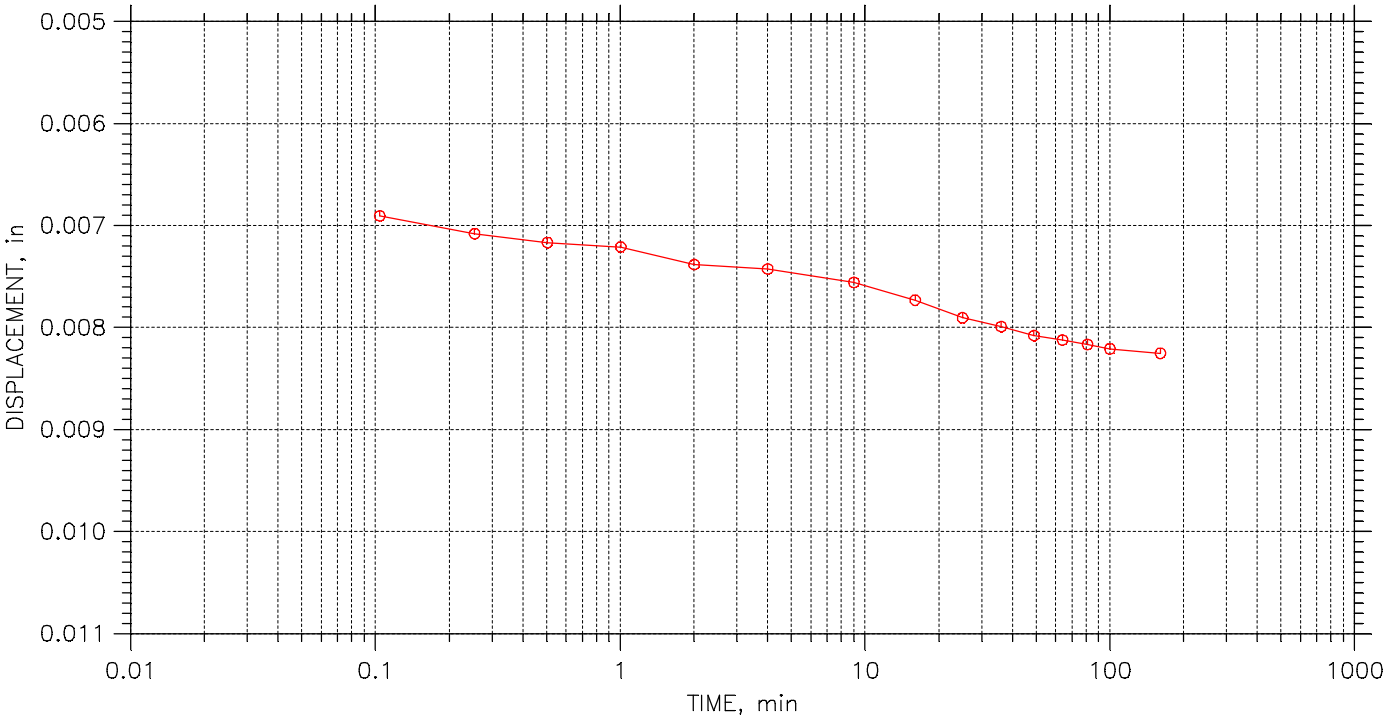
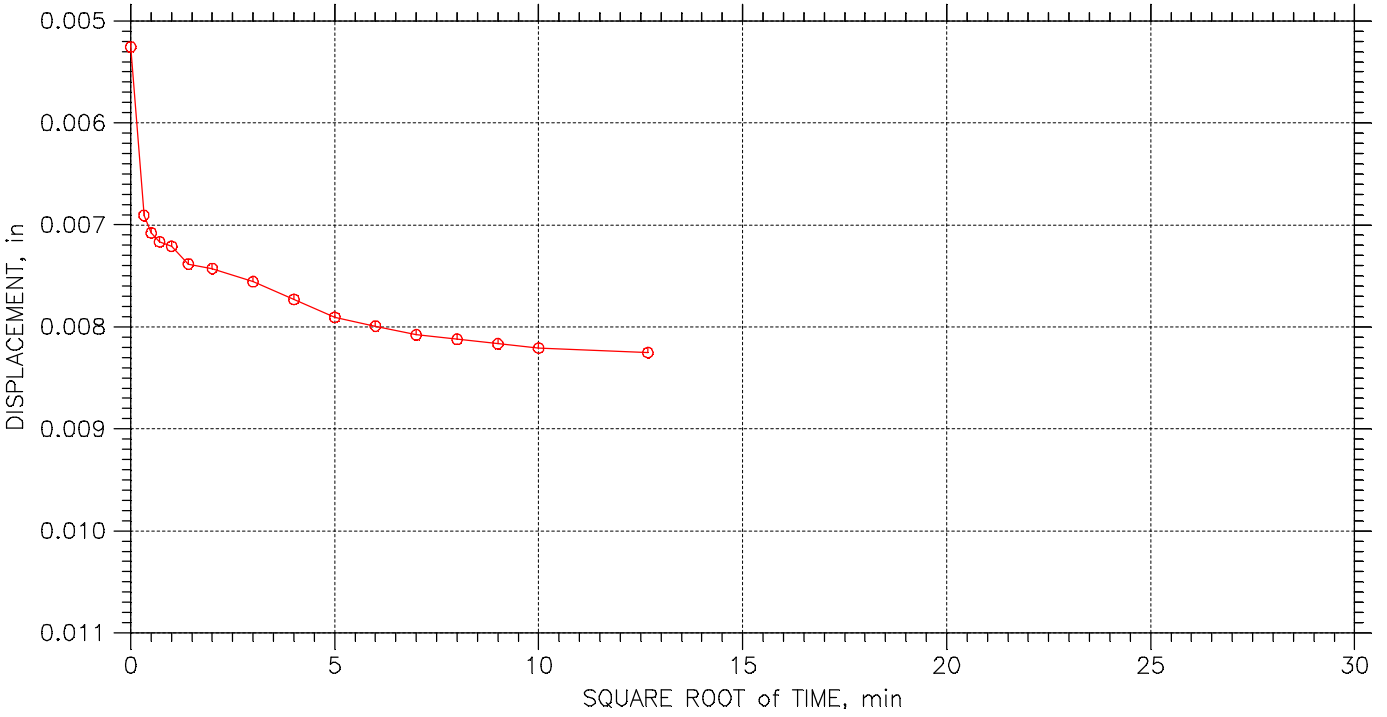
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	224		

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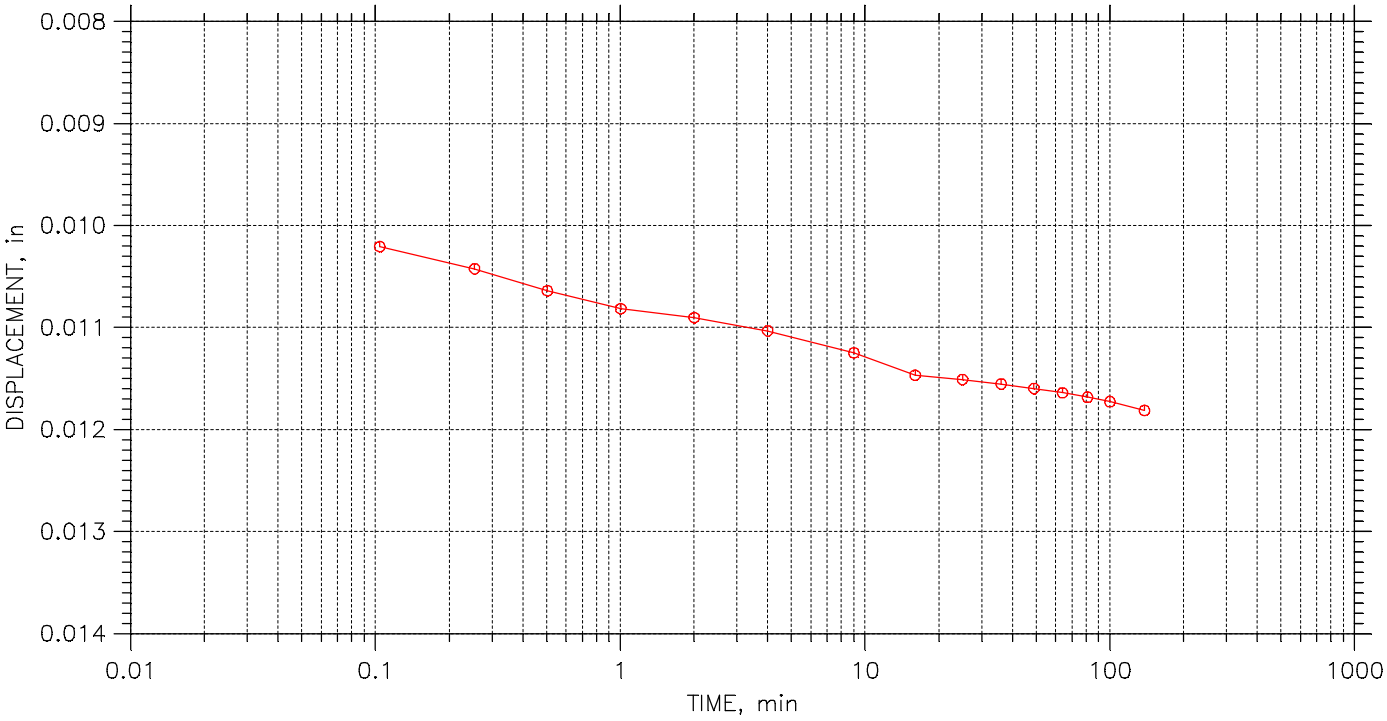
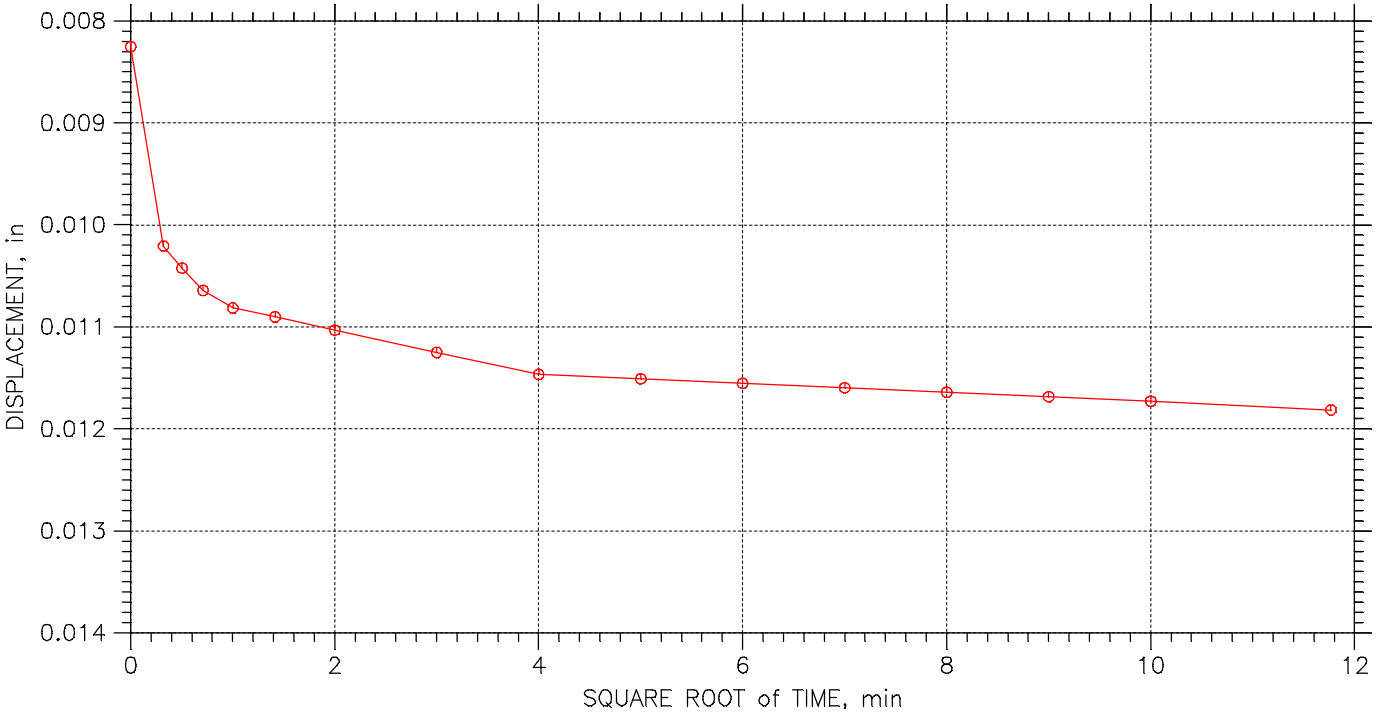
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 4 of 23

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	225		

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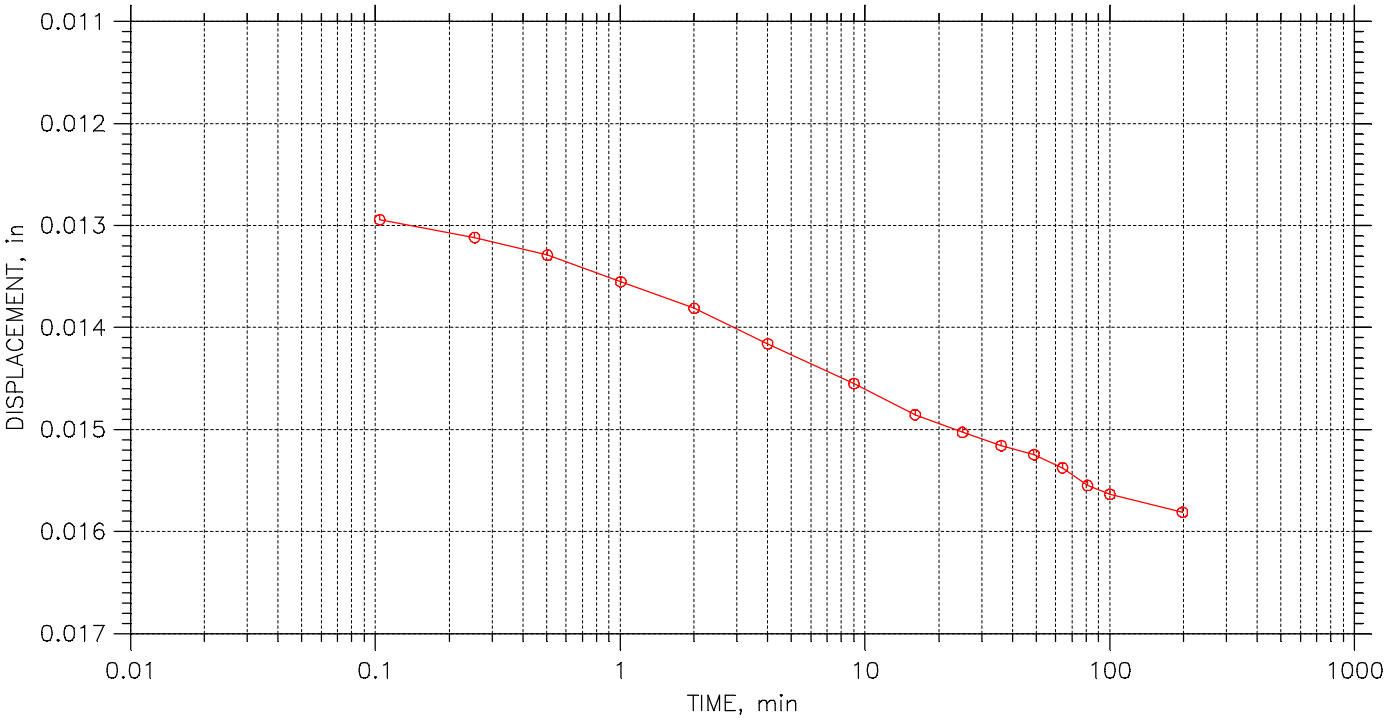
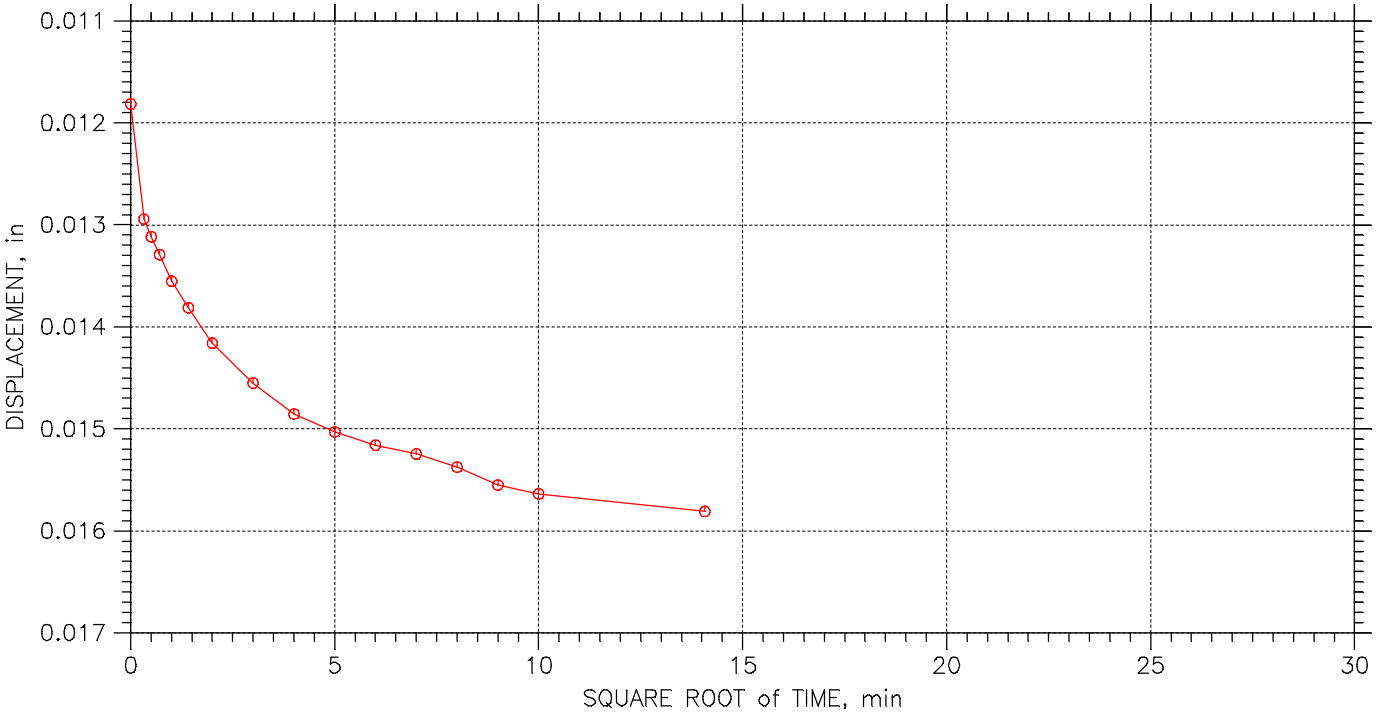
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	226		

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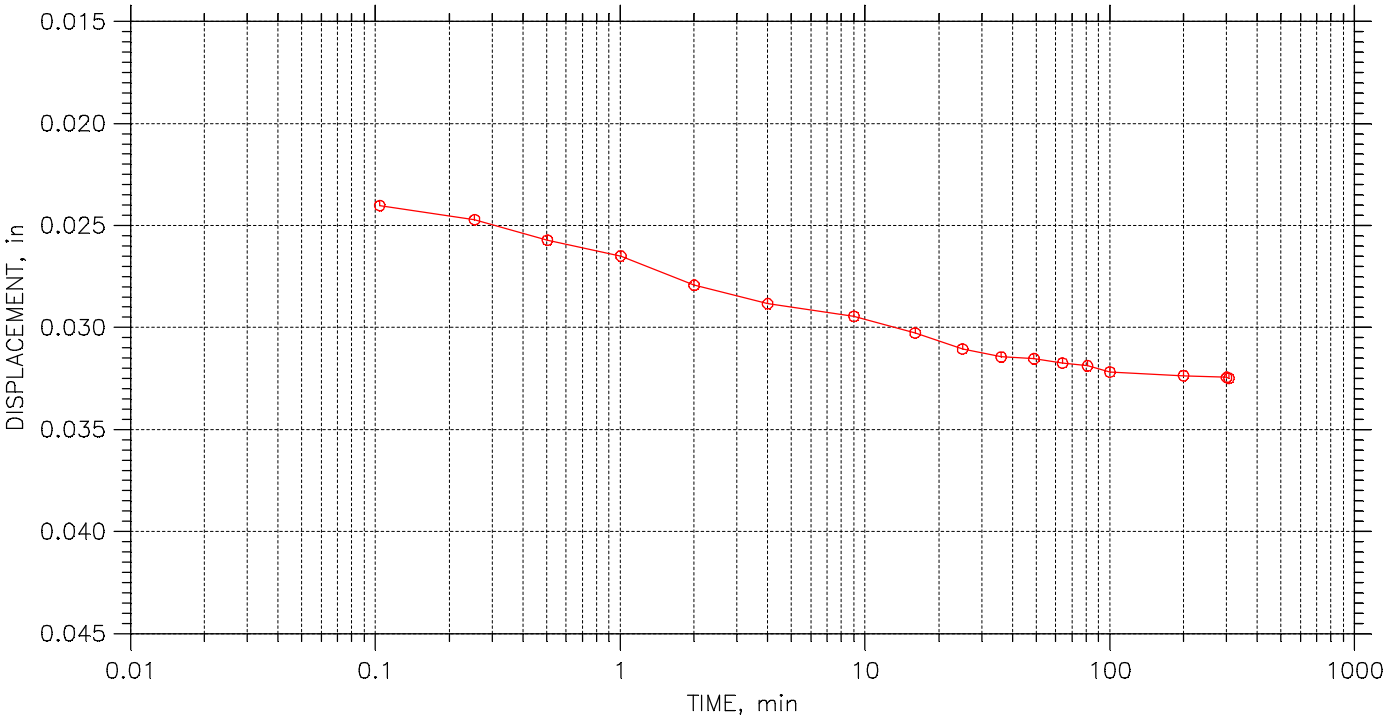
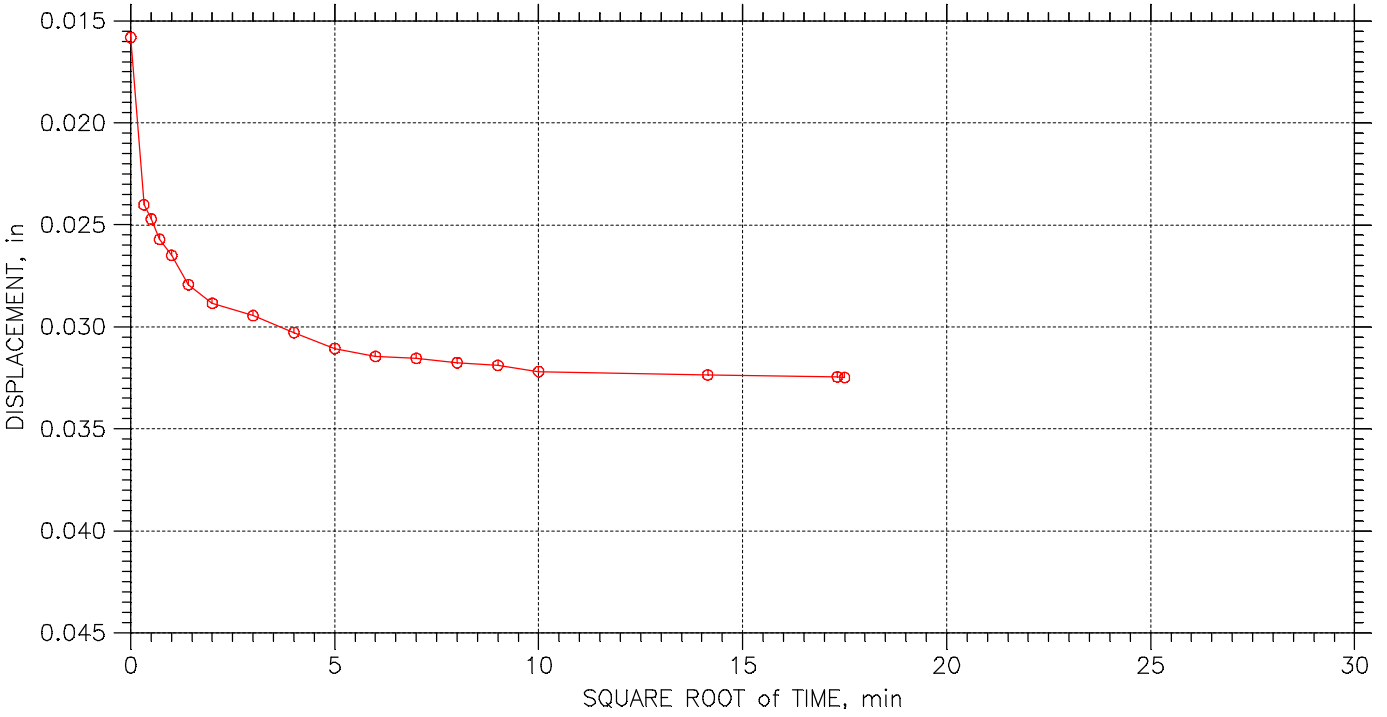
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 23

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	227		

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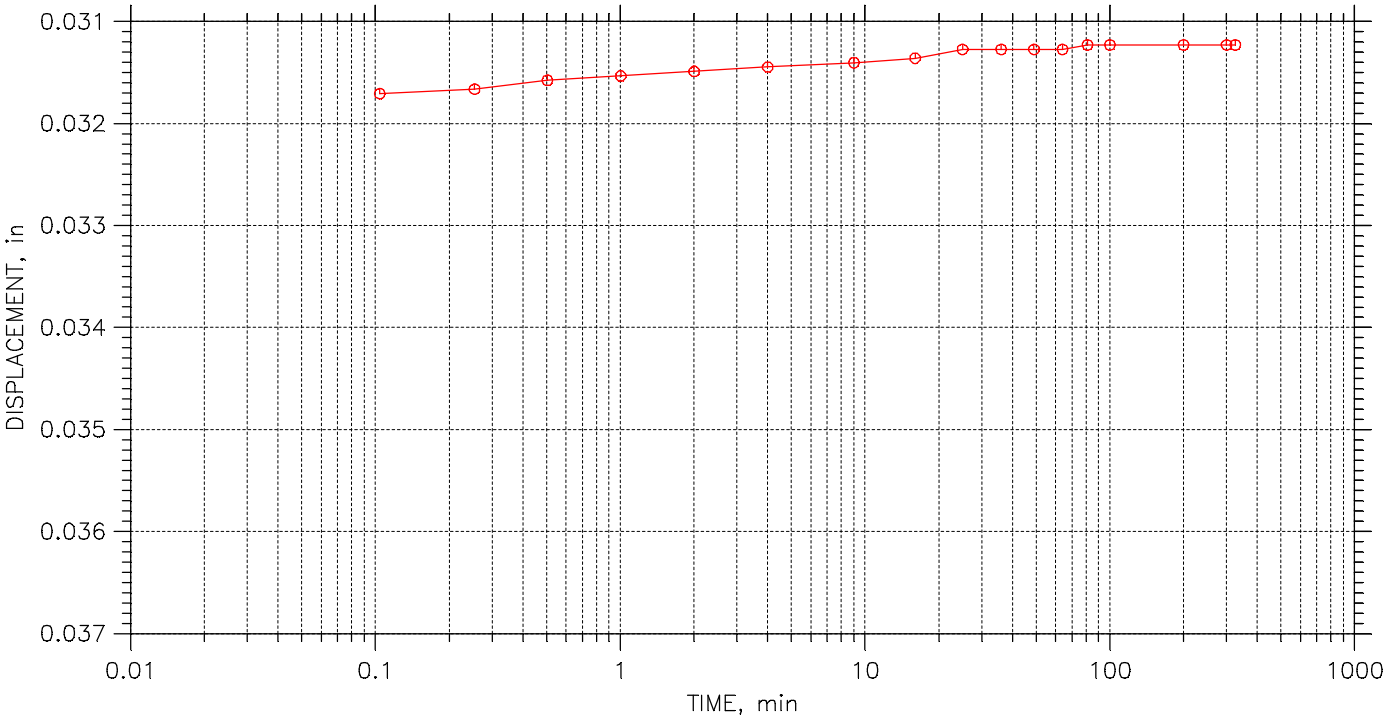
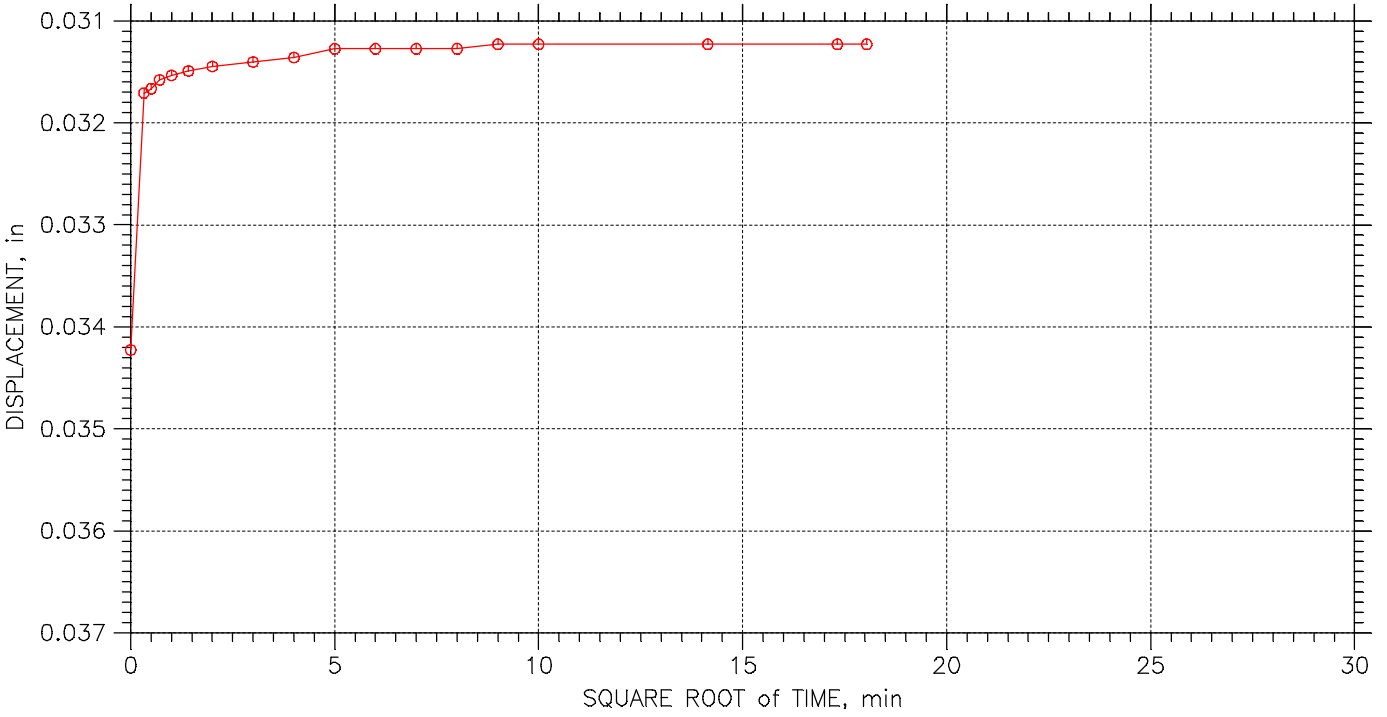
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 7 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	228		

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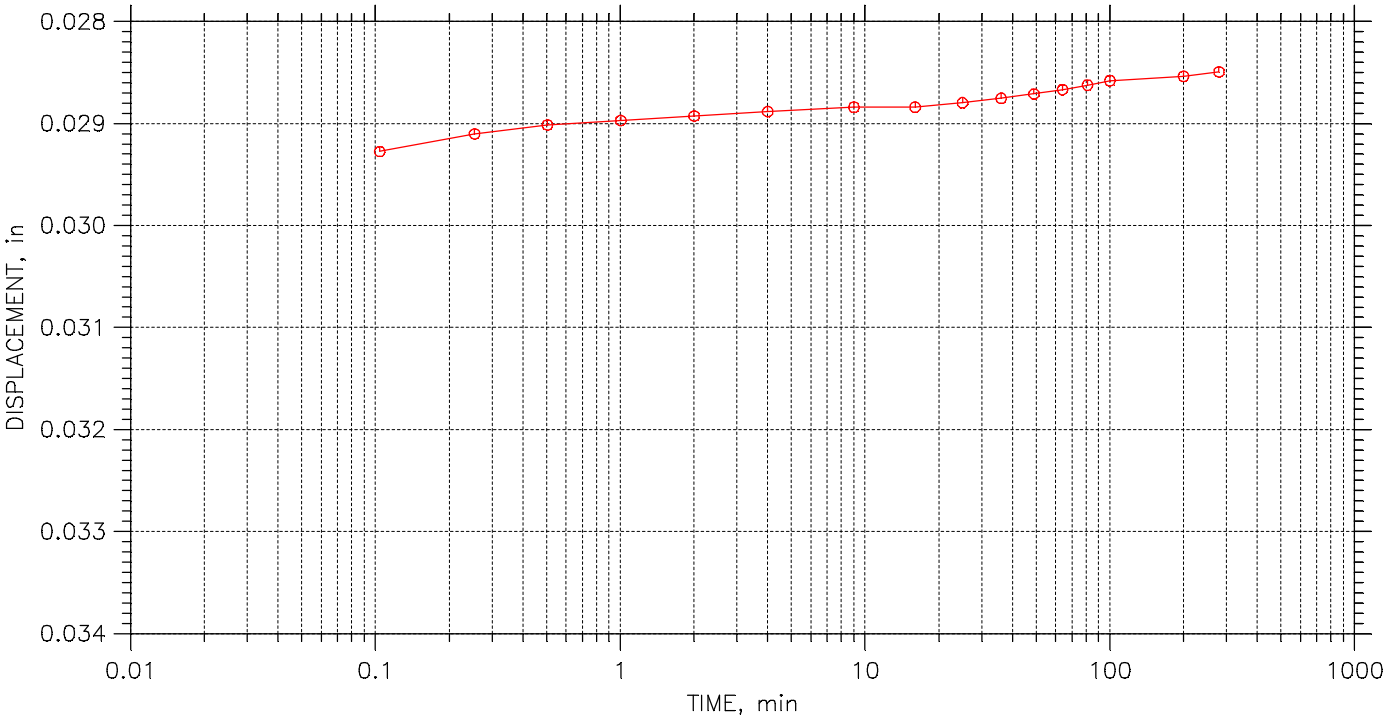
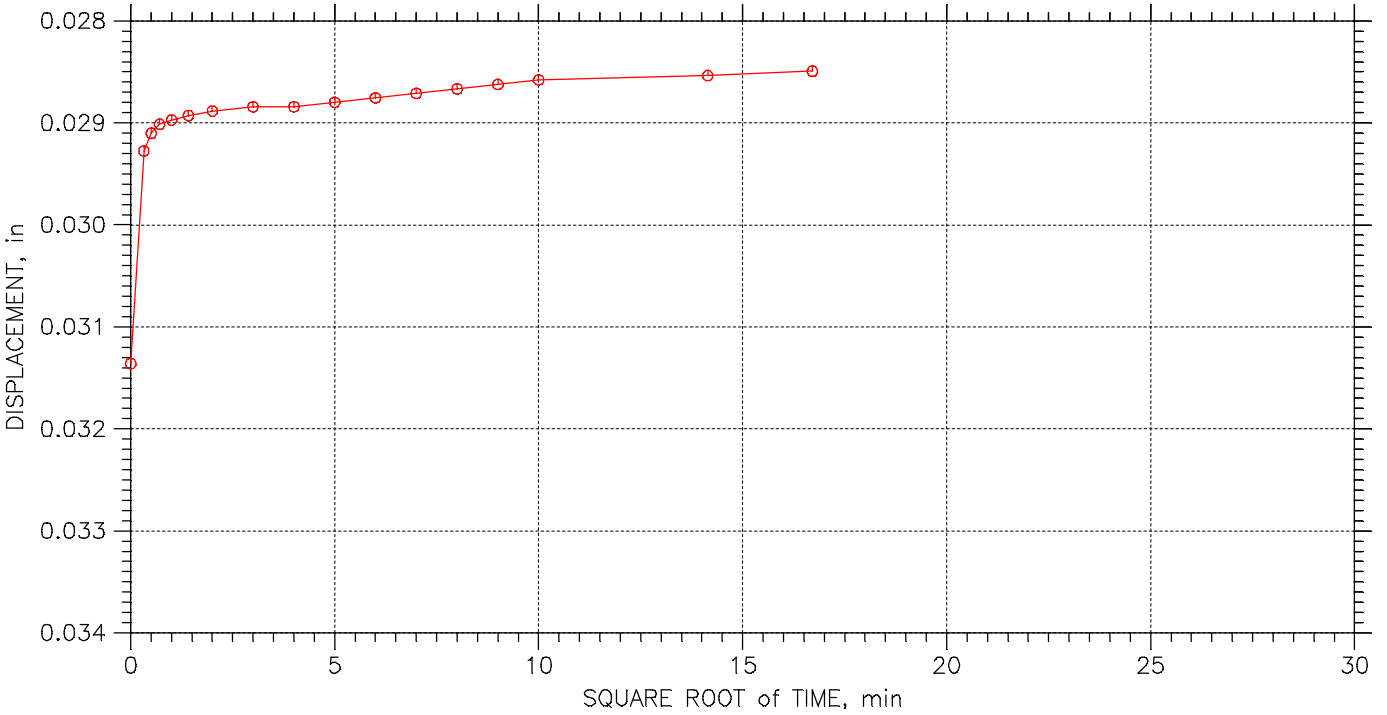
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	229		

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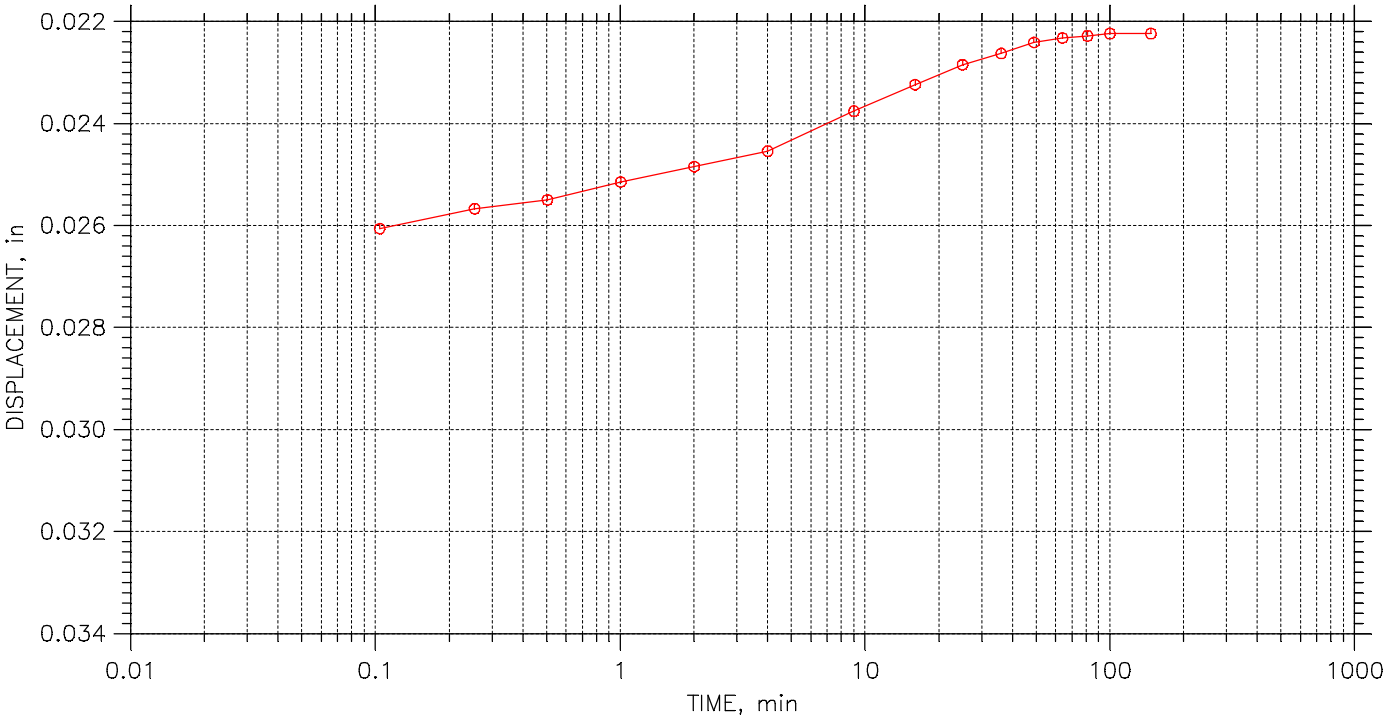
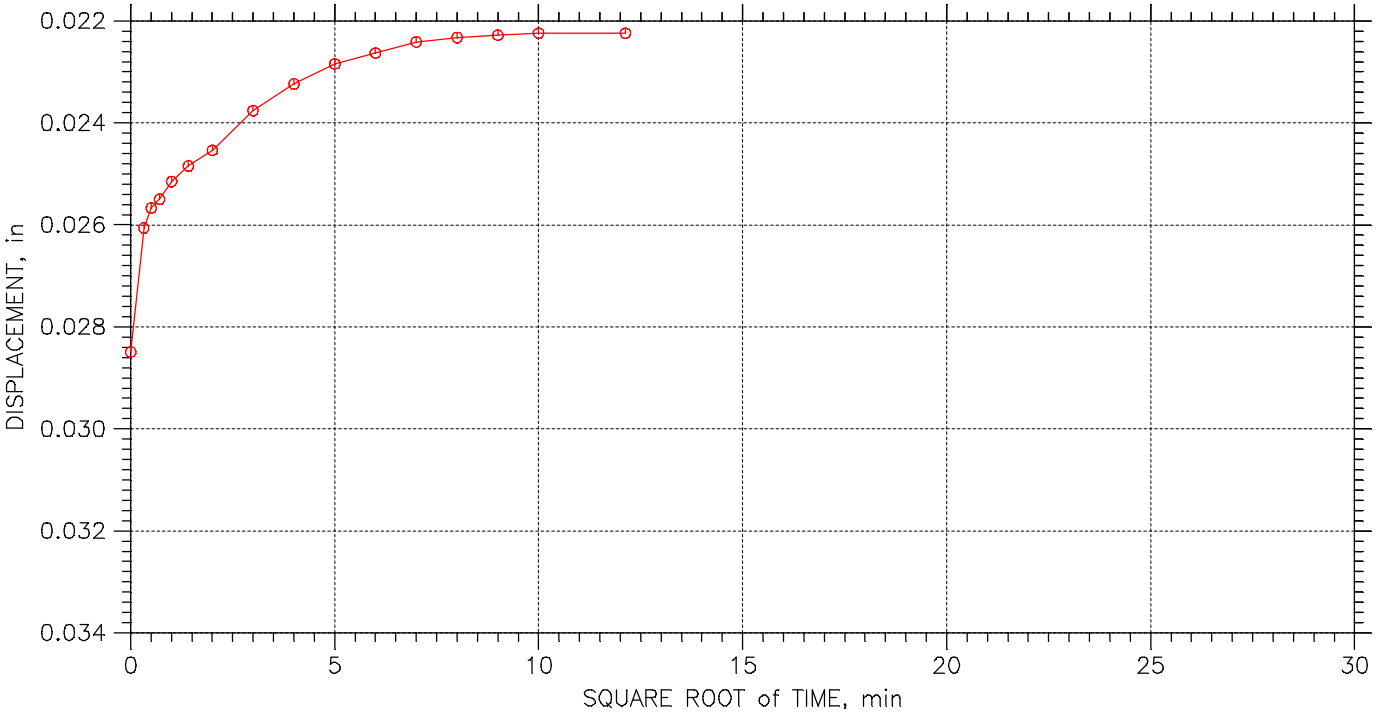
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 9 of 23

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	230		

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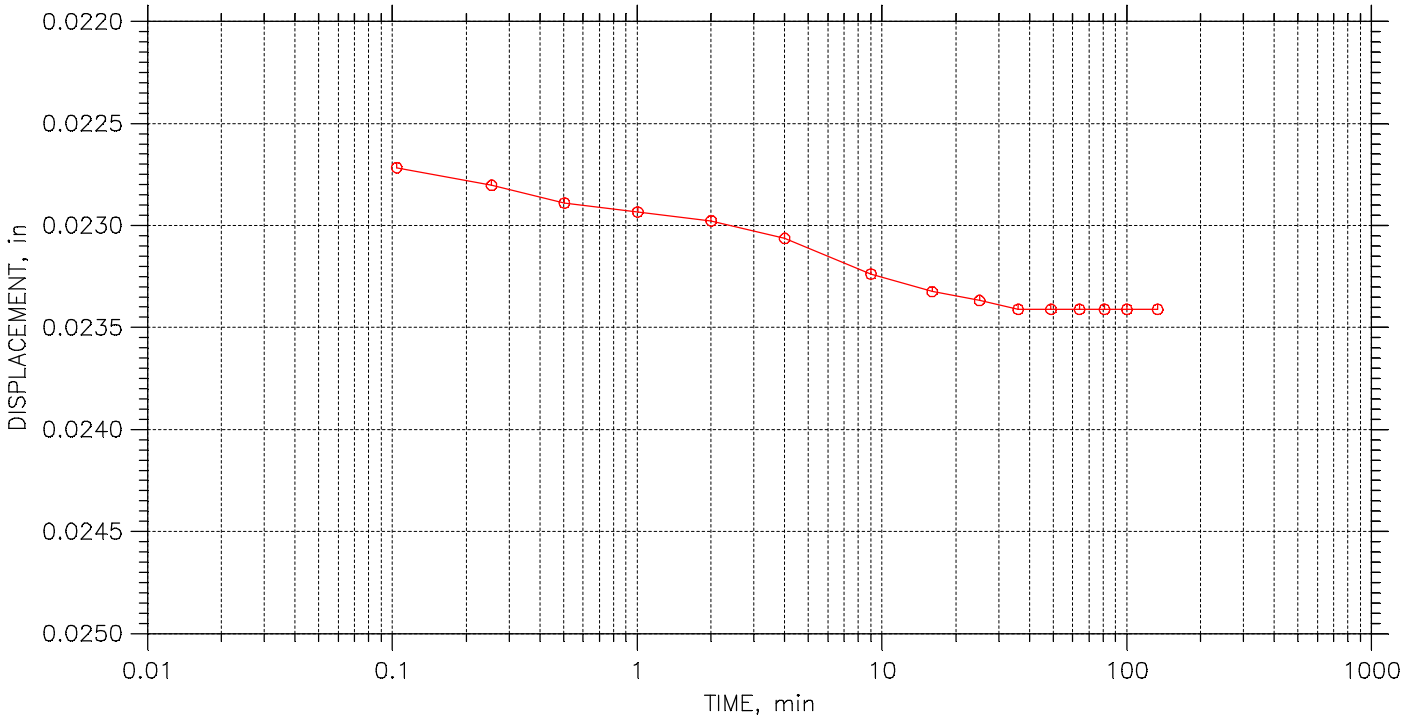
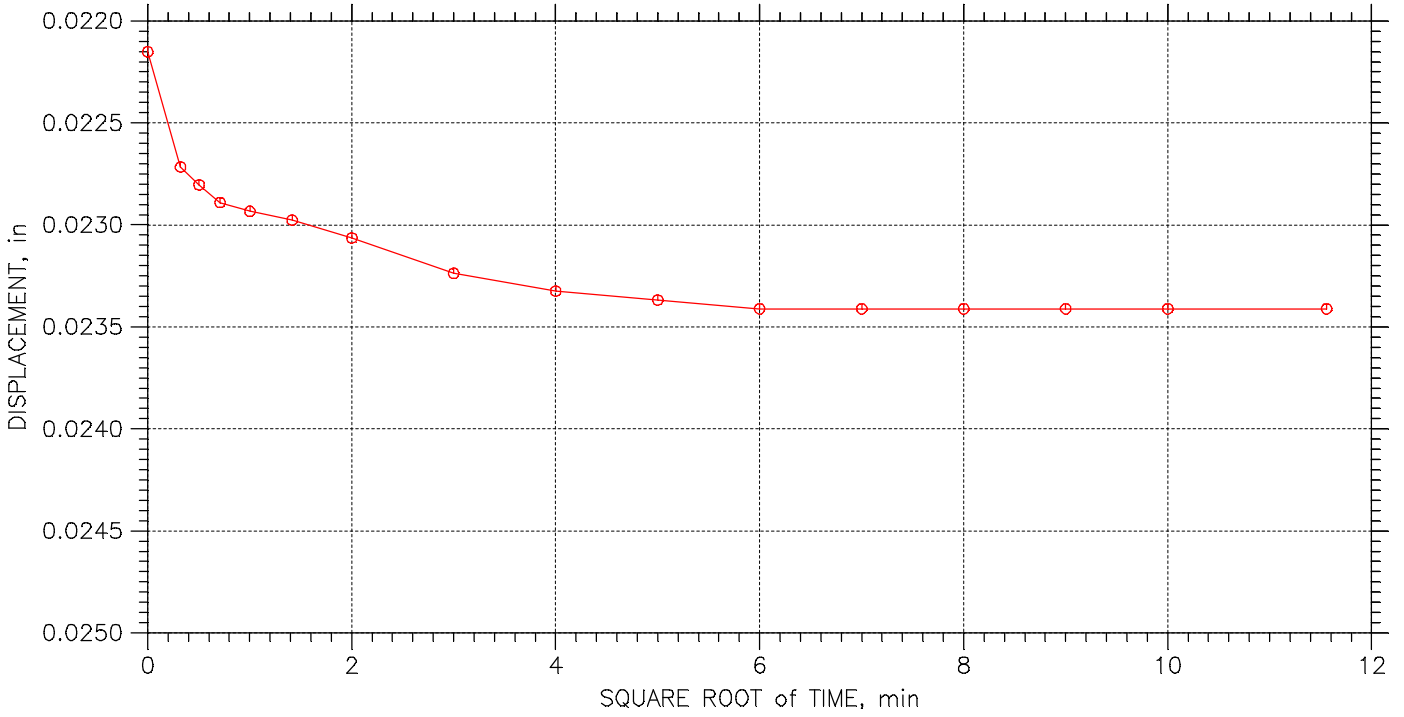
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 23

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	231		

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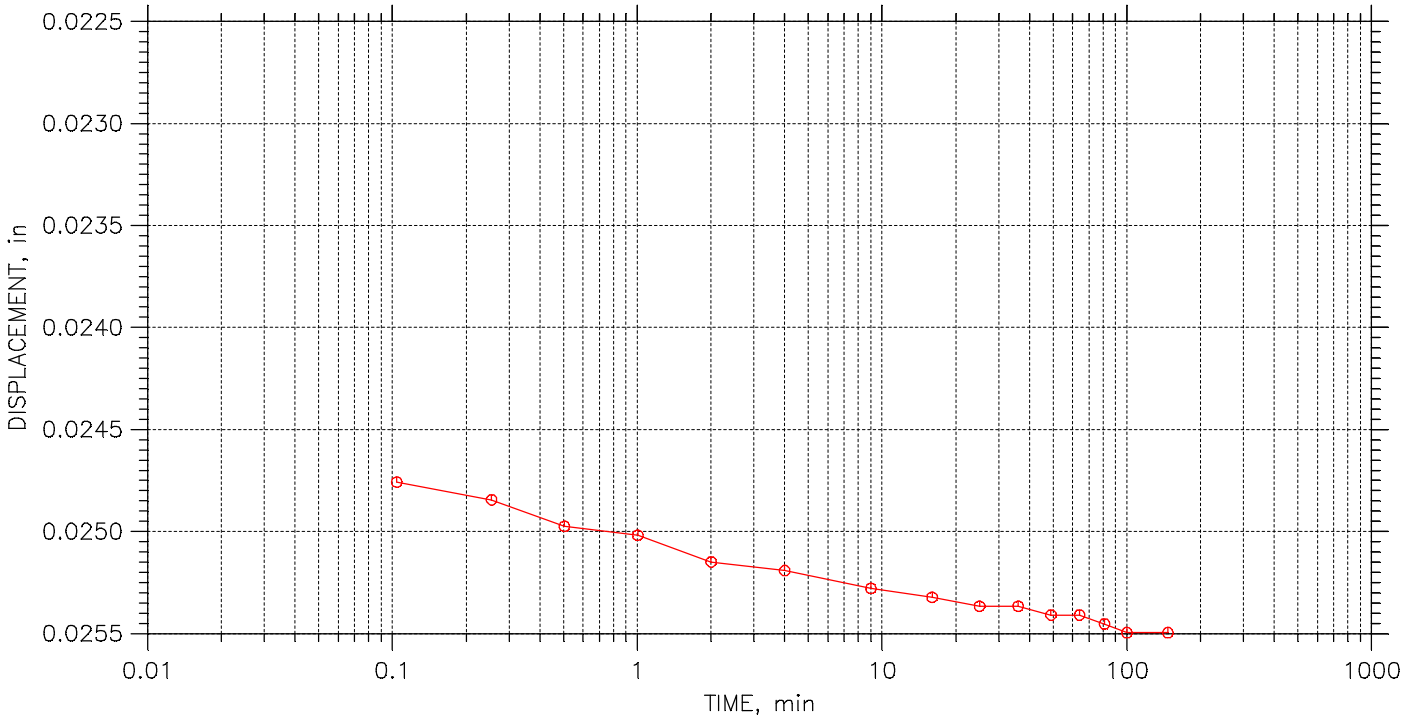
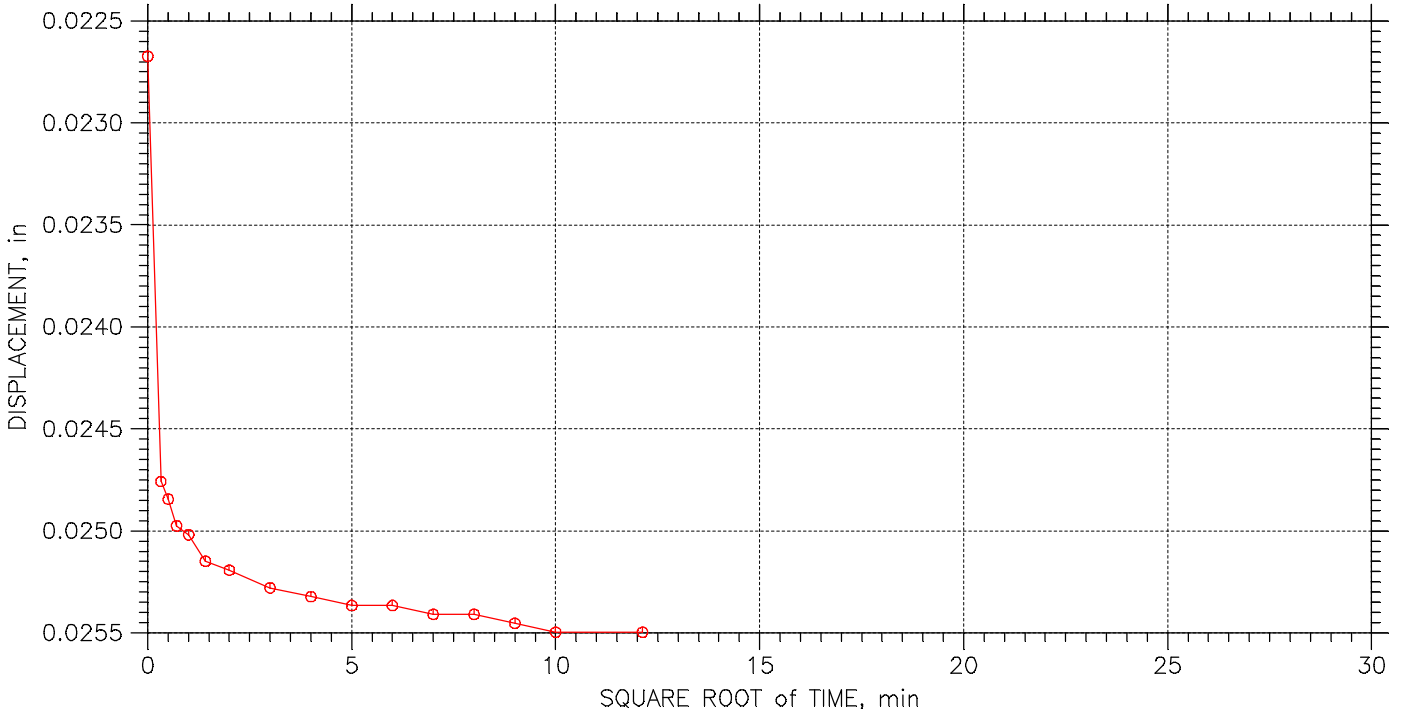
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 11 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	232		

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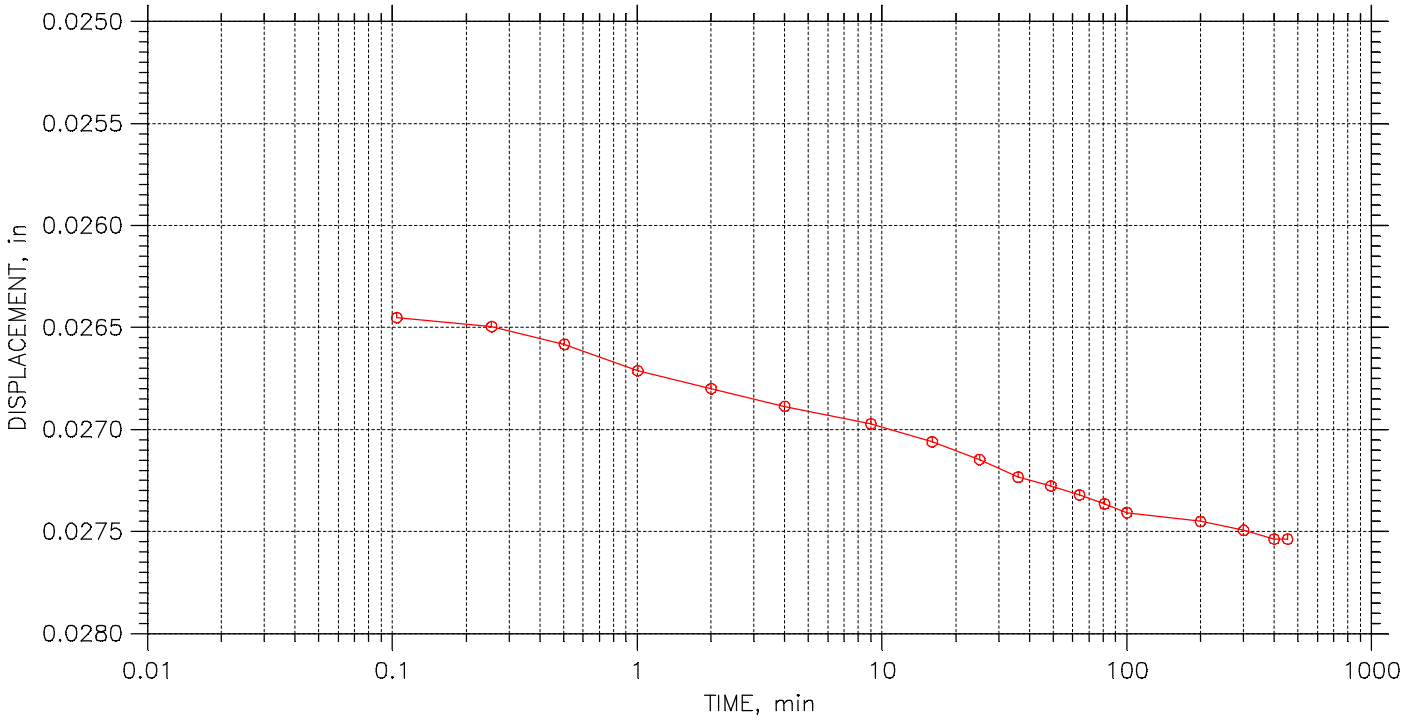
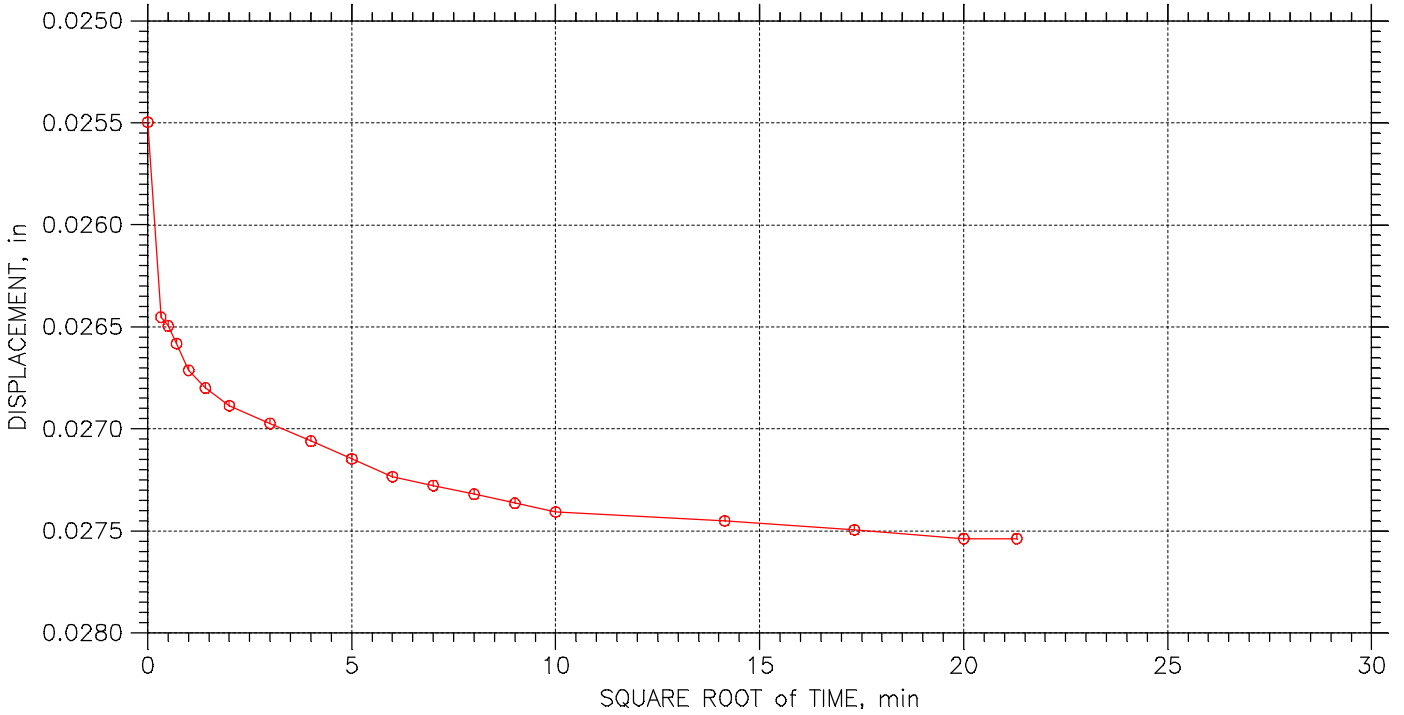
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 23

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	233		

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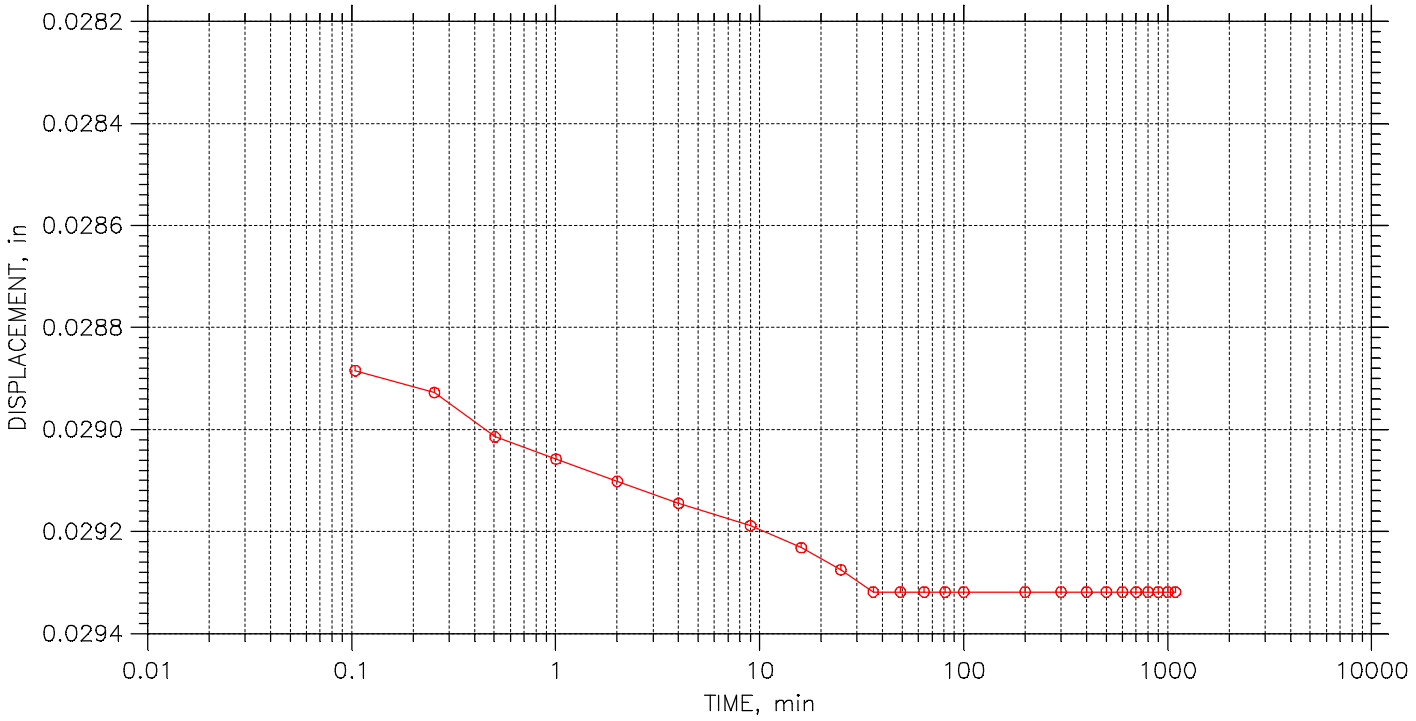
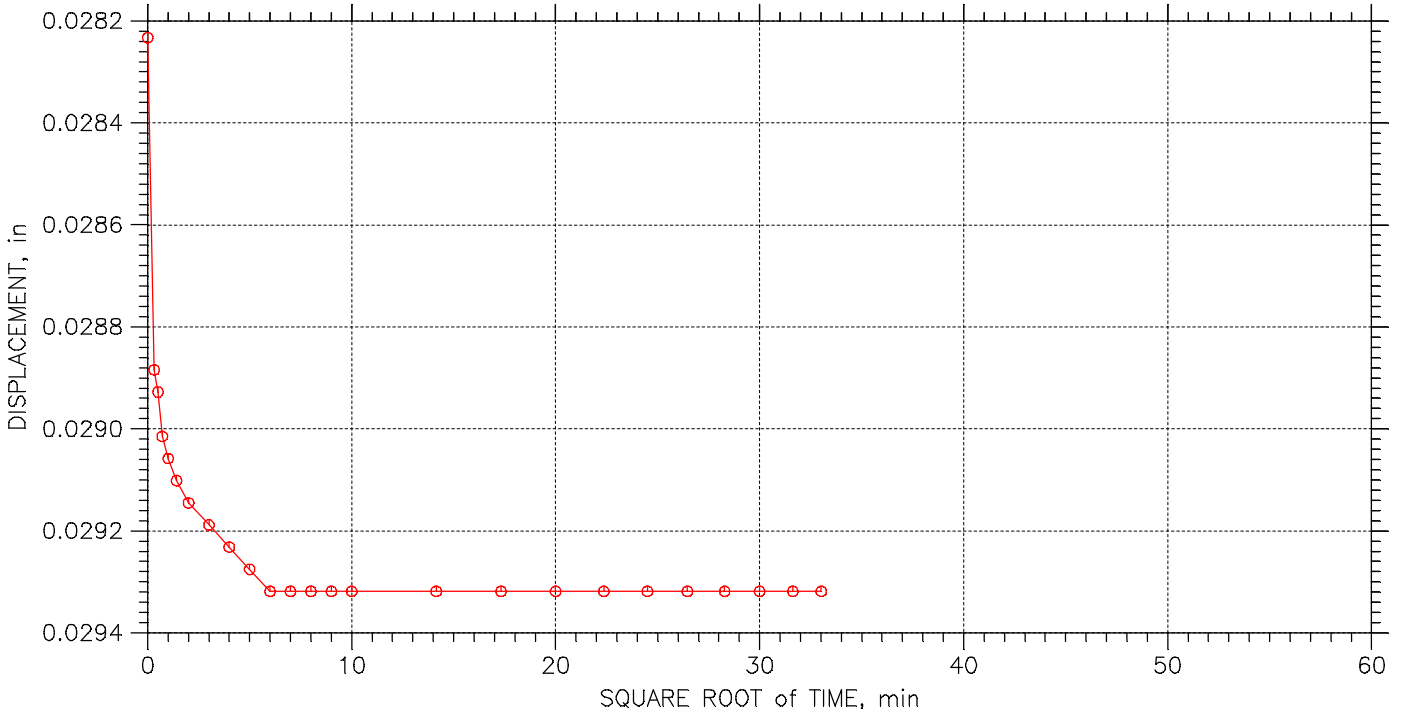
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 13 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	234		

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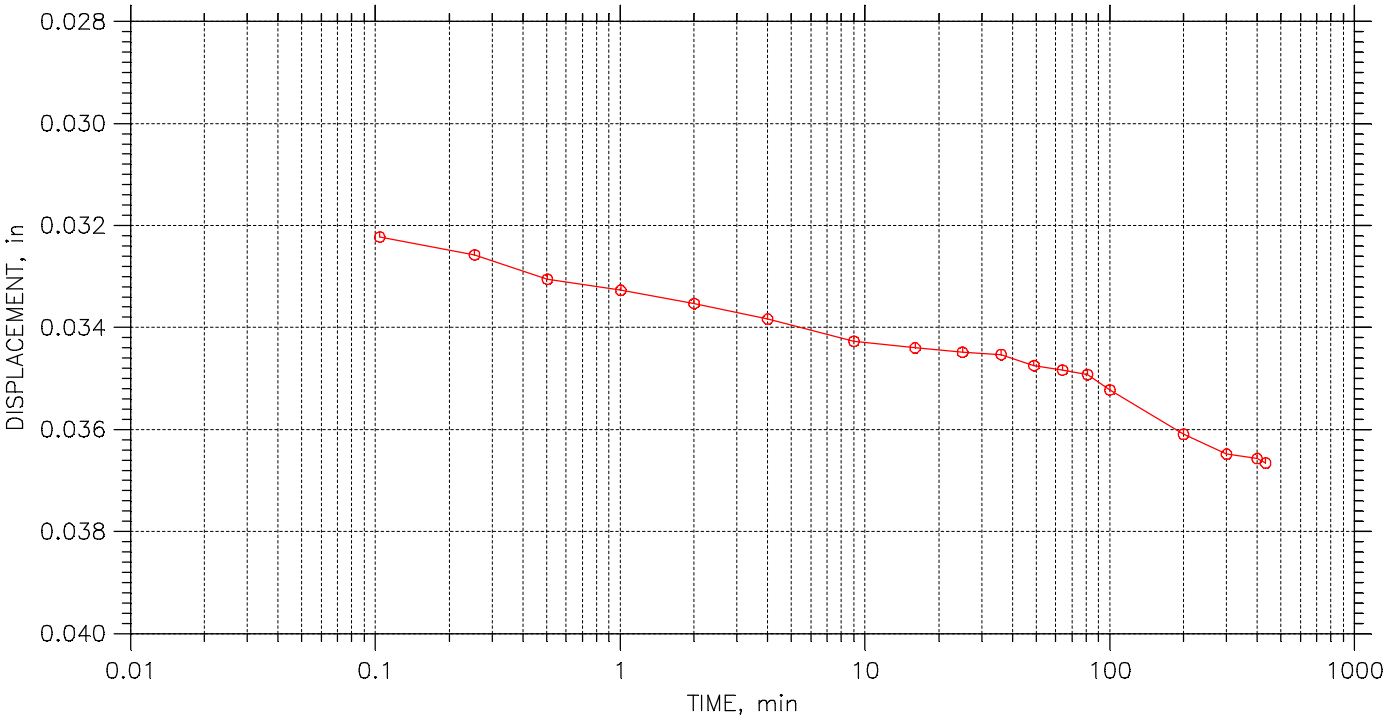
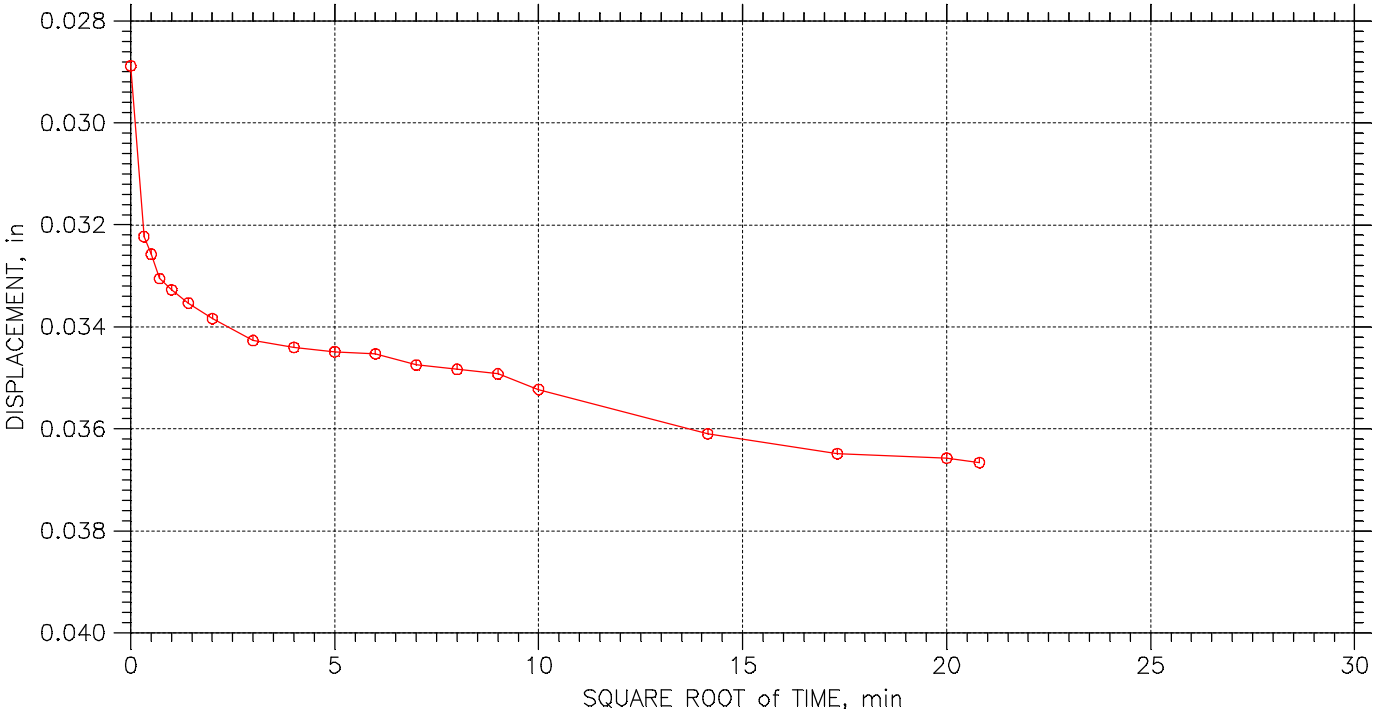
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 14 of 23

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	235		

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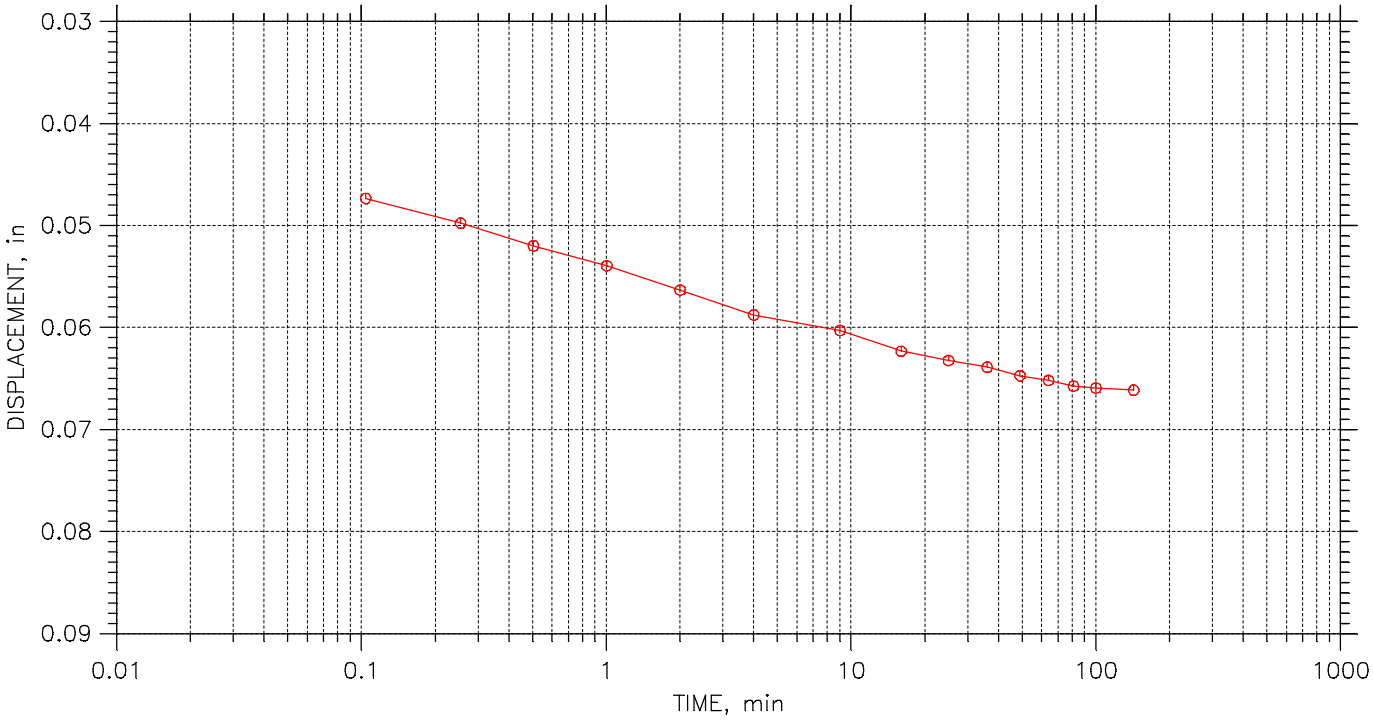
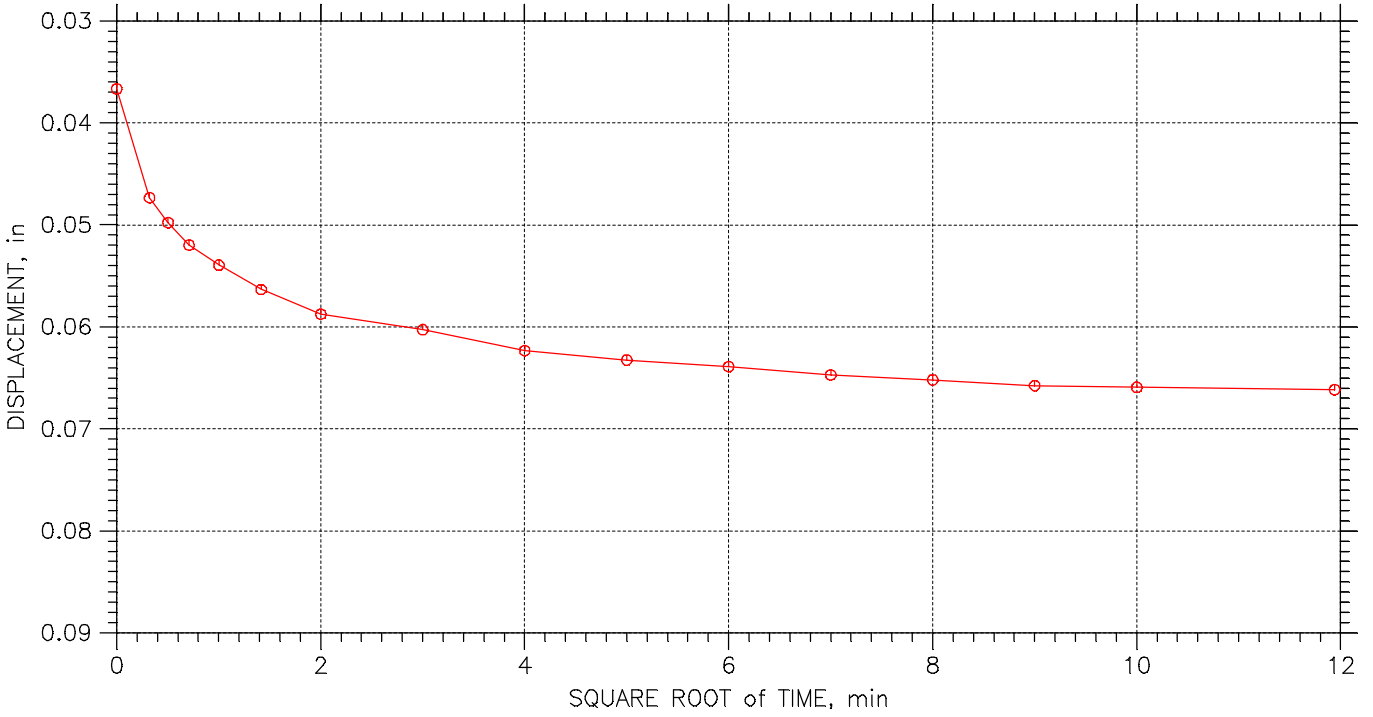
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 15 of 23

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	236		

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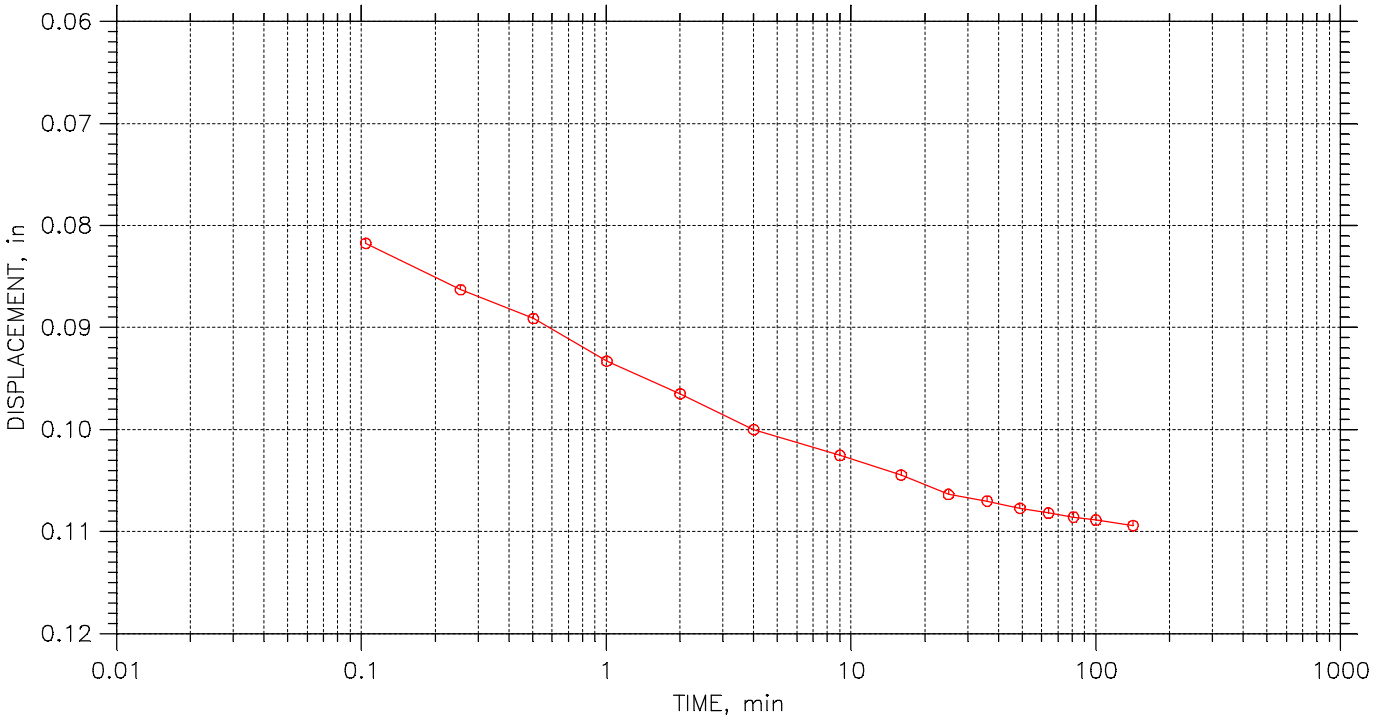
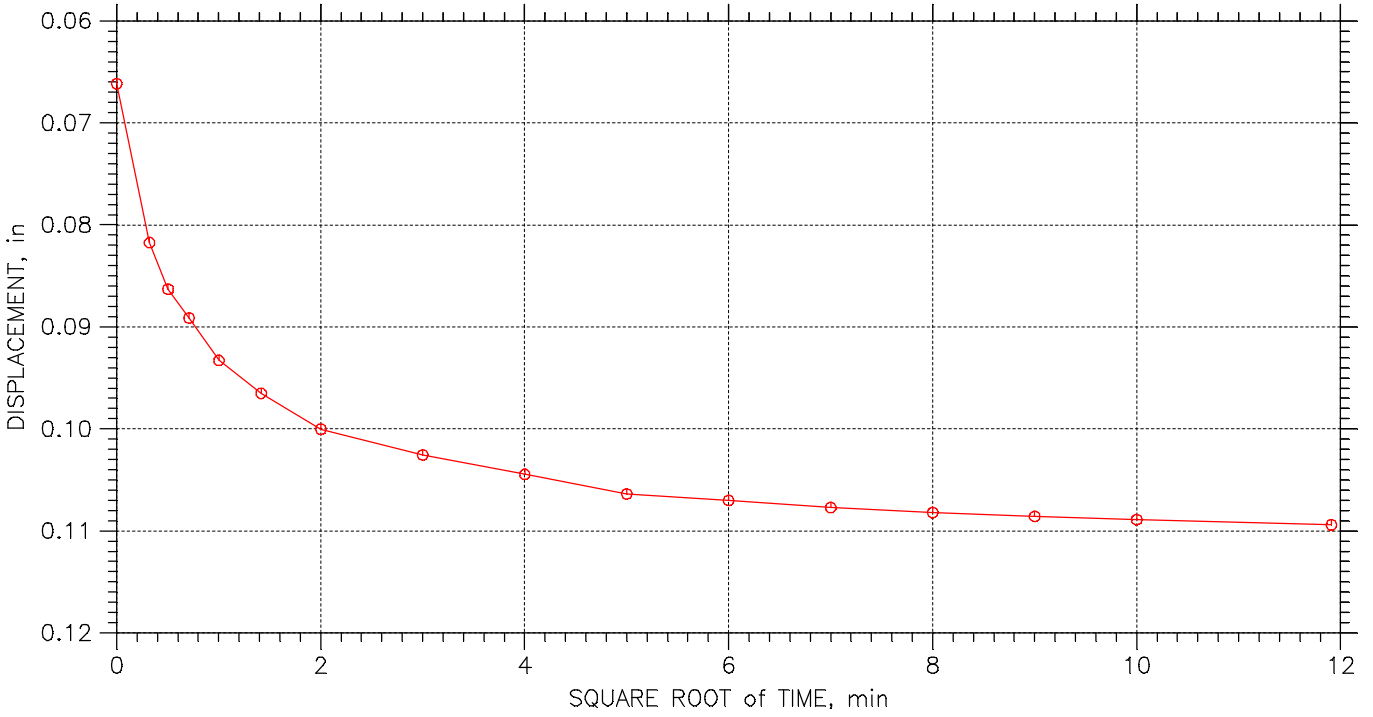
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 16 of 23

Stress: 8. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	237		

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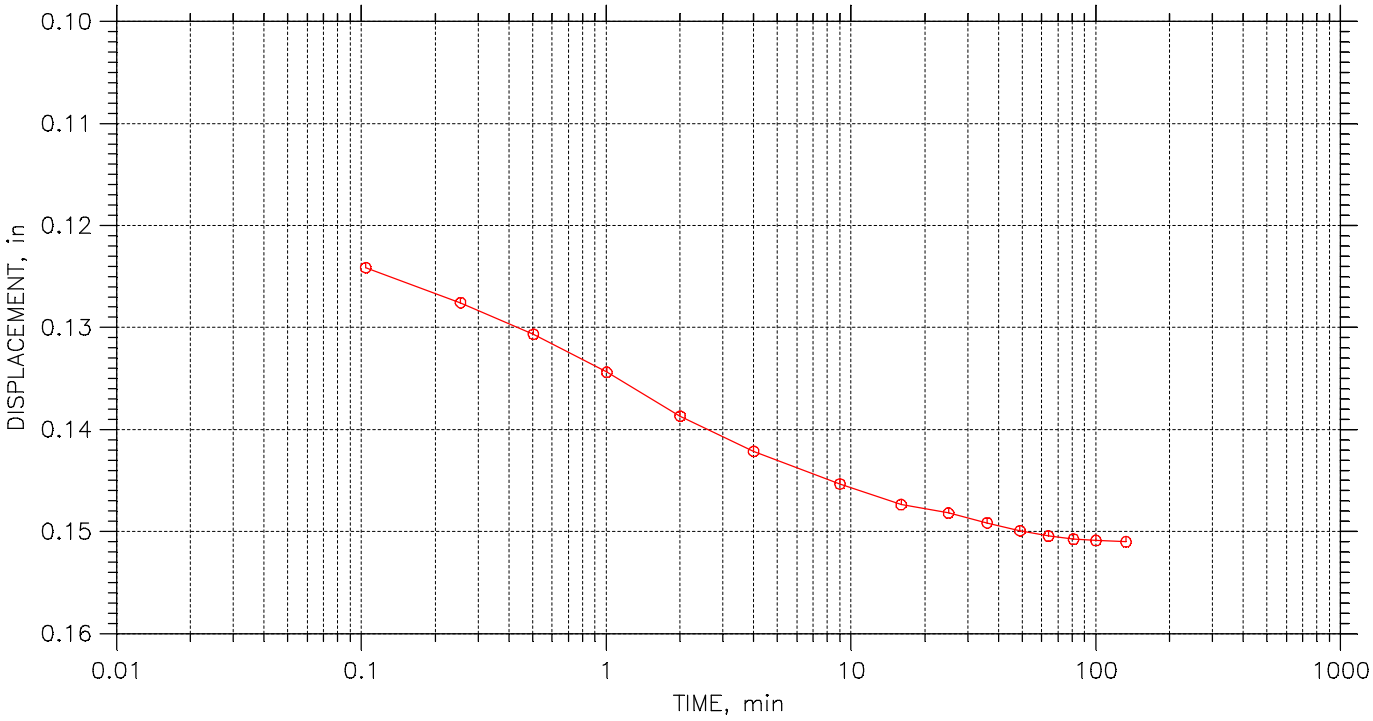
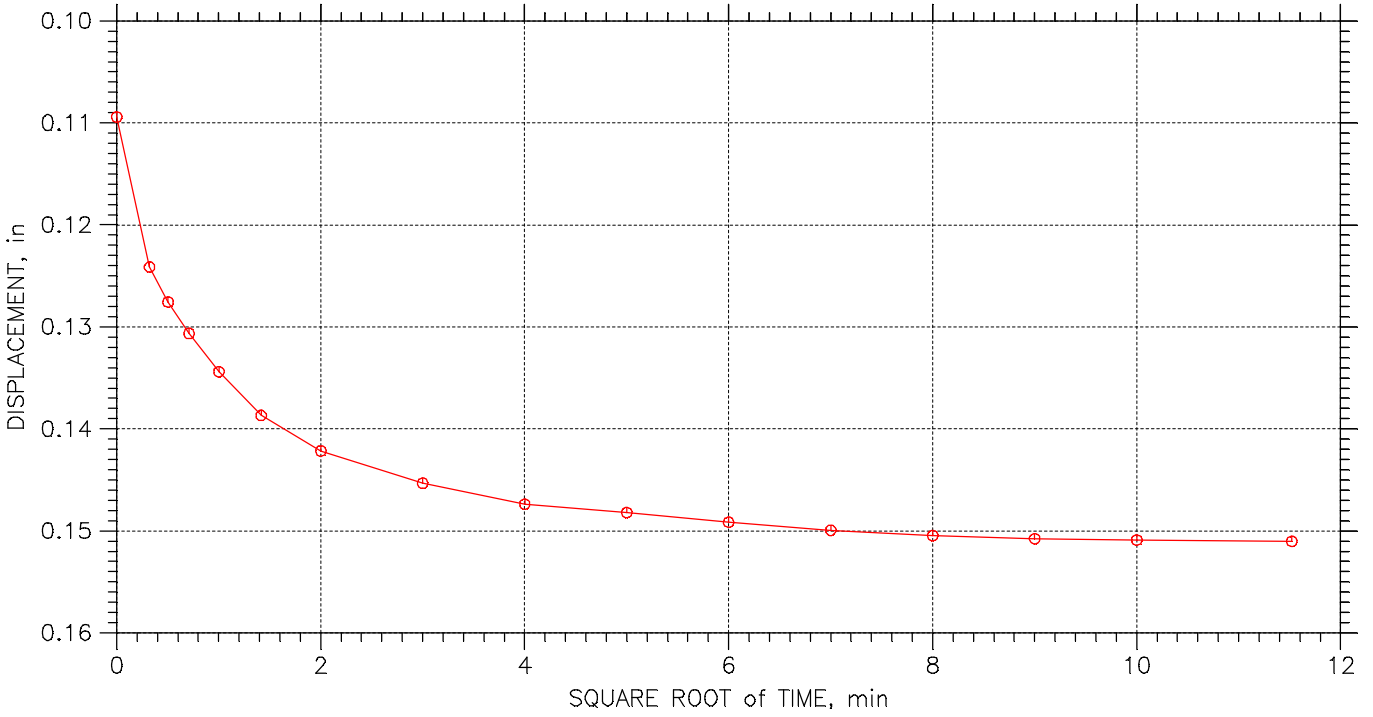
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 23

Stress: 16. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	238		

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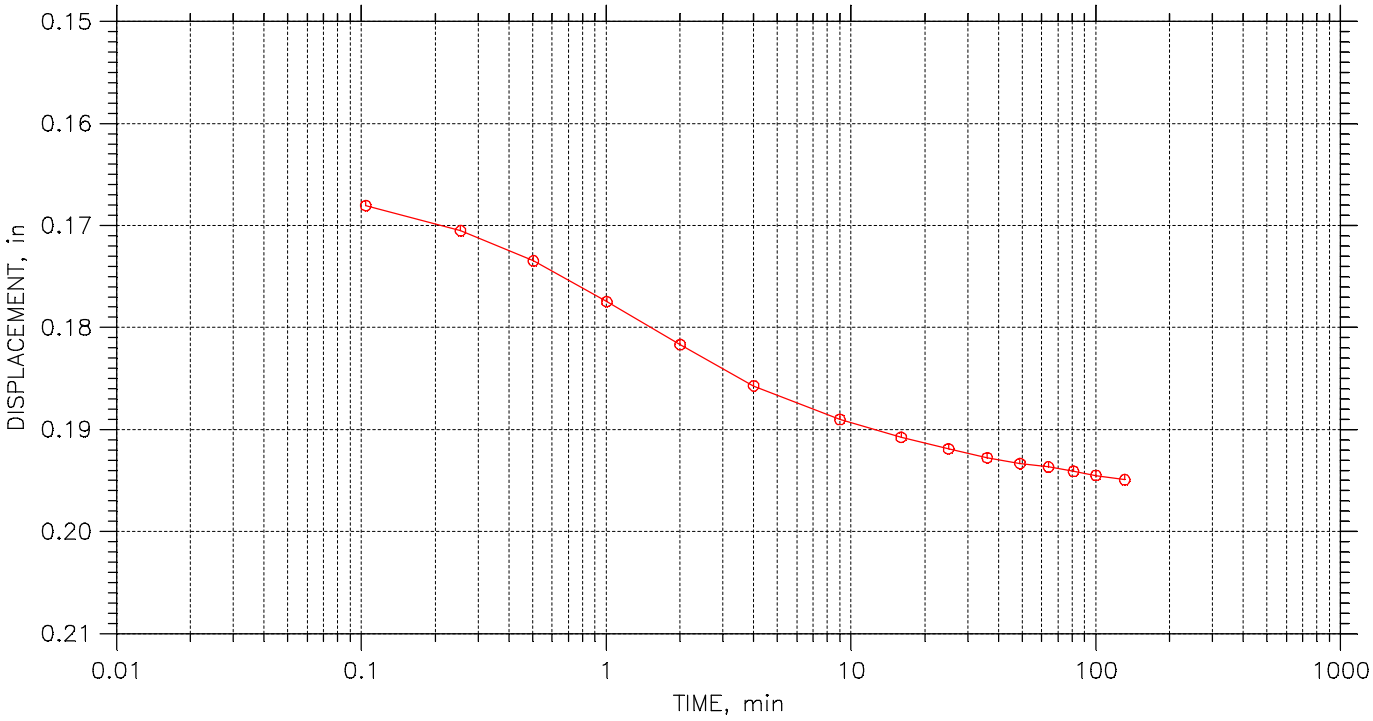
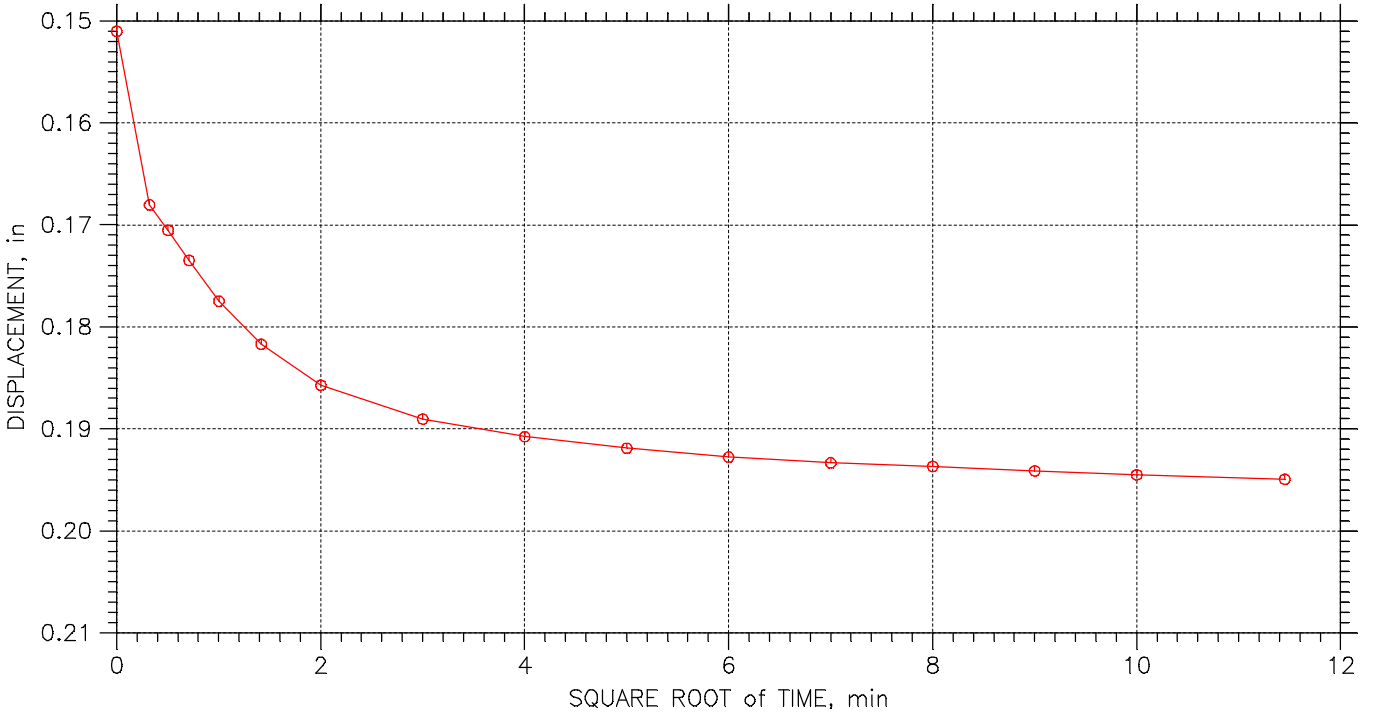
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 18 of 23

Stress: 32. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	239		

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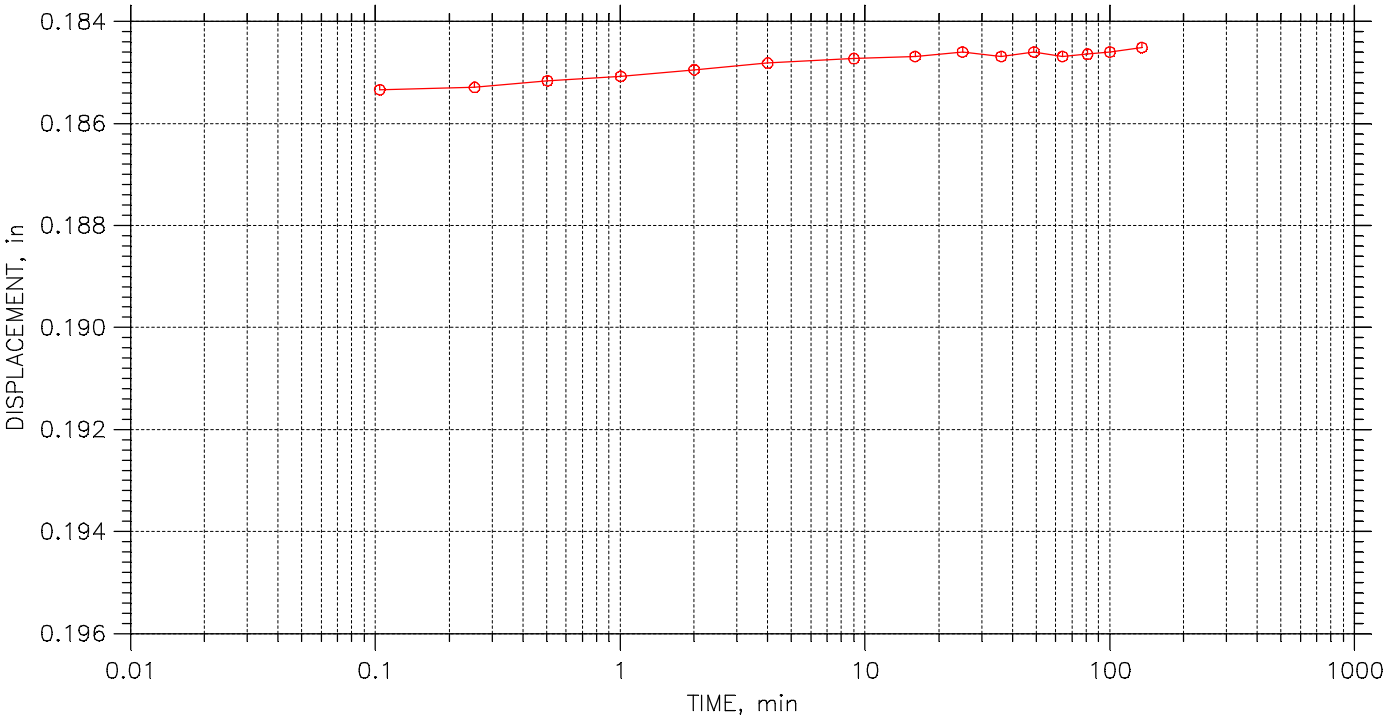
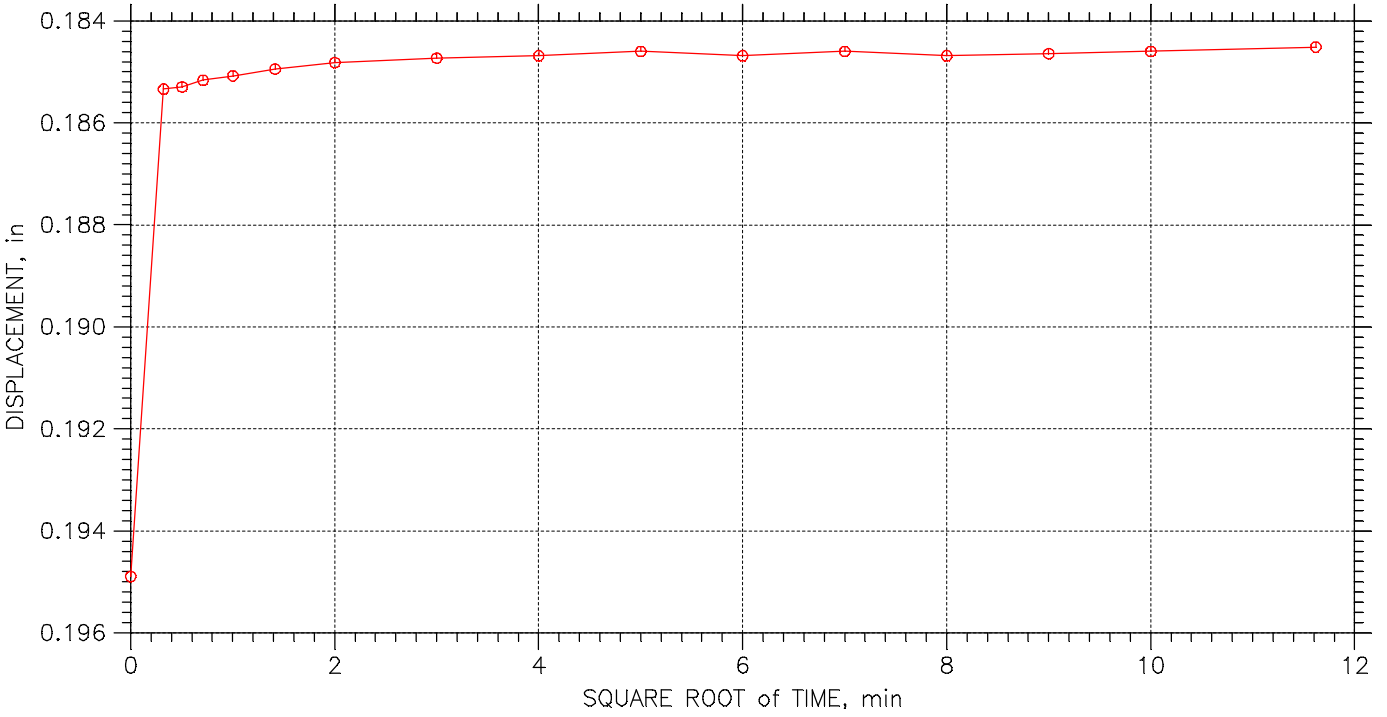
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 19 of 23

Stress: 16. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	240		

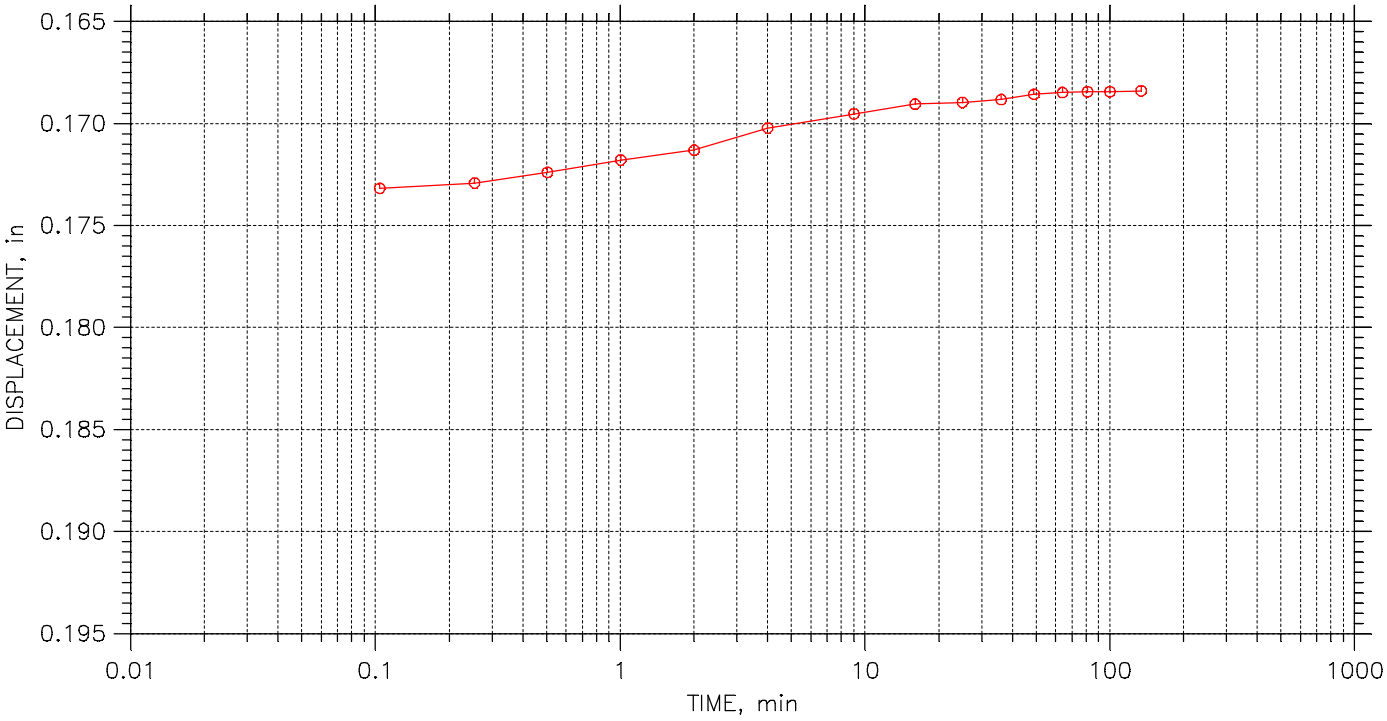
Mon, 21-DEC-2015 16:26:06

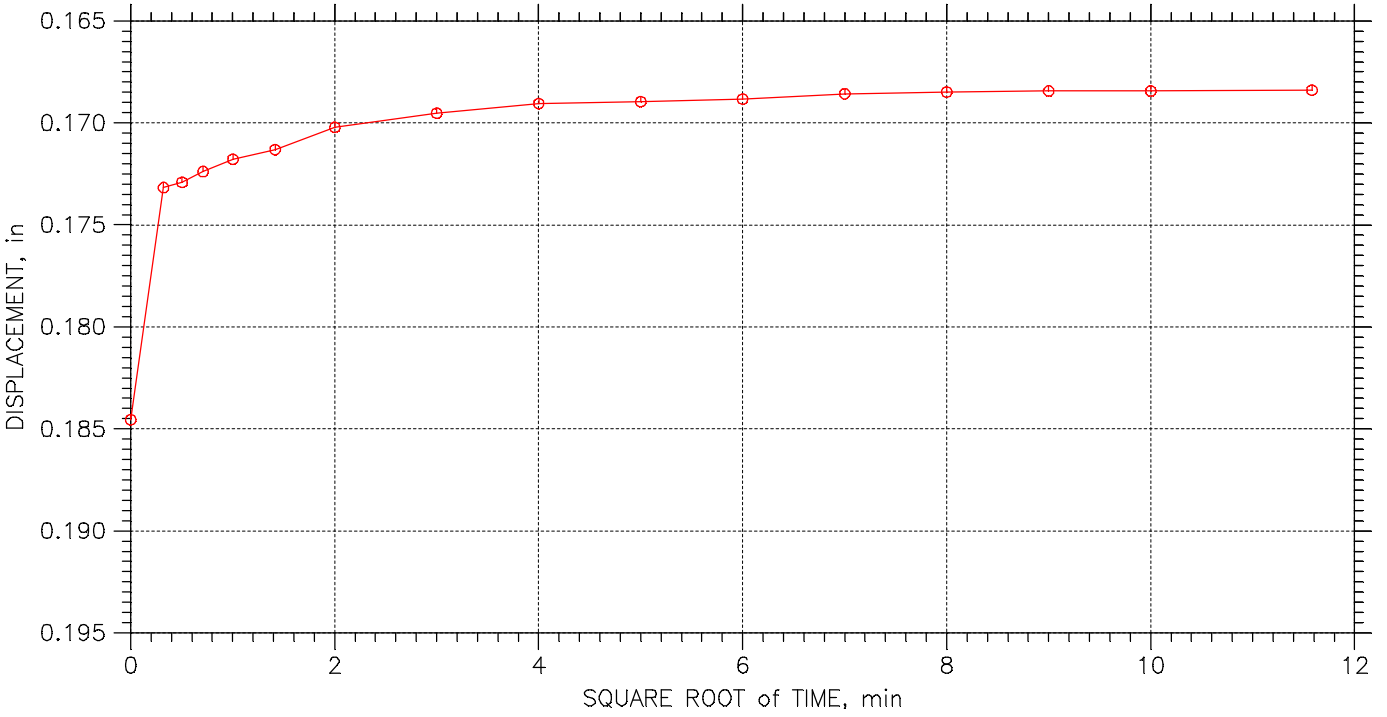
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 20 of 23

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	241		

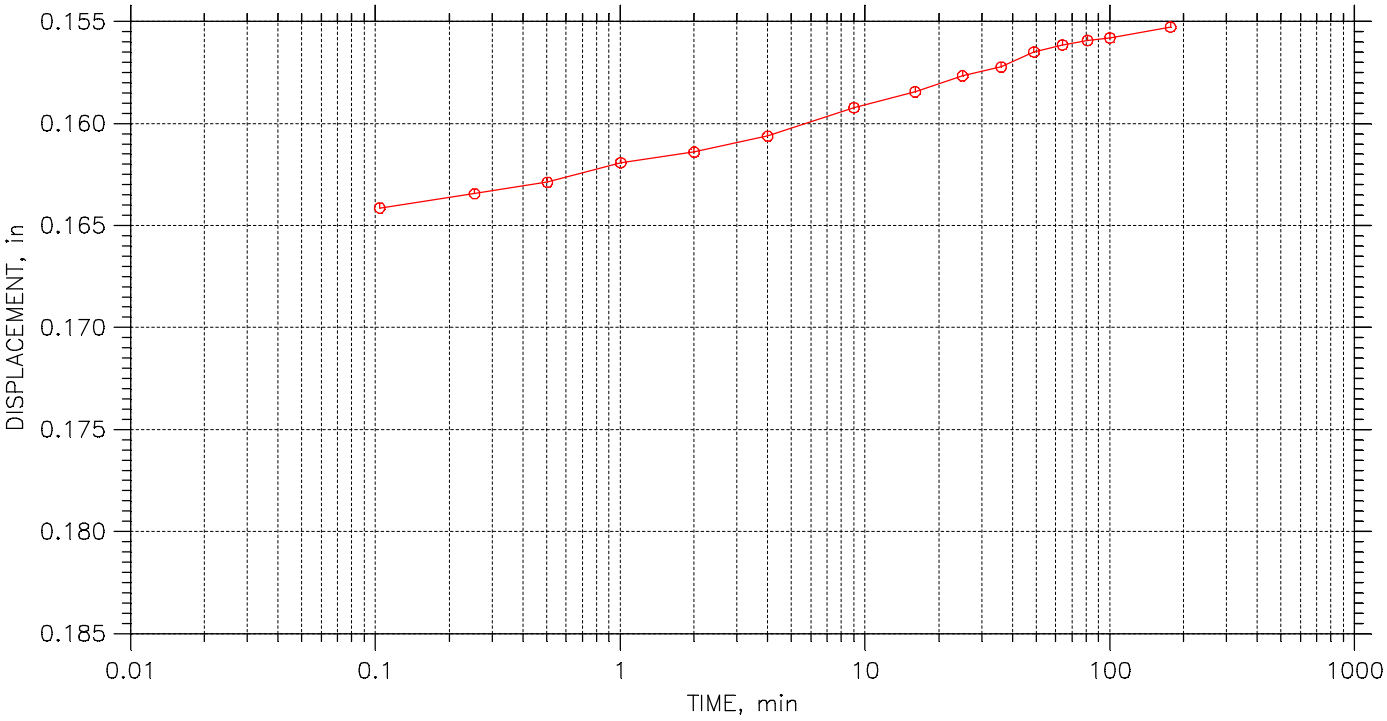
Mon, 21-DEC-2015 16:26:07

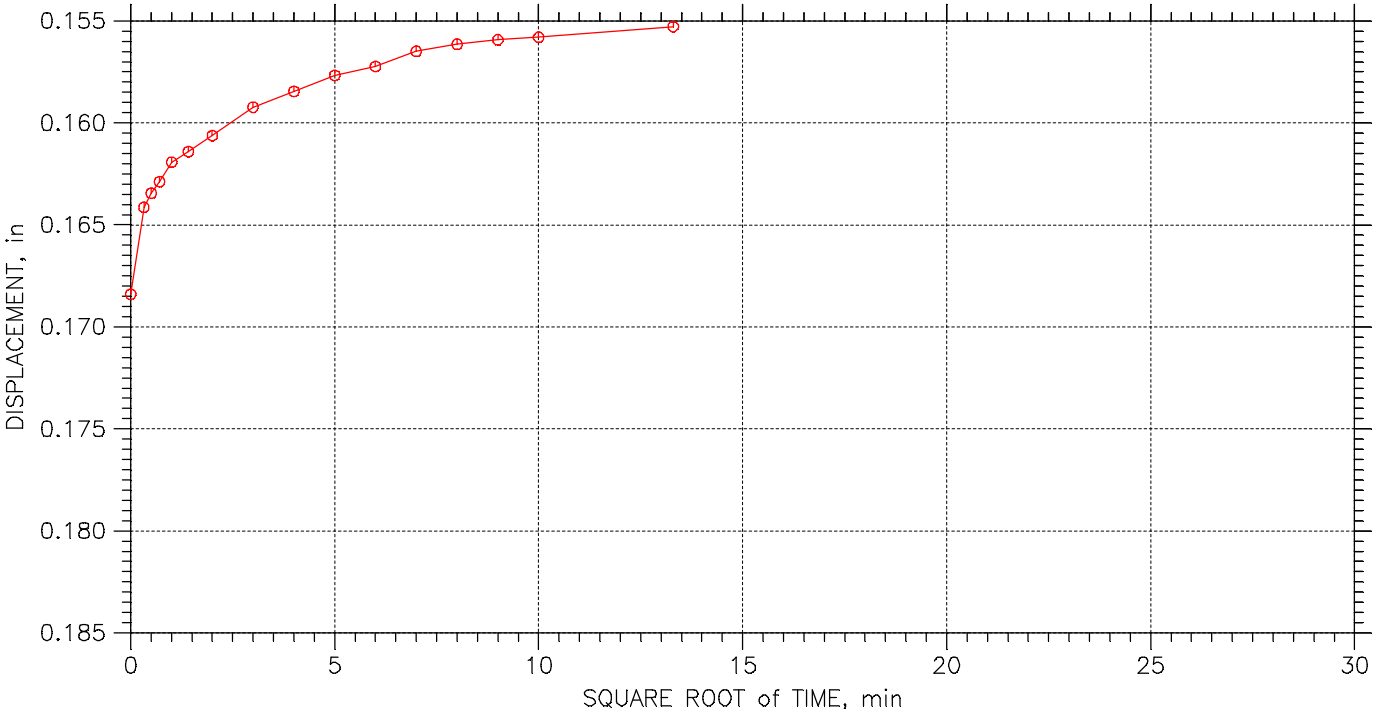
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 21 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	242		

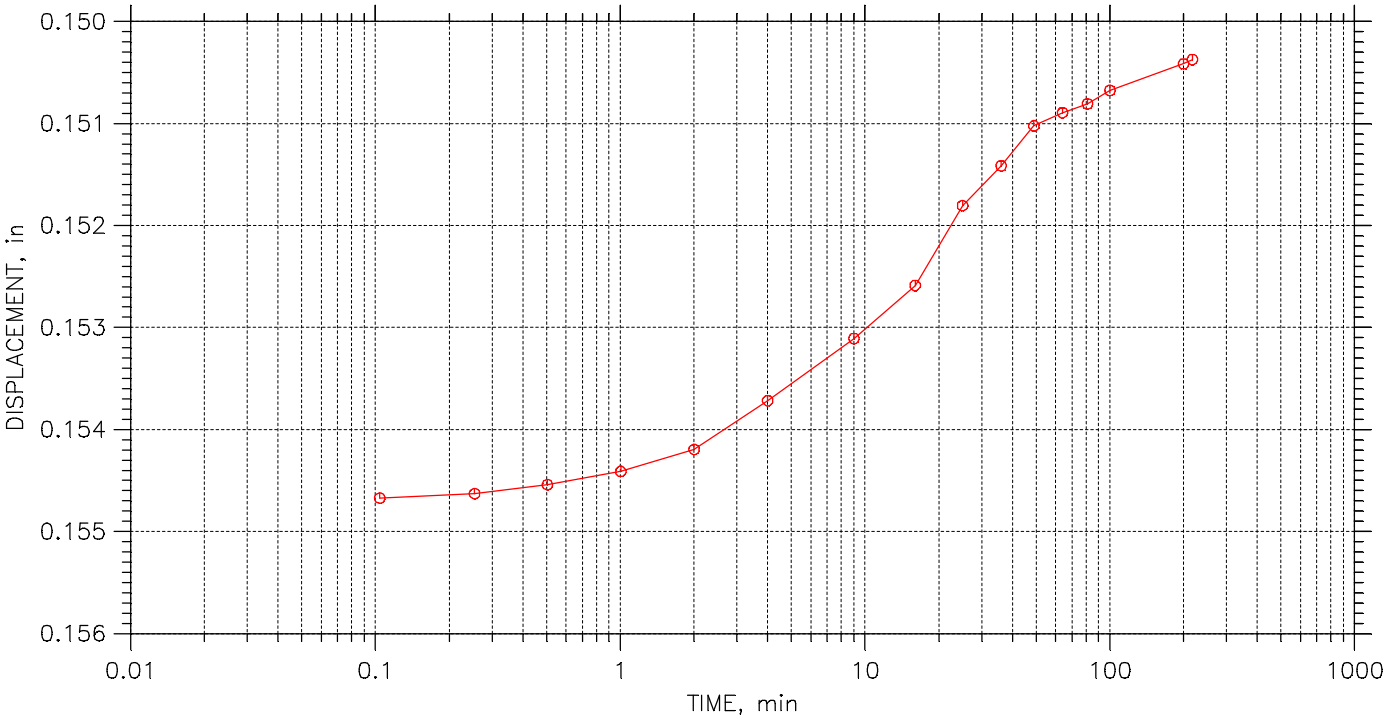
Mon, 21-DEC-2015 16:26:09

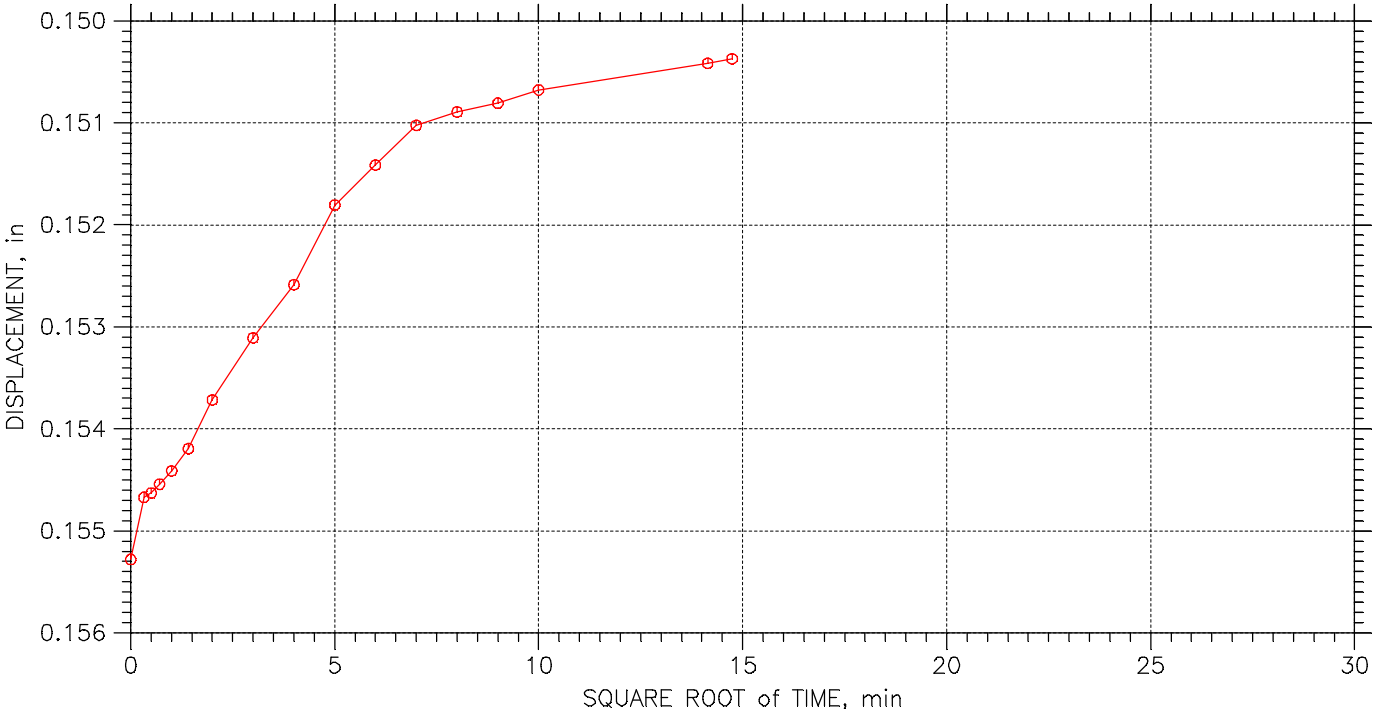
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	243		

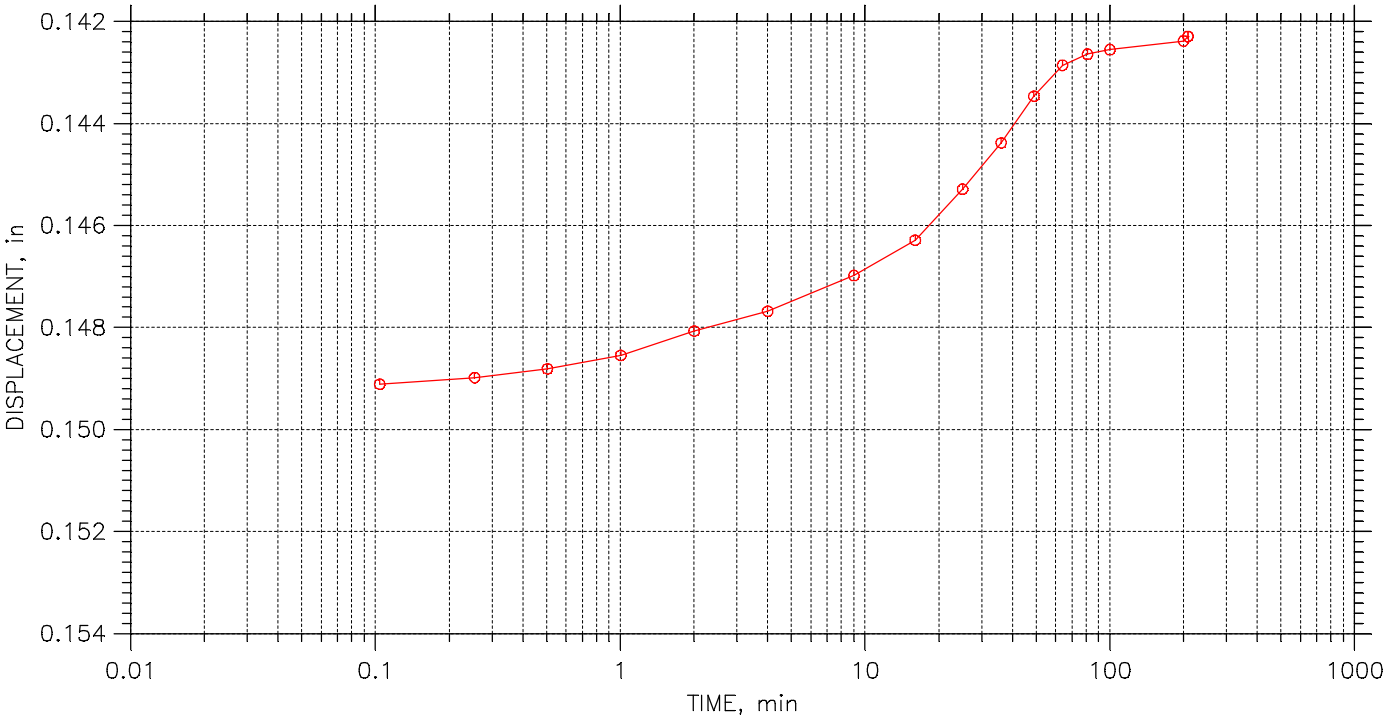
Mon, 21-DEC-2015 16:26:10

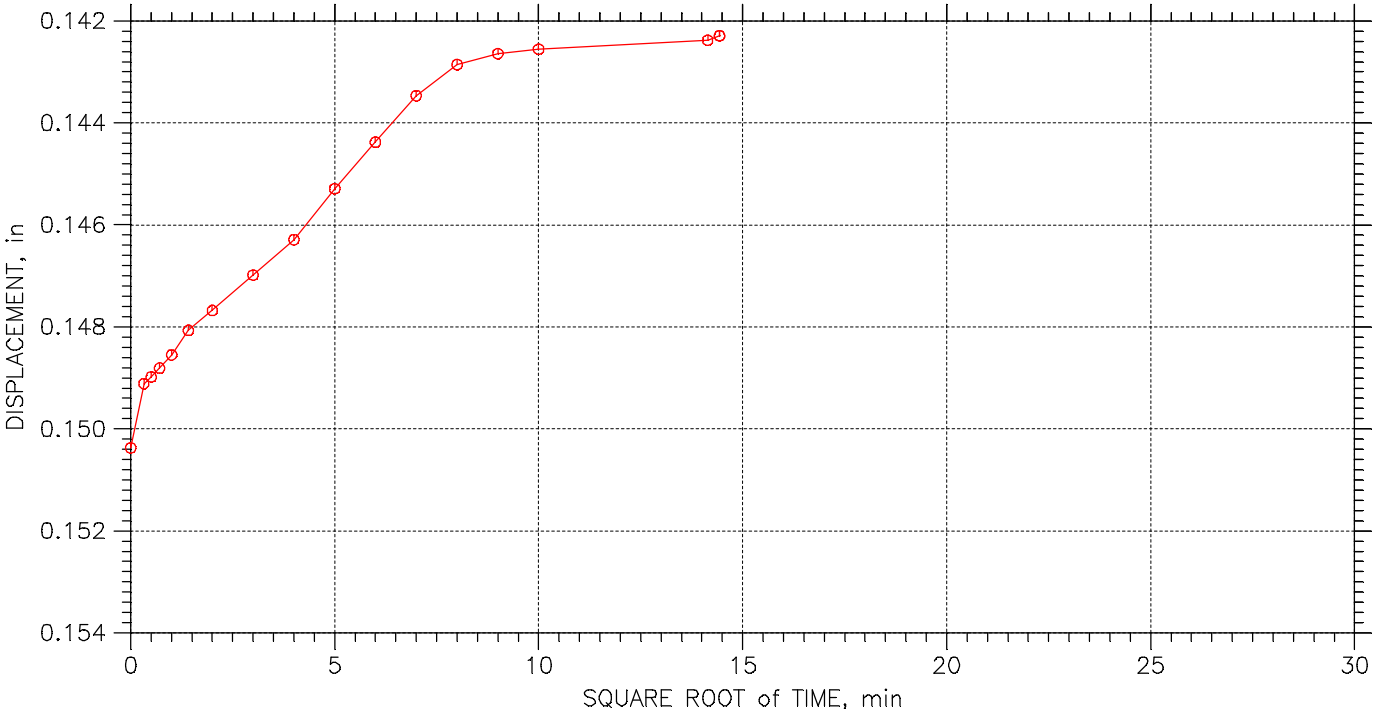
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 23

Stress: 0.125 tsf

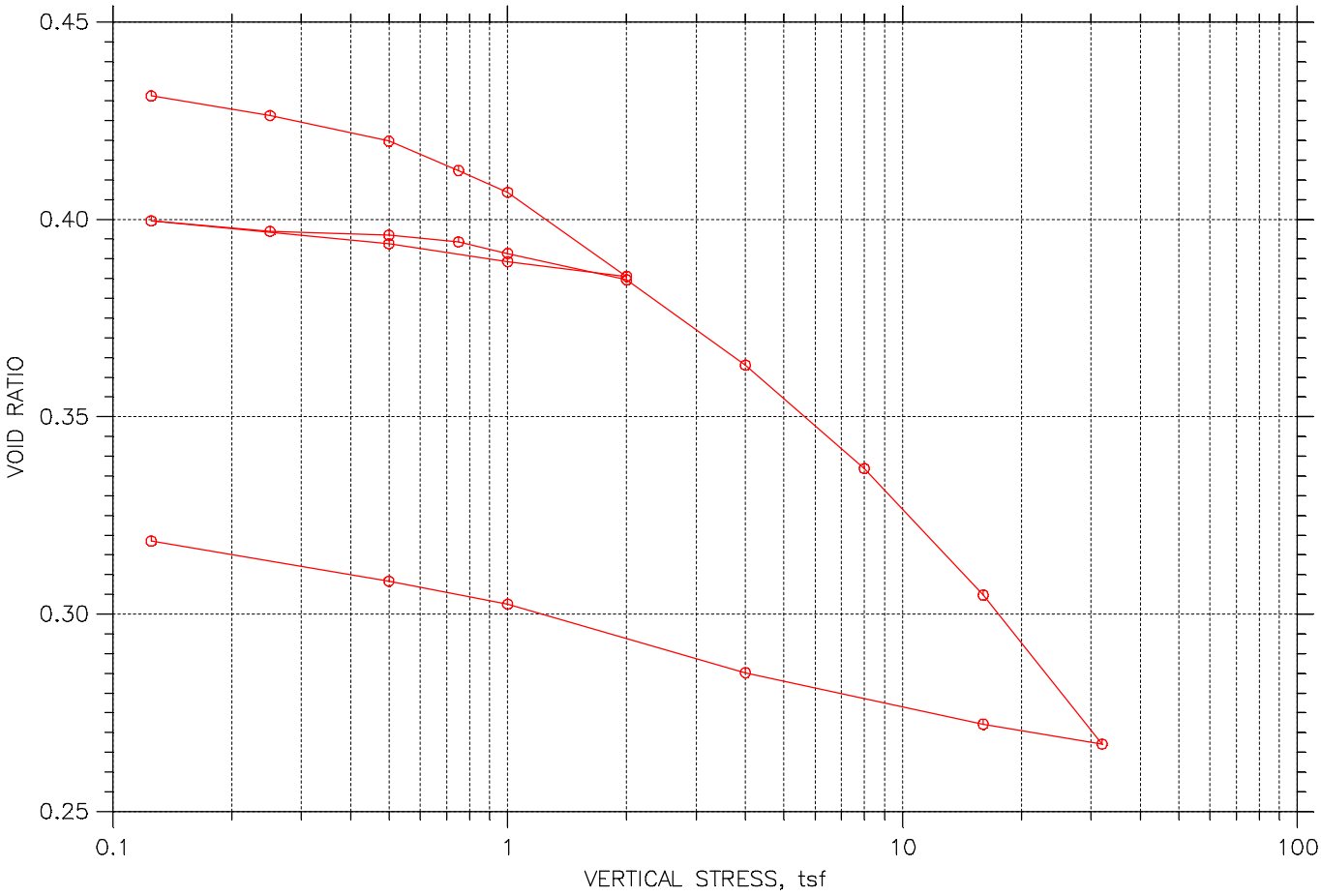


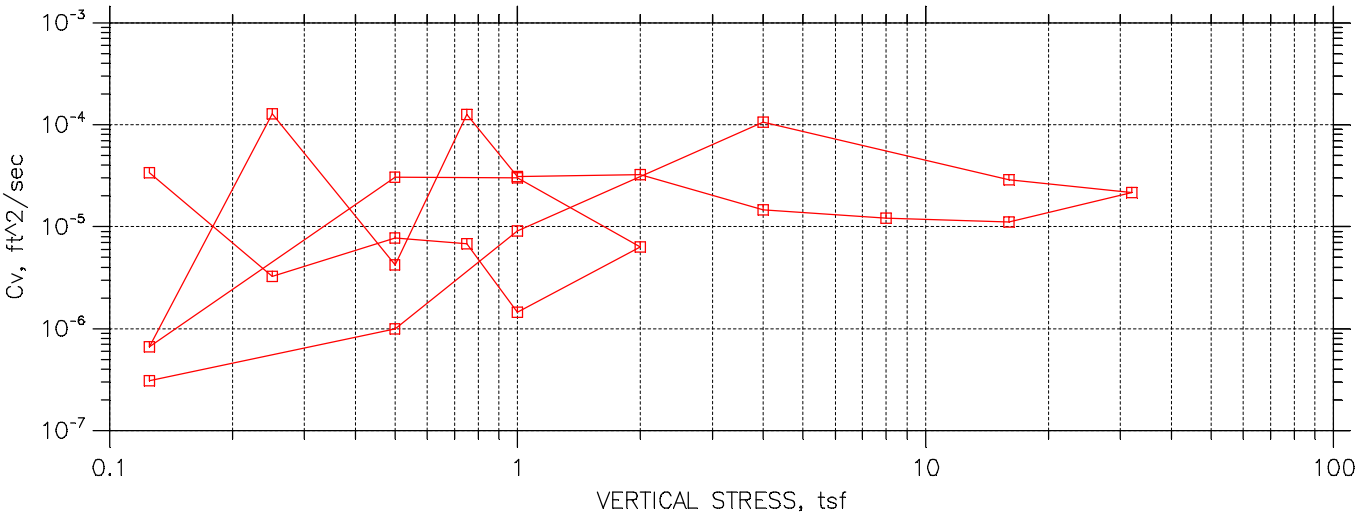


Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-016 S-7	Tested By: HP	Checked By: BCM
	Sample No.: S-7	Test Date: 12/13/15	Depth: 30.0'-22.0'
	Test No.: HENB016S7	Sample Type: 3.0" ST	Elevation: ----
	Description: VERY DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL		
	Remarks: Pc = 2.1 tsf Cc = 0.235 Ccr = 0.056 TEST PERFORMED AS PER ASTM D 2435		
	244		

Mon, 21-DEC-2015 16:26:12

ONE DIMENSIONAL CONSOLIDATION TEST
ASTM D2435





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	245		

Mon, 21-DEC-2015 16:29:50

CONSOLIDATION TEST DATA

Terracon
Consulting Engineers & Scientists

Project: DYNERGY HENNEPIN
Boring No.: HEN B020
Sample No.: S-5
Test No.: HENB020

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: BCM
Depth: 9.5'-11.5'
Elevation: -----

Soil Description: BROWN SANDY LEAN CLAY AND GRAVEL
Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435

Estimated Specific Gravity: 2.72
Initial Void Ratio: 0.44
Final Void Ratio: 0.32

Liquid Limit: 0
Plastic Limit: 0
Plasticity Index: 0

Initial Height: 0.75 in
Specimen Diameter: 2.50 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	X-1	RING	RING	X-9
Wt. Container + Wet Soil, gm	111.2	202.4	200.77	169.91
Wt. Container + Dry Soil, gm	102.93	187.19	187.19	152.25
Wt. Container, gm	44.86	73.34	73.34	4.21
Wt. Dry Soil, gm	58.07	113.85	113.85	148.04
Water Content, %	14.24	13.36	11.93	11.93
Void Ratio	---	0.44	0.32	---
Degree of Saturation, %	---	82.94	101.88	---
Dry Unit Weight, pcf	---	118.07	128.79	---

CONSOLIDATION TEST DATA

Project: DYNERGY HENNEPIN
Boring No.: HEN B020
Sample No.: S-5
Test No.: HENB020

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: BCM
Depth: 9.5'-11.5'
Elevation: -----

Soil Description: BROWN SANDY LEAN CLAY AND GRAVEL
Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435

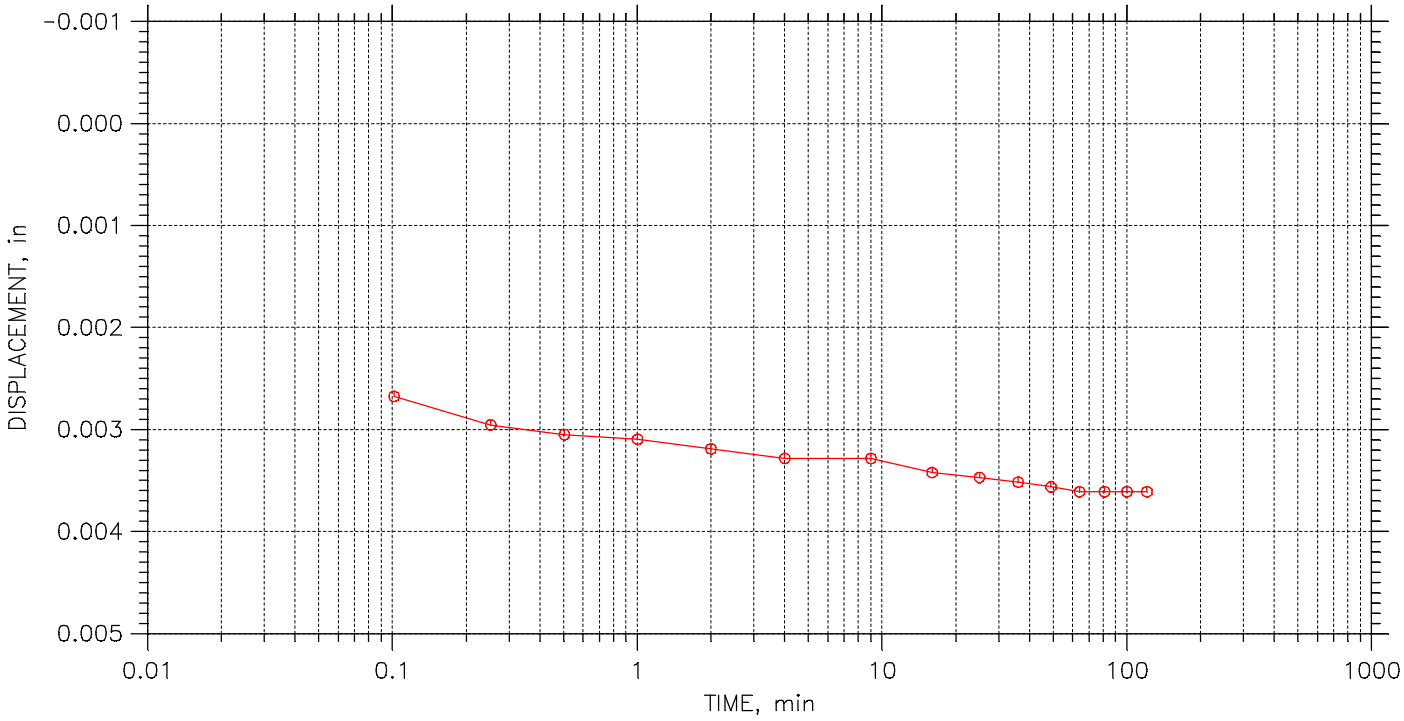
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting Sq.Rt. min	T50 Fitting Log min	Coefficient of Consolidation Sq.Rt. ft^2/sec	Coefficient of Consolidation Log ft^2/sec	Coefficient of Consolidation Ave. ft^2/sec
1	0.125	0.00361	0.431	0.48	0.1	0.0	3.40e-005	0.00e+000	3.40e-005
2	0.25	0.006166	0.426	0.82	1.0	0.0	3.26e-006	0.00e+000	3.26e-006
3	0.5	0.009553	0.420	1.28	0.4	0.0	7.74e-006	0.00e+000	7.74e-006
4	0.75	0.01341	0.412	1.79	0.5	0.0	6.84e-006	0.00e+000	6.84e-006
5	1	0.01633	0.407	2.18	2.1	0.5	1.46e-006	6.72e-006	2.40e-006
6	2	0.02736	0.386	3.66	0.5	0.0	6.30e-006	0.00e+000	6.30e-006
7	1	0.02531	0.389	3.39	0.1	0.0	3.04e-005	0.00e+000	3.04e-005
8	0.5	0.02311	0.394	3.09	0.1	0.0	3.06e-005	0.00e+000	3.06e-005
9	0.125	0.02032	0.399	2.72	0.9	0.0	3.23e-006	0.00e+000	3.23e-006
10	0.25	0.02154	0.397	2.88	0.1	0.0	3.18e-005	0.00e+000	3.18e-005
11	0.5	0.02194	0.396	2.94	0.2	0.0	1.52e-005	0.00e+000	1.52e-005
12	0.75	0.02305	0.394	3.08	0.1	0.0	3.12e-005	0.00e+000	3.12e-005
13	1	0.02438	0.391	3.26	0.1	0.0	2.54e-005	0.00e+000	2.54e-005
14	2	0.02792	0.384	3.73	0.1	0.0	3.25e-005	0.00e+000	3.25e-005
15	4	0.03906	0.363	5.22	0.2	0.0	1.45e-005	0.00e+000	1.45e-005
16	8	0.05266	0.337	7.04	0.2	0.0	1.22e-005	0.00e+000	1.22e-005
17	16	0.06932	0.305	9.27	0.2	0.0	1.11e-005	0.00e+000	1.11e-005
18	32	0.08893	0.267	11.90	0.1	0.0	2.17e-005	0.00e+000	2.17e-005
19	16	0.08627	0.272	11.54	0.1	0.0	2.47e-005	0.00e+000	2.47e-005
20	4	0.07955	0.285	10.64	0.0	0.0	1.06e-004	0.00e+000	1.06e-004
21	1	0.07068	0.302	9.45	0.3	0.0	9.06e-006	0.00e+000	9.06e-006
22	0.5	0.06777	0.308	9.07	9.7	0.0	2.72e-007	0.00e+000	2.72e-007
23	0.125	0.06223	0.318	8.32	8.3	8.9	3.20e-007	3.00e-007	3.10e-007

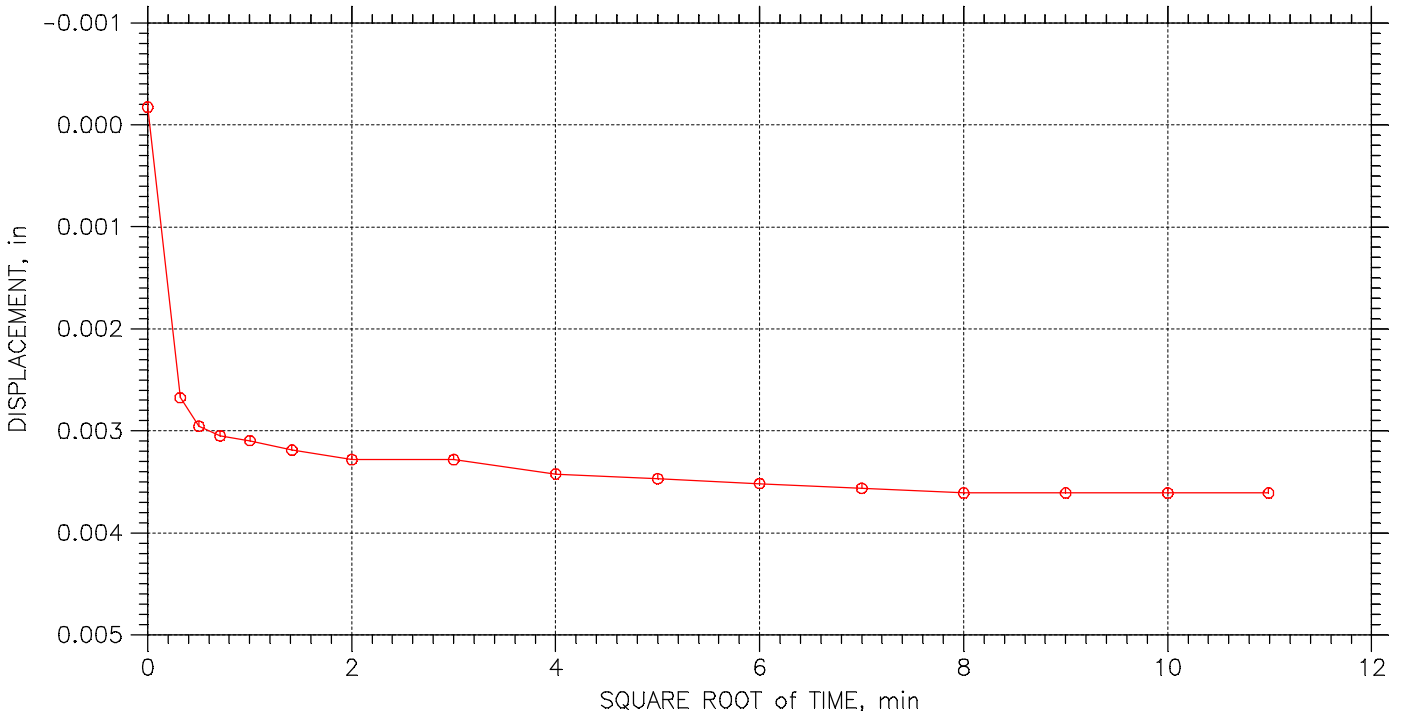
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 23

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	248		

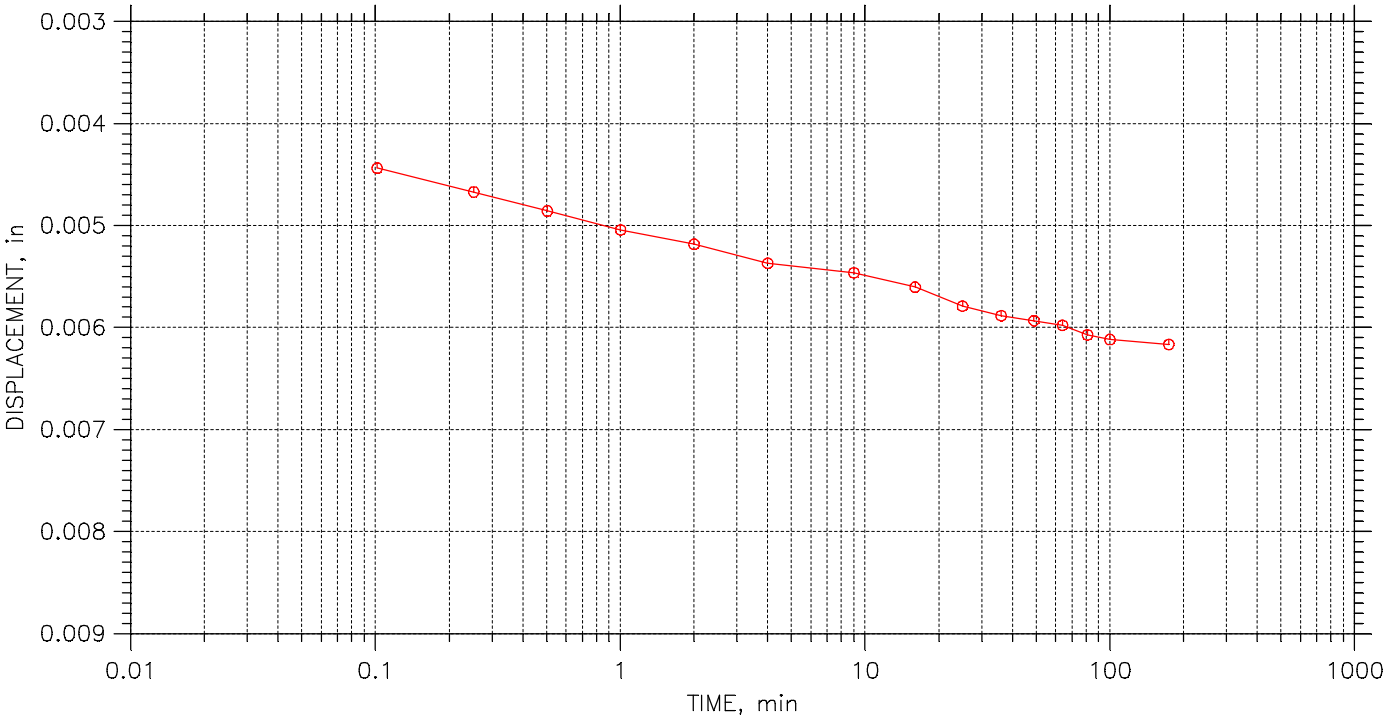
Mon, 21-DEC-2015 16:42:53

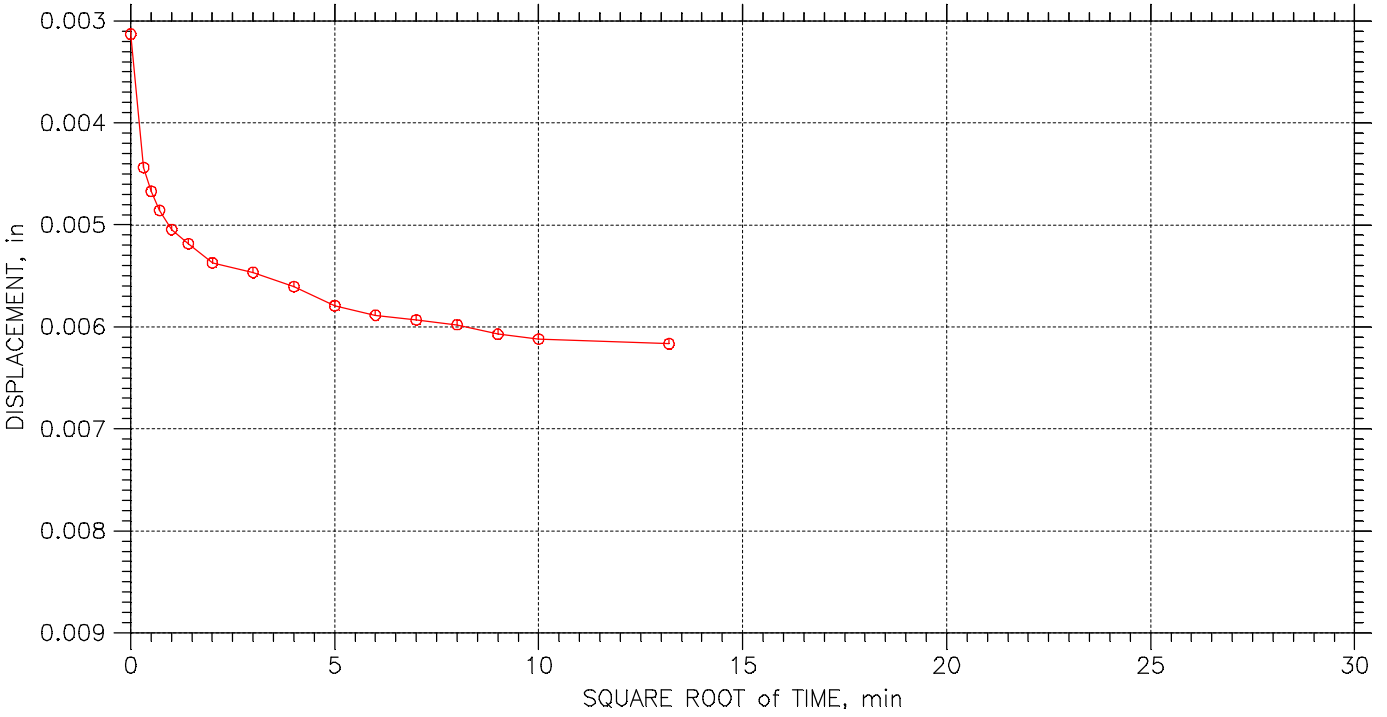
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 23

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	249		

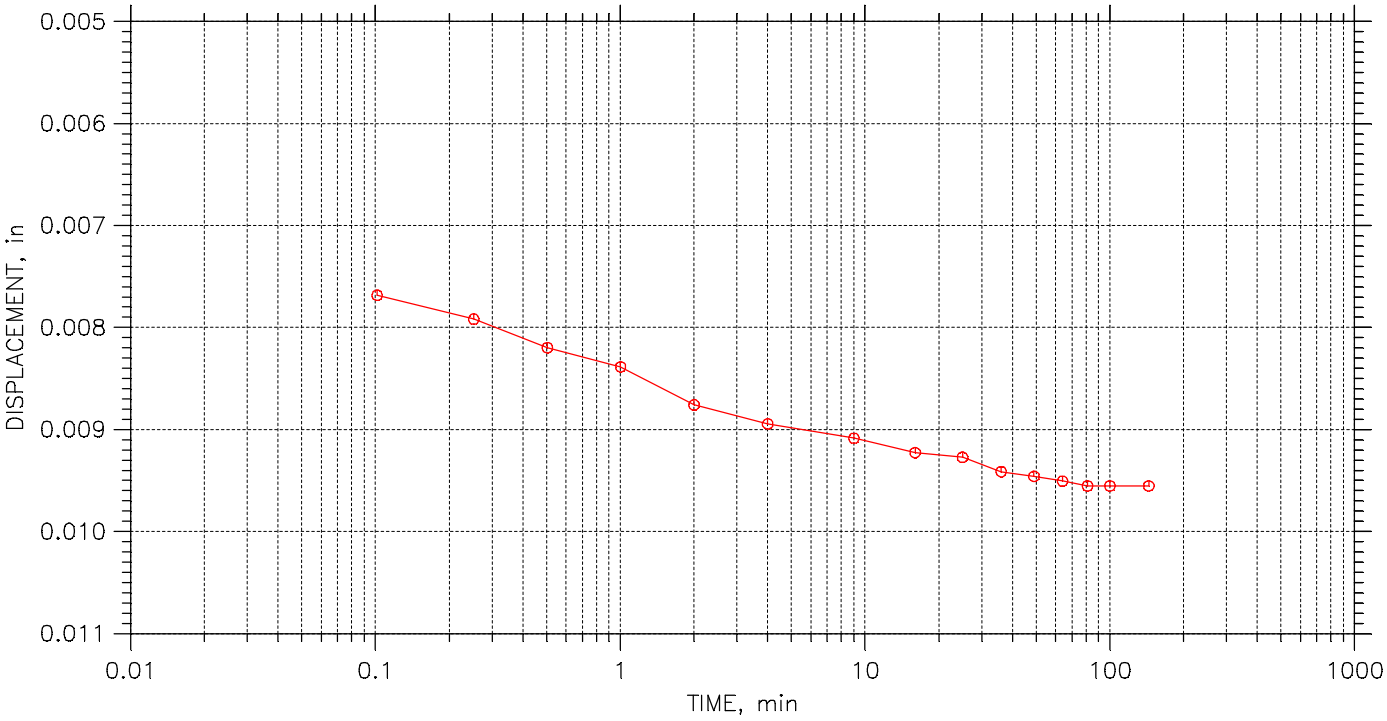
Mon, 21-DEC-2015 16:42:54

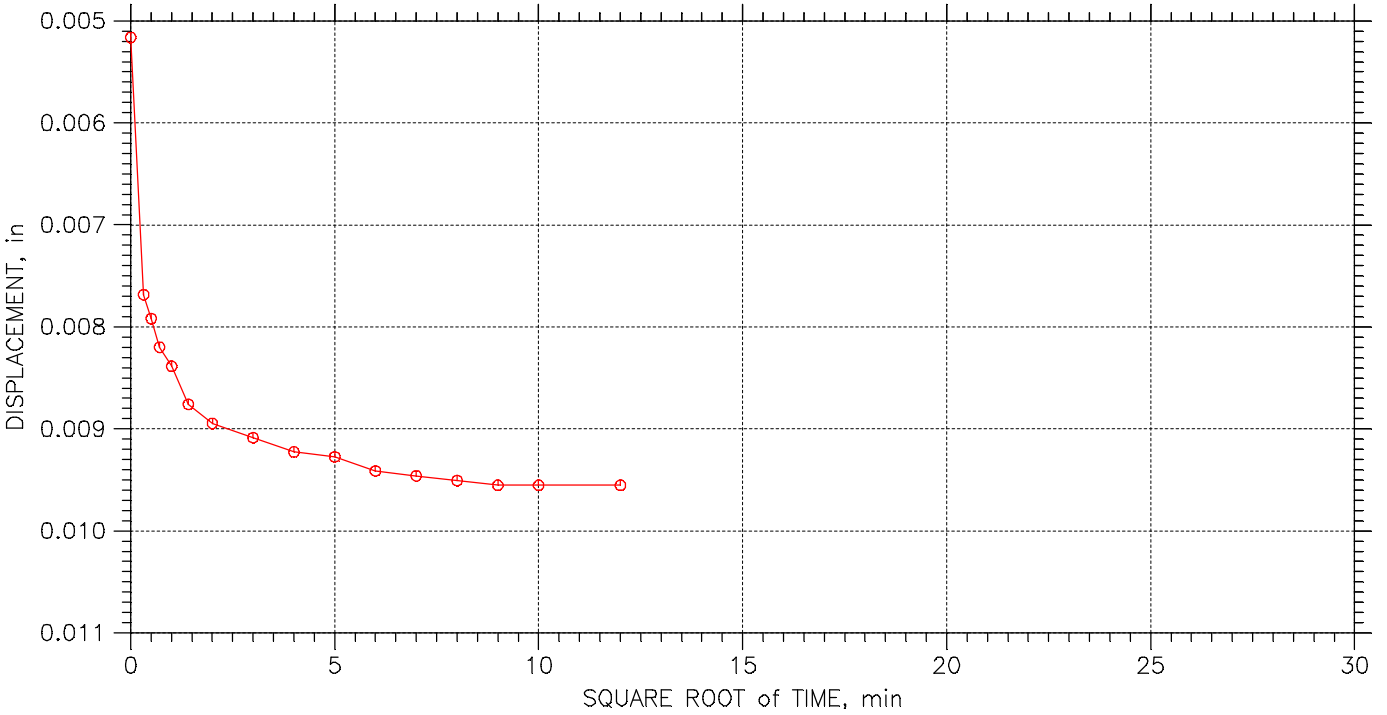
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	250		

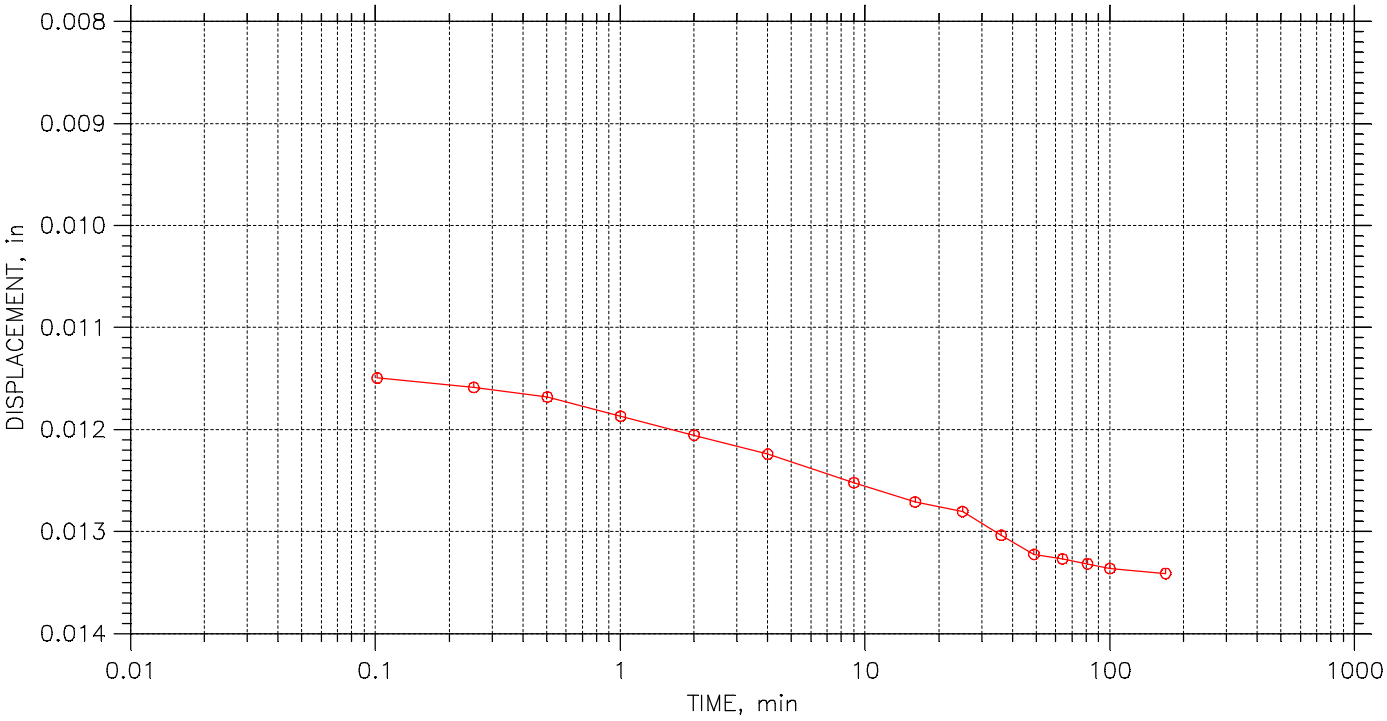
Mon, 21-DEC-2015 16:42:56

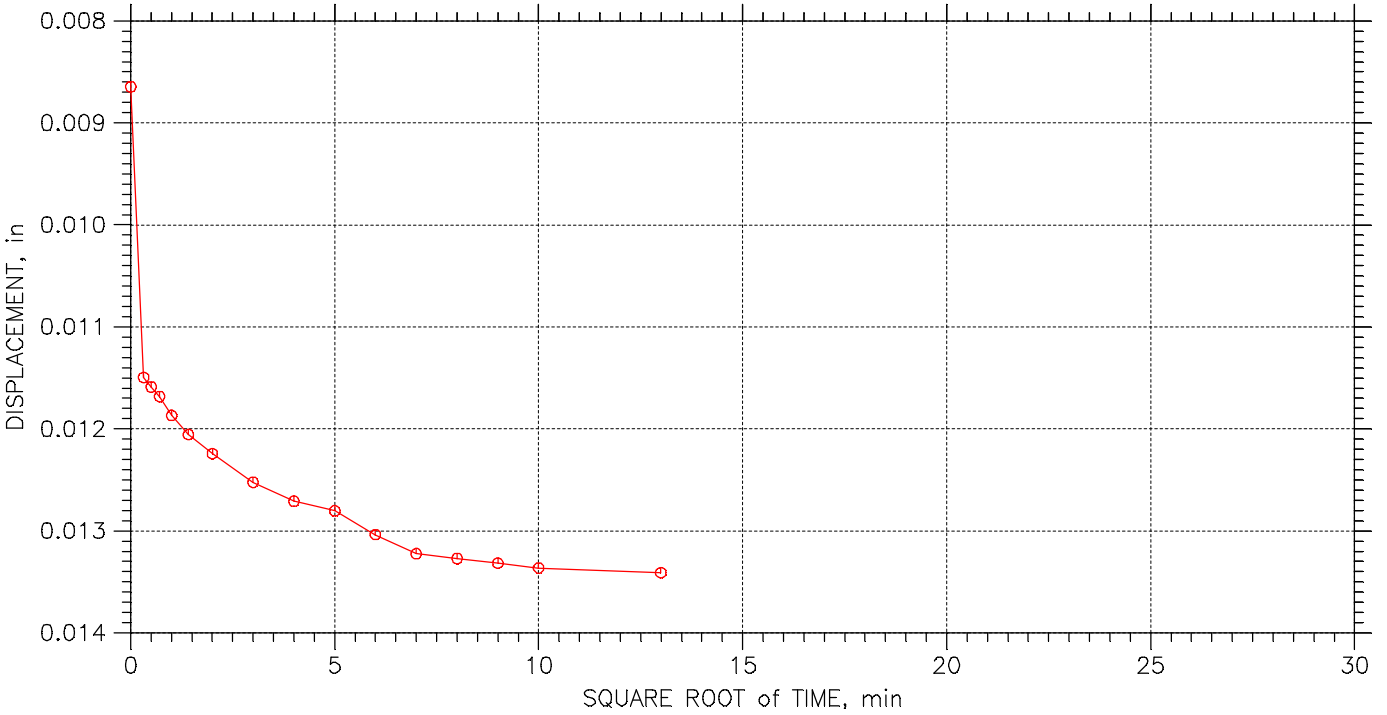
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 4 of 23

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	251		

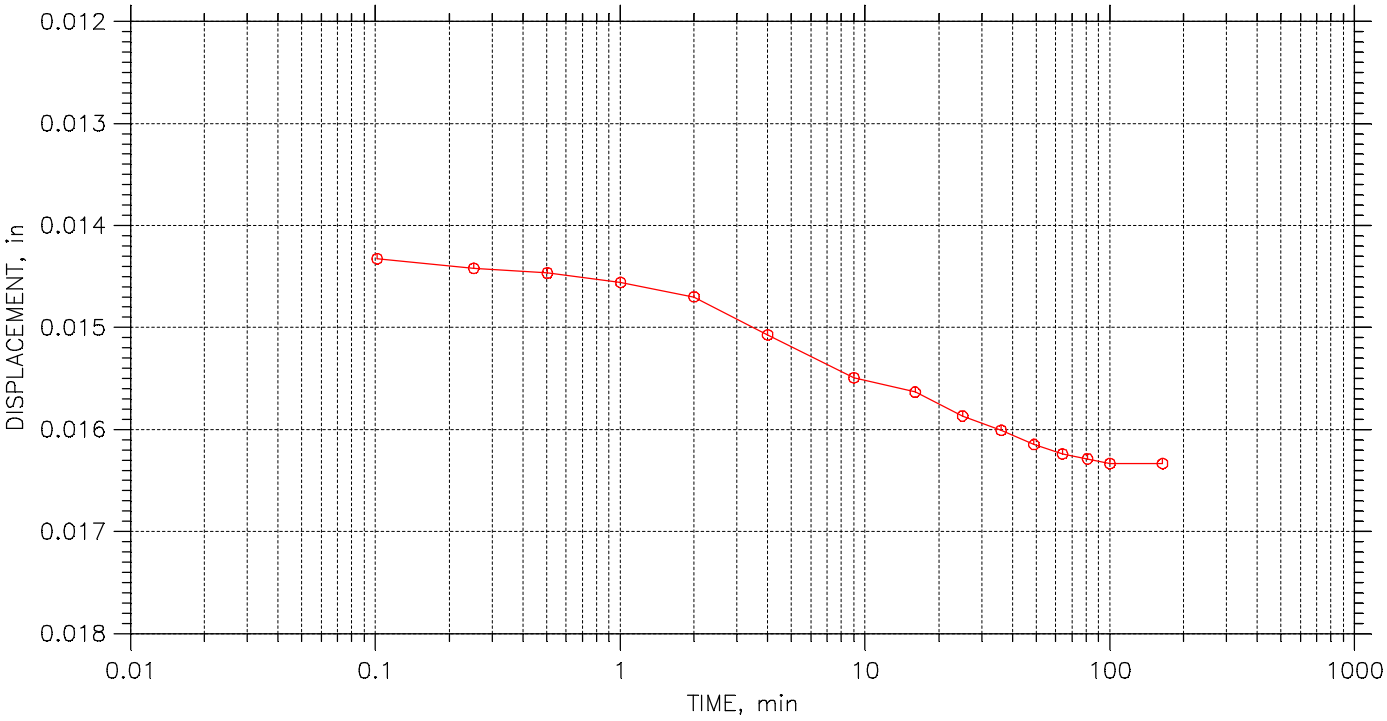
Mon, 21-DEC-2015 16:42:57

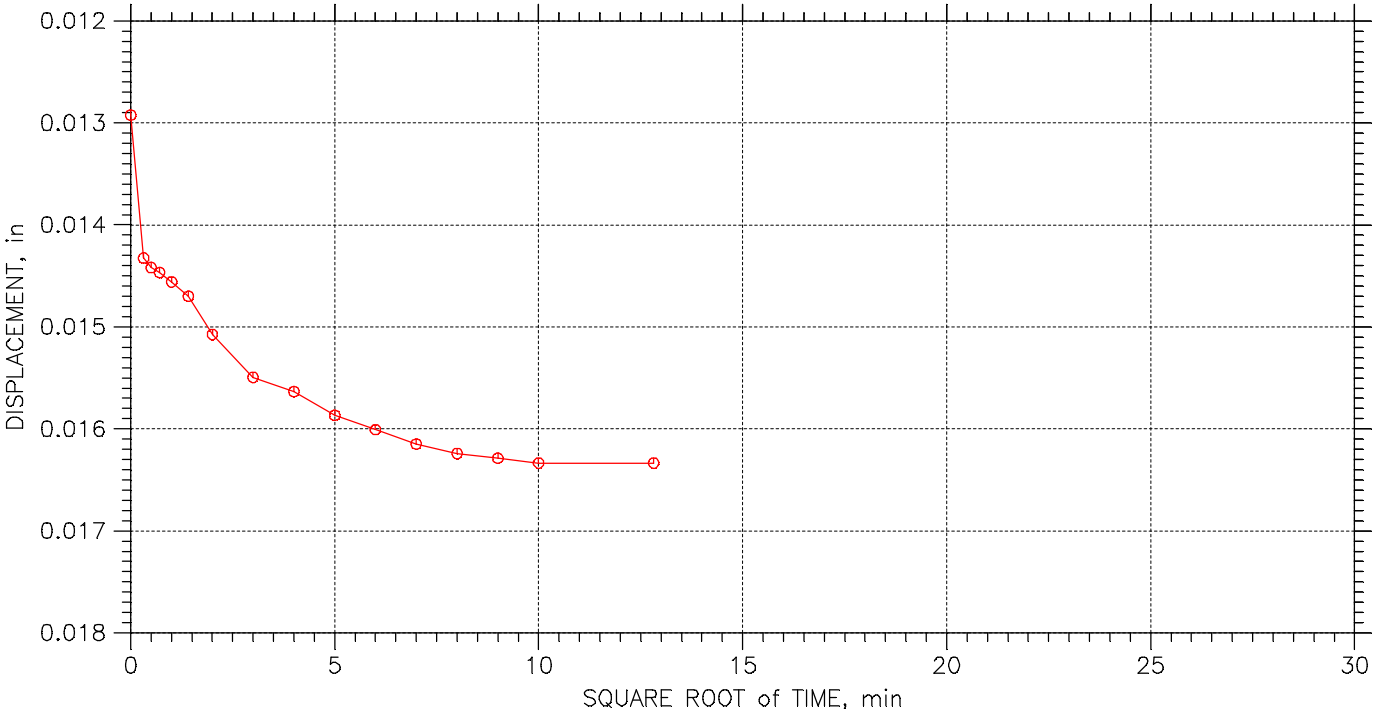
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 23

Stress: 1. tsf





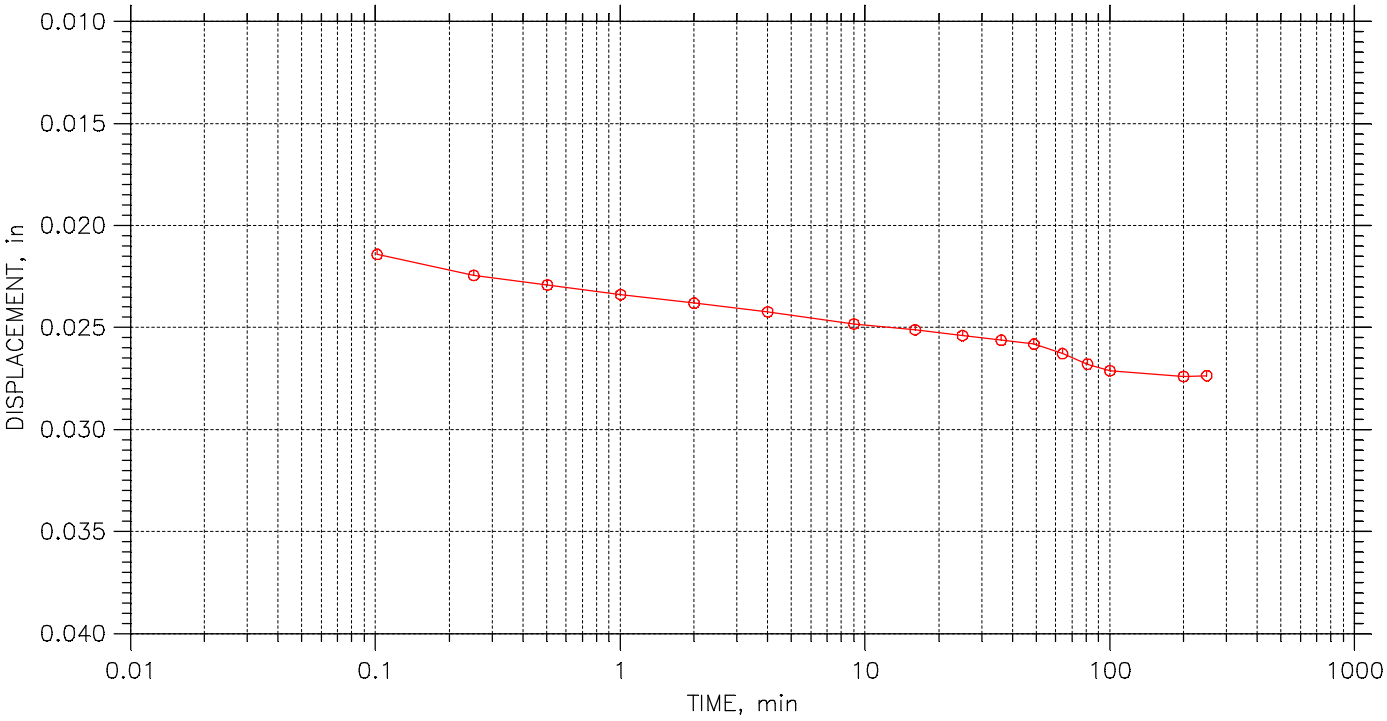
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	252		

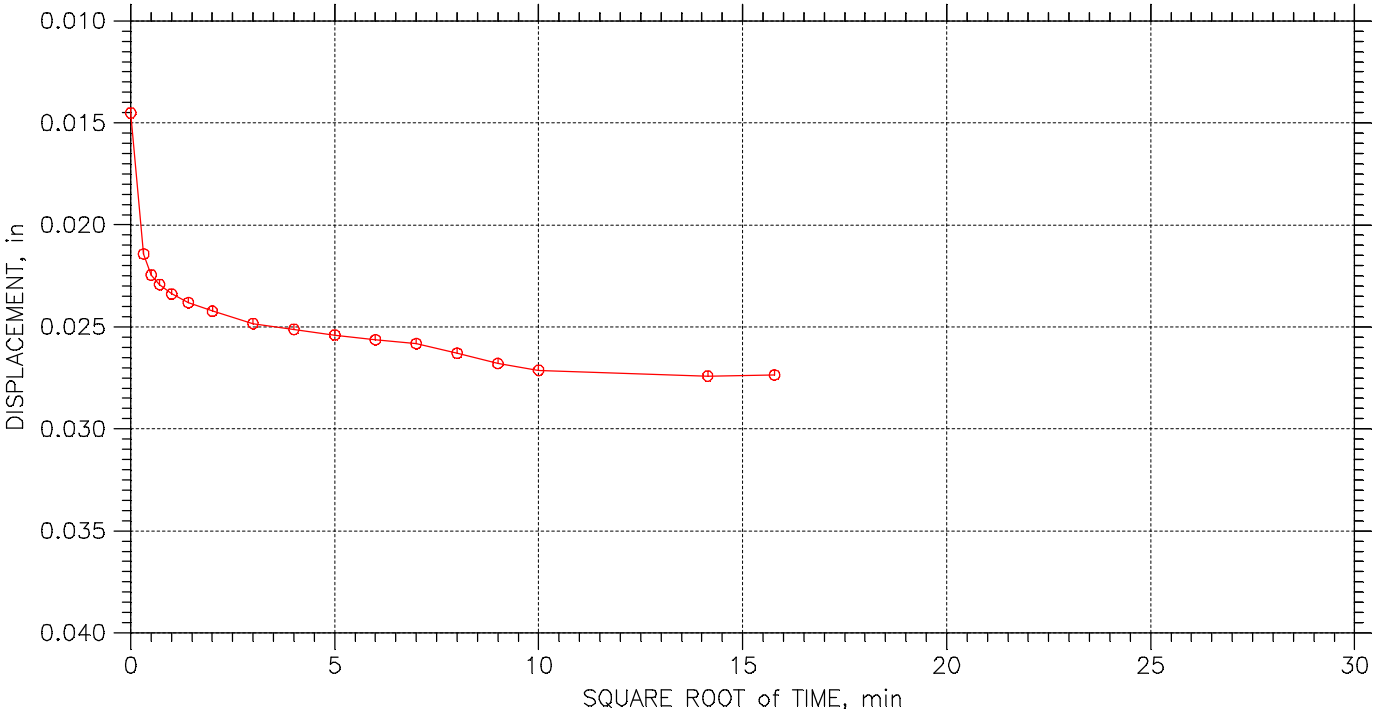
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 23

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	253		

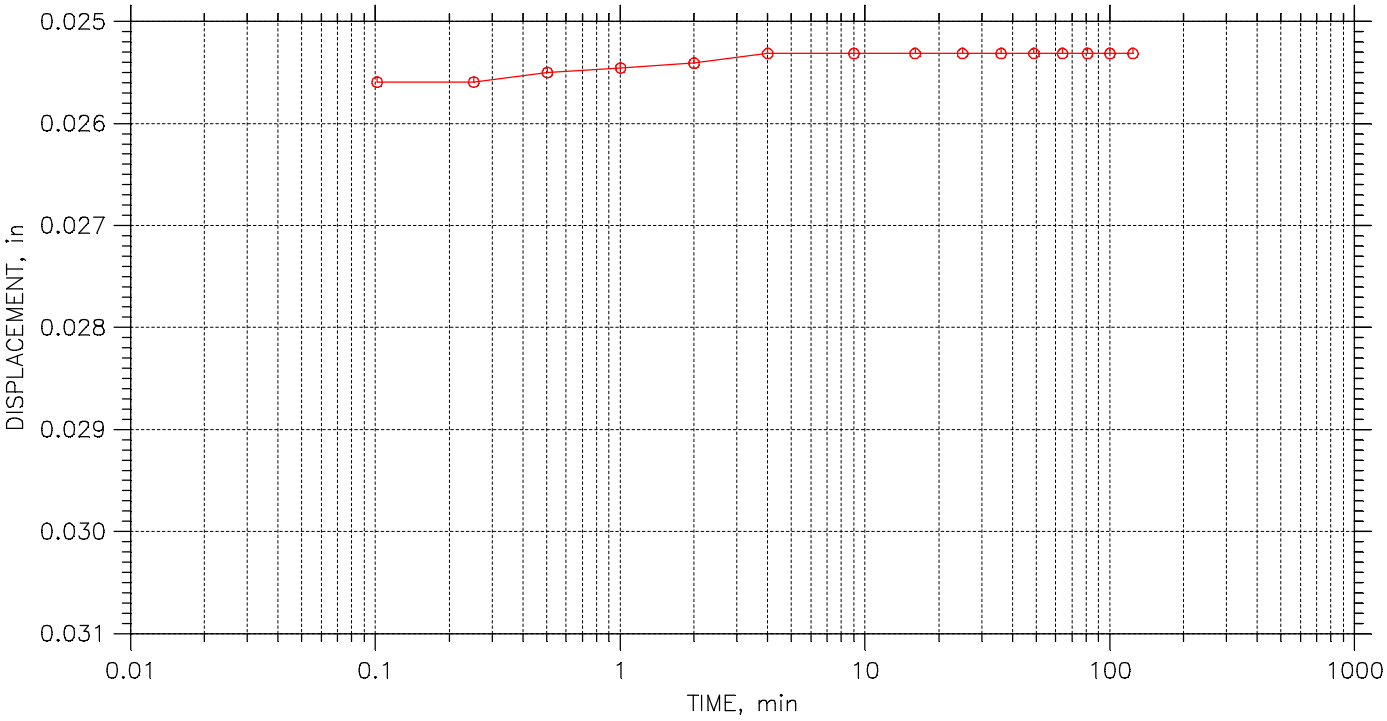
Mon, 21-DEC-2015 16:43:00

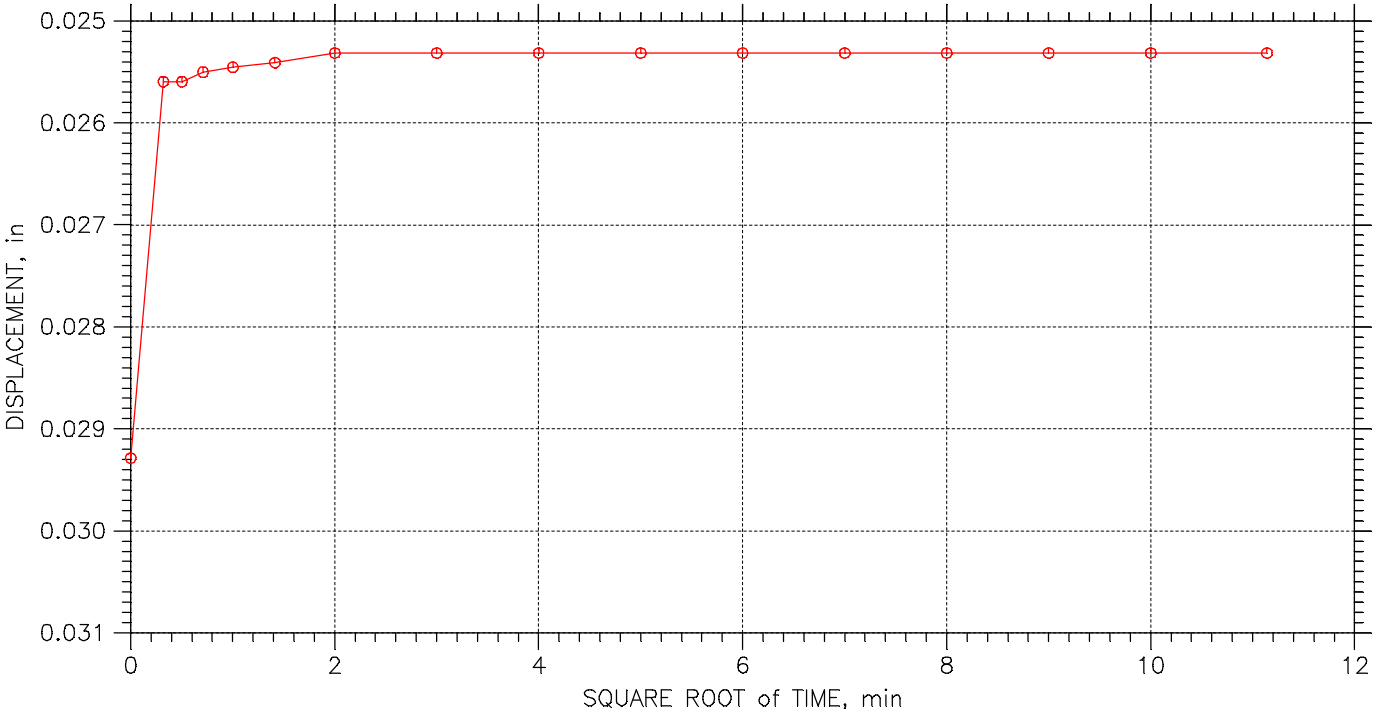
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 7 of 23

Stress: 1. tsf





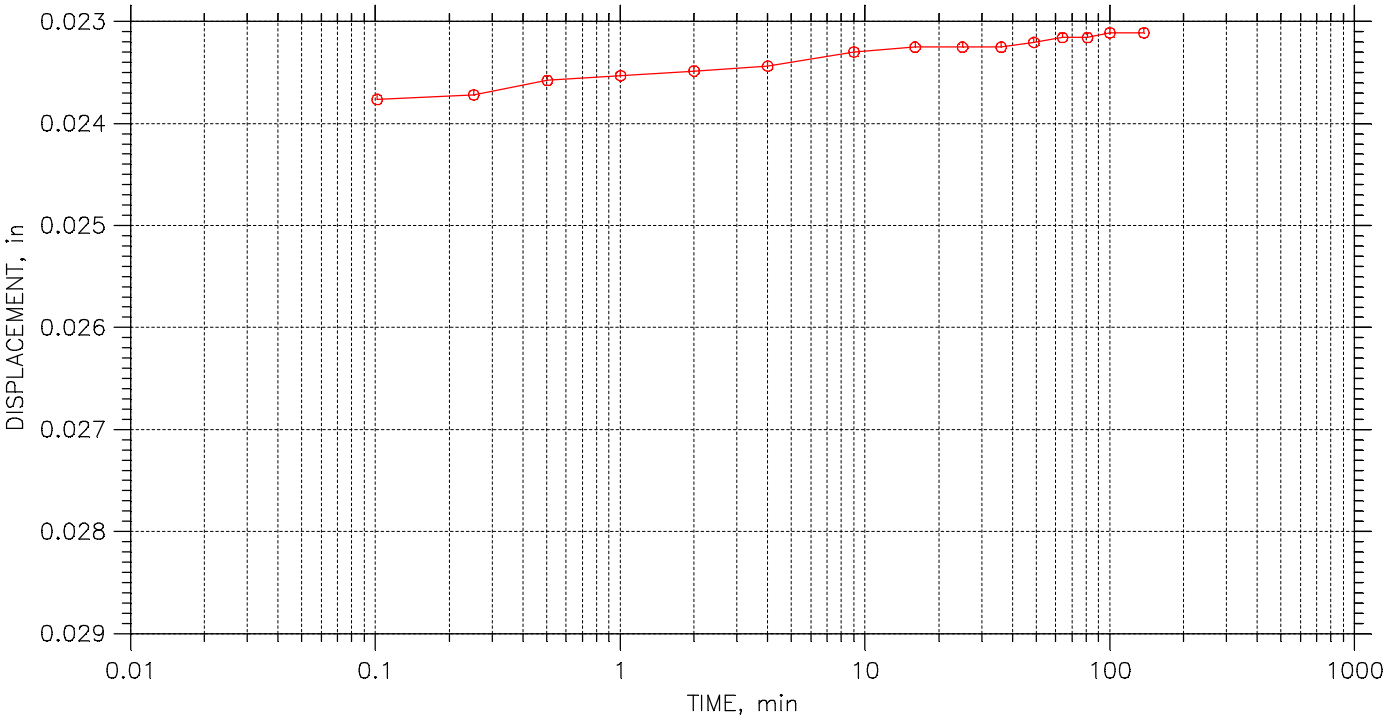
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	254		

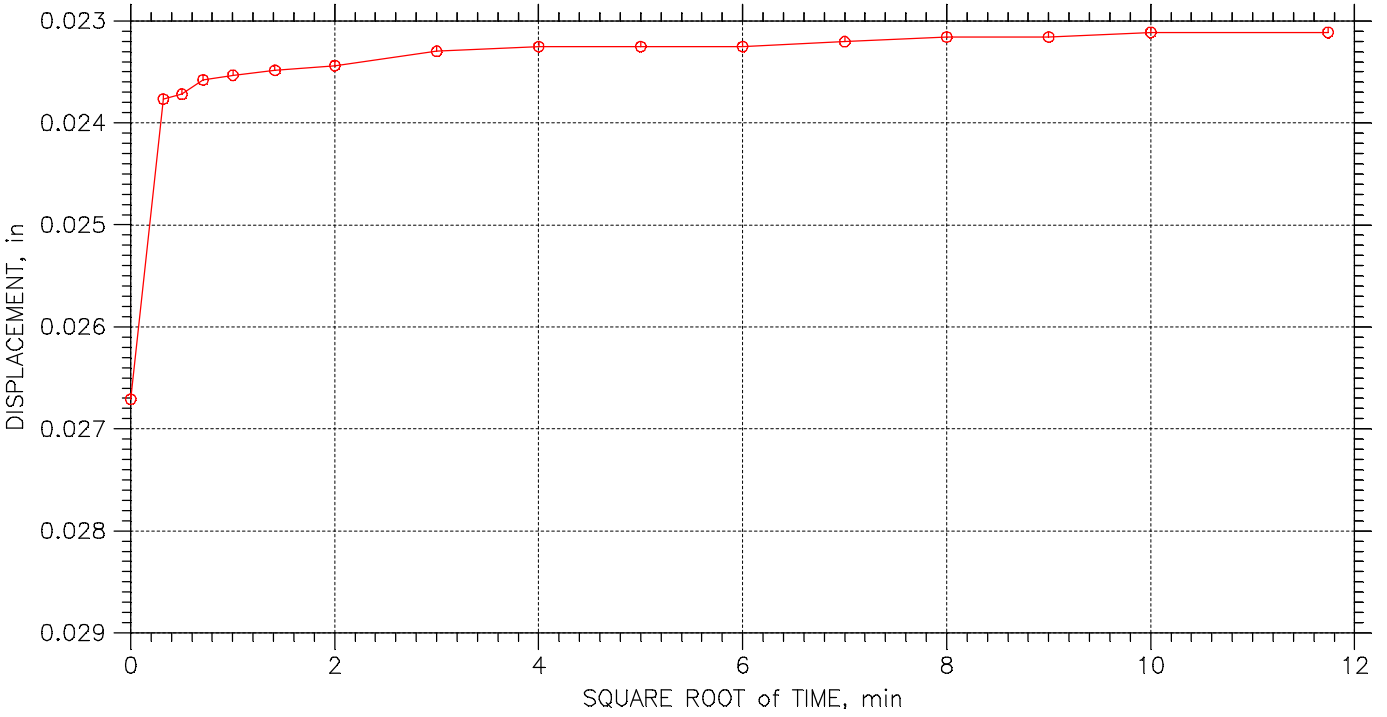
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	255		

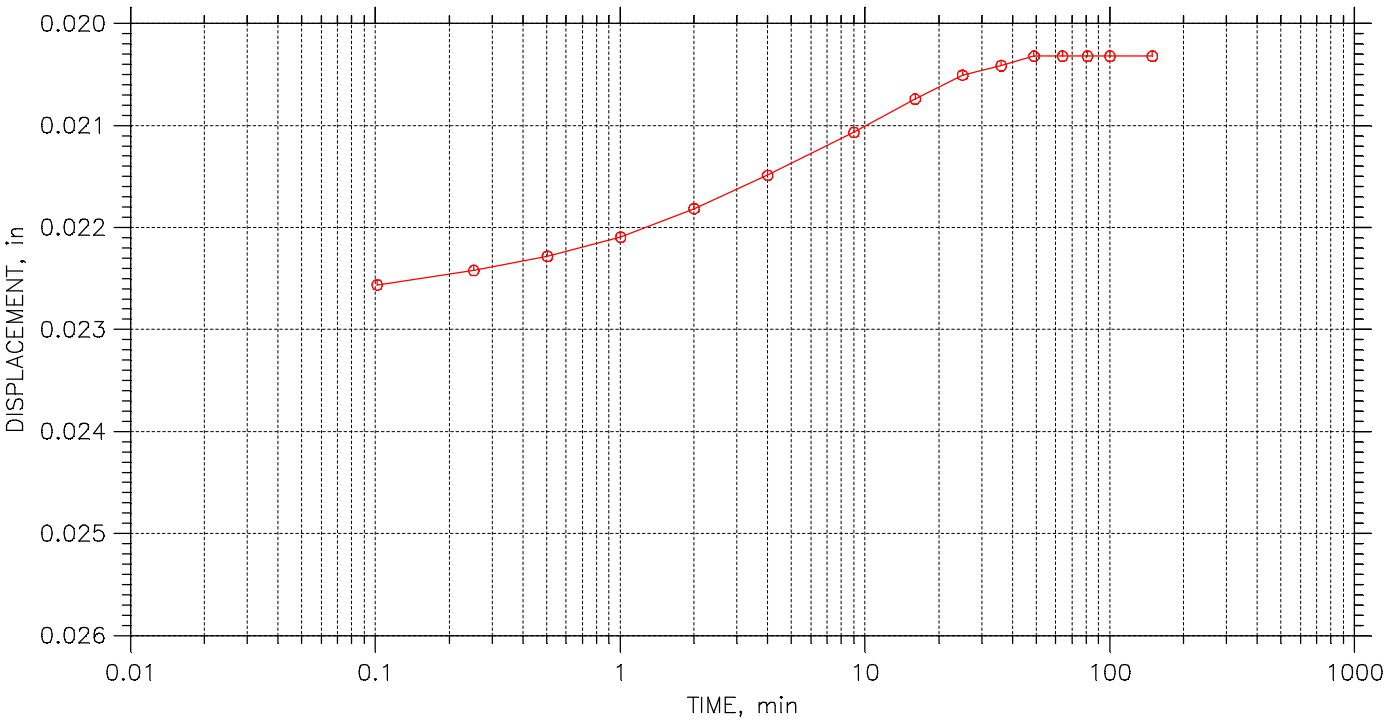
Mon, 21-DEC-2015 16:43:03

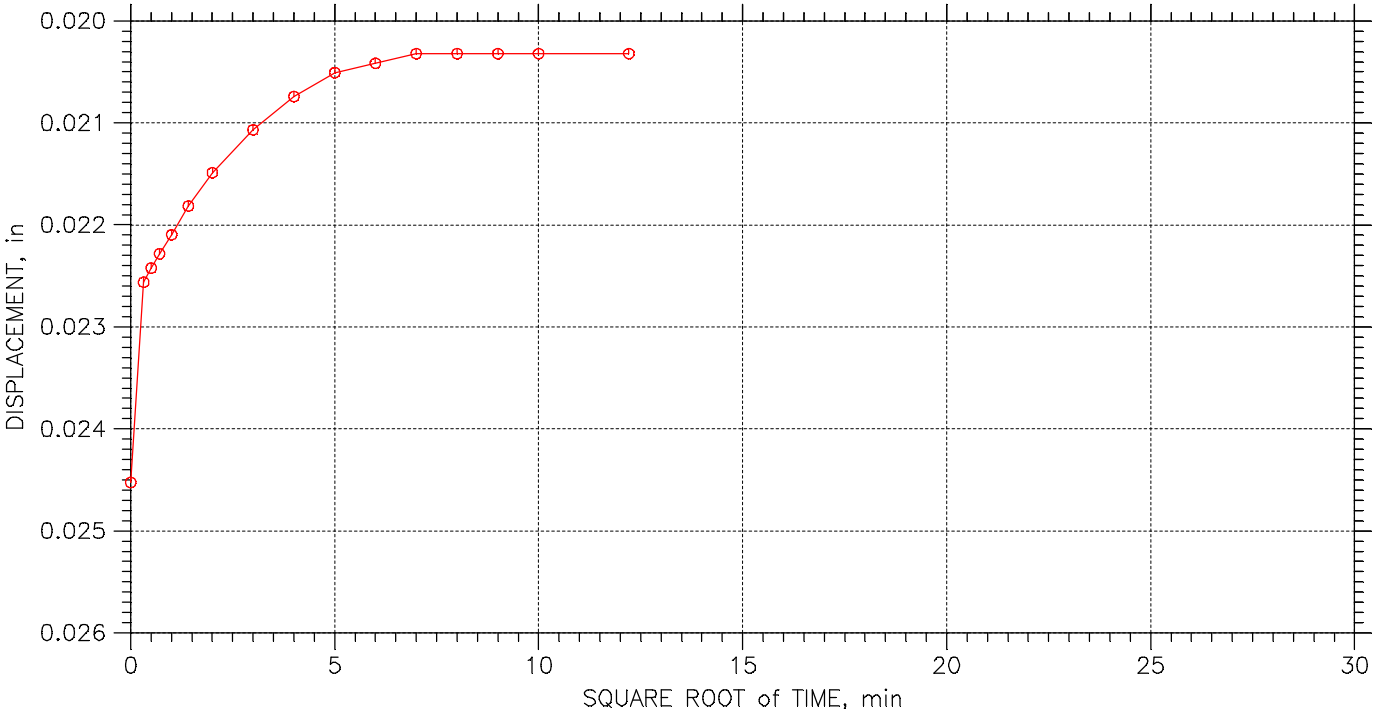
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 9 of 23

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	256		

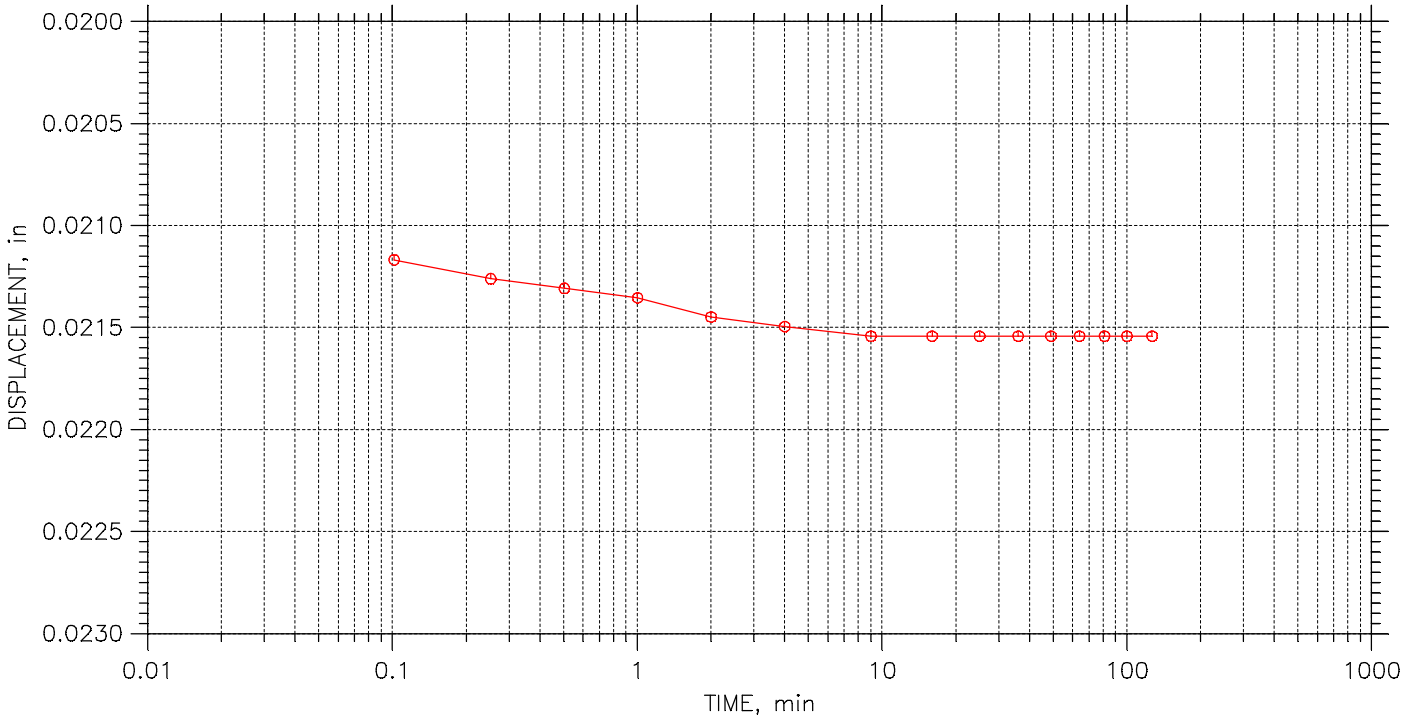
Mon, 21-DEC-2015 16:43:04

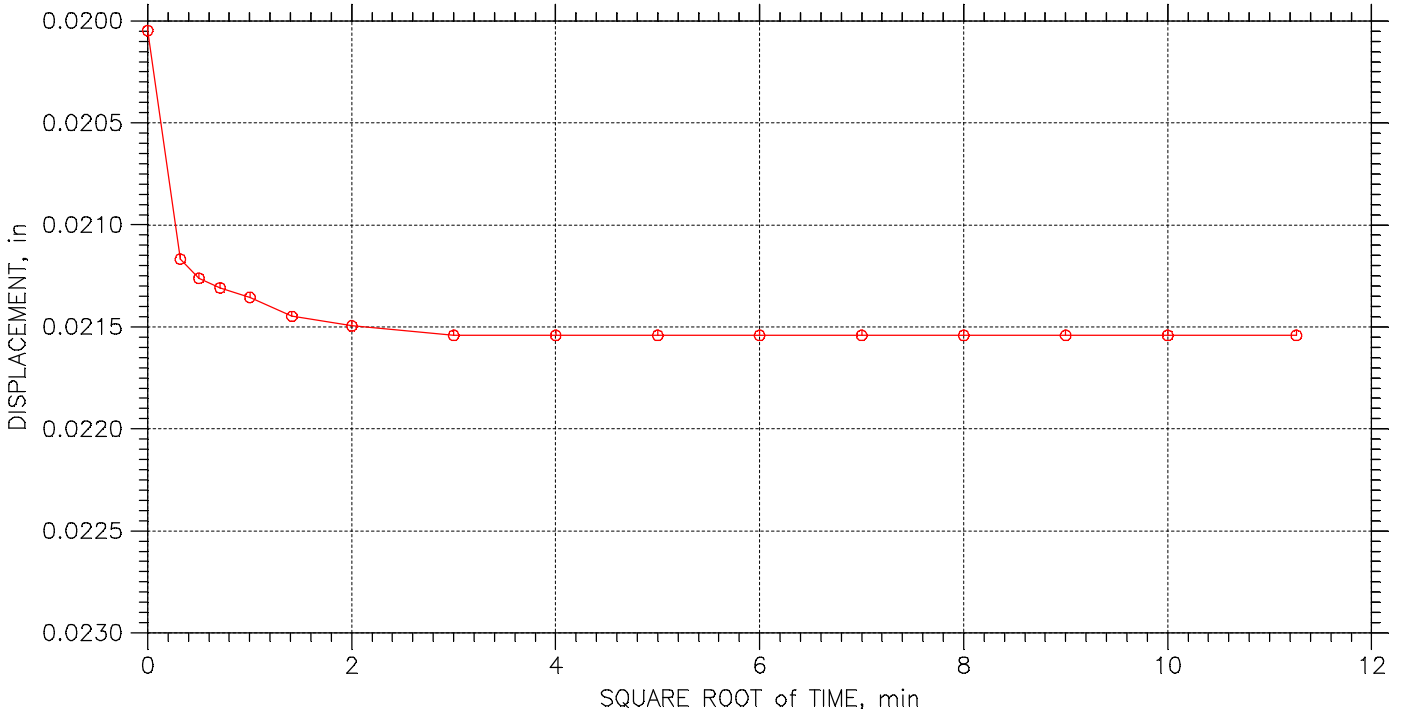
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 23

Stress: 0.25 tsf





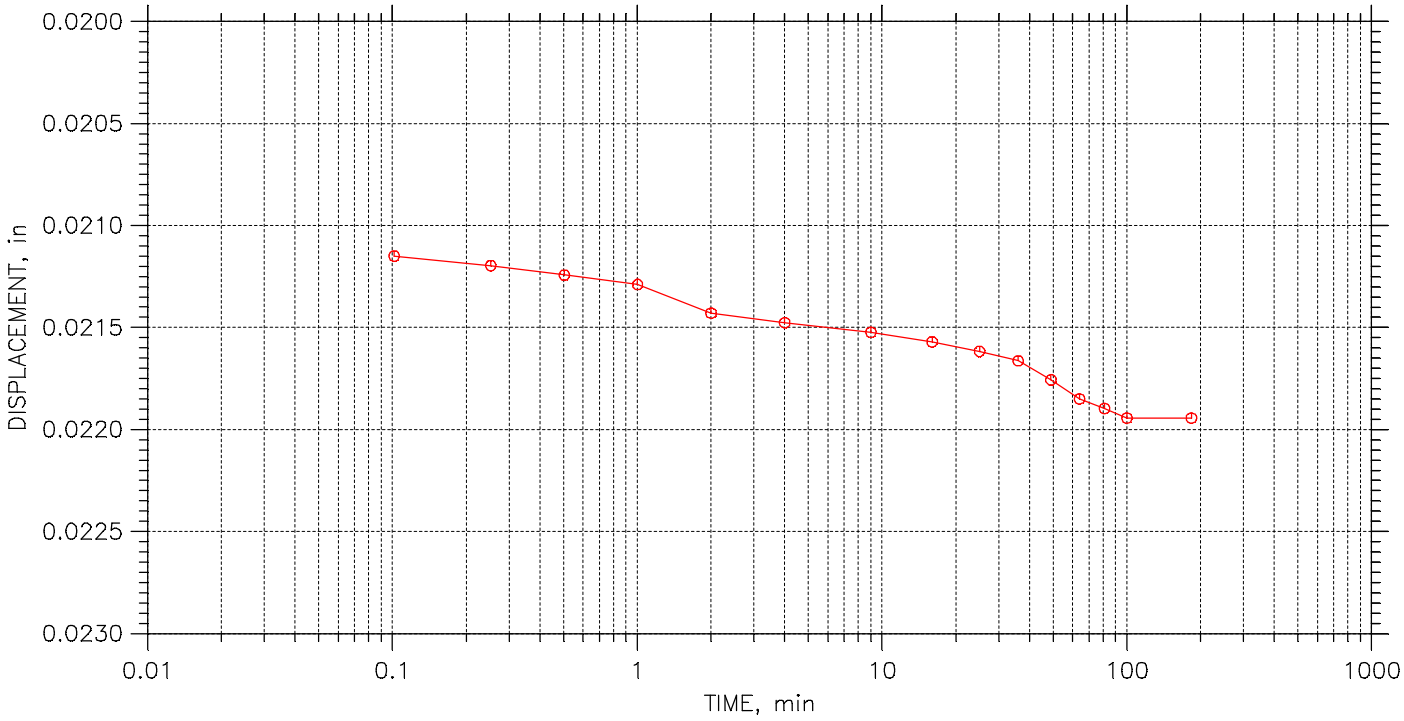
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	257		

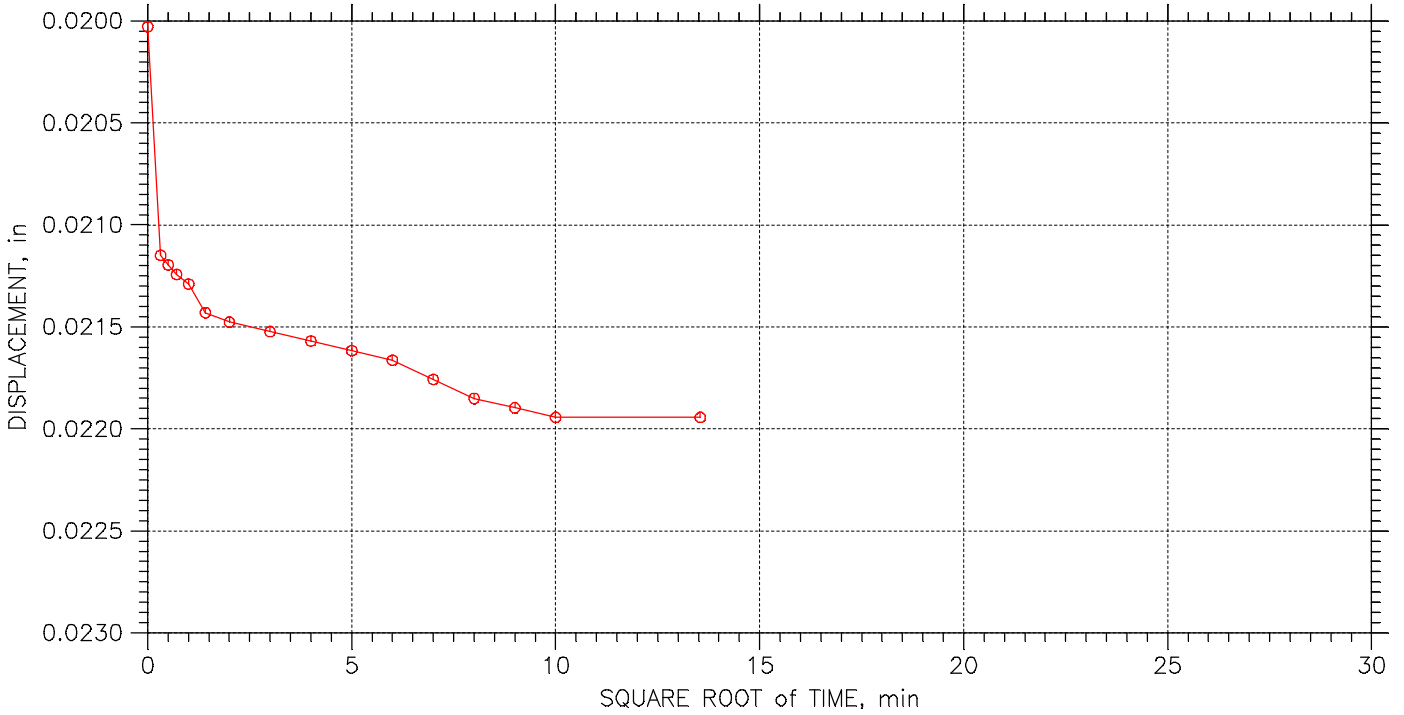
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 11 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	258		

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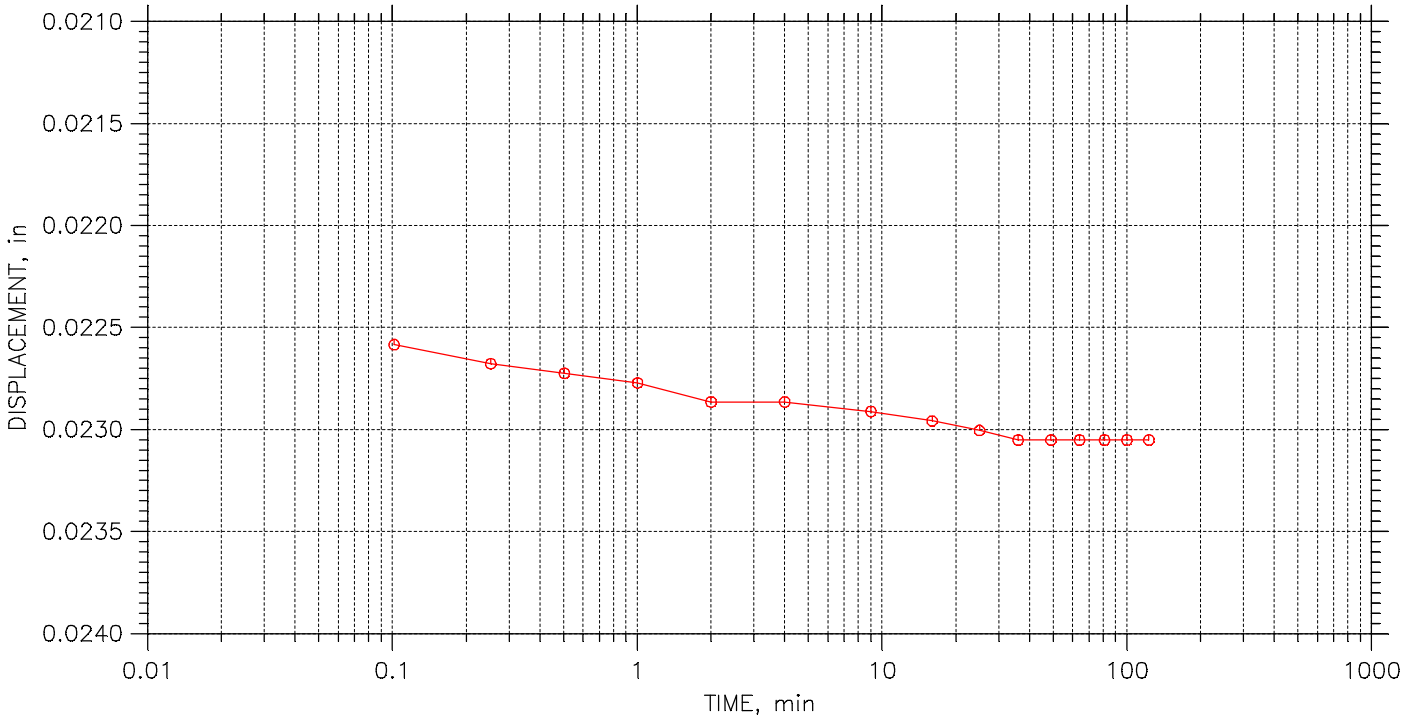
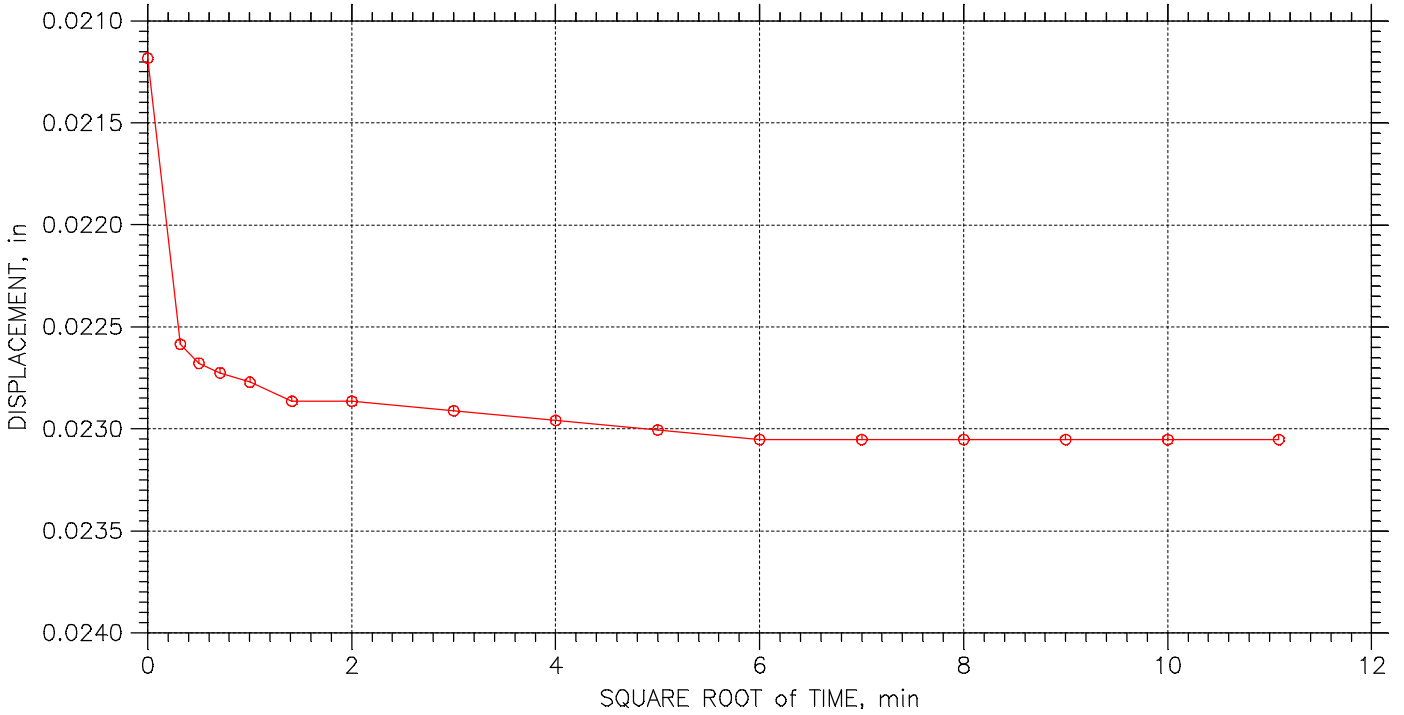
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 23

Stress: 0.75 tsf





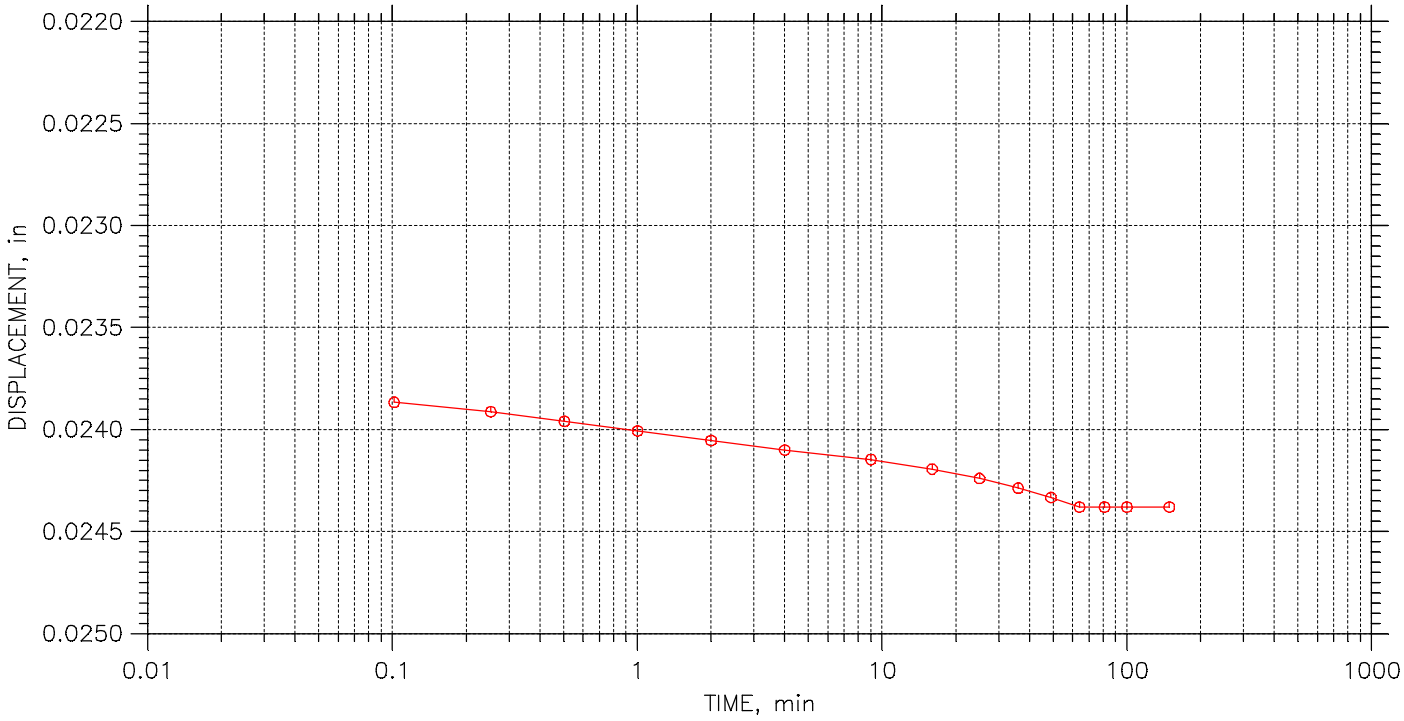
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	259		

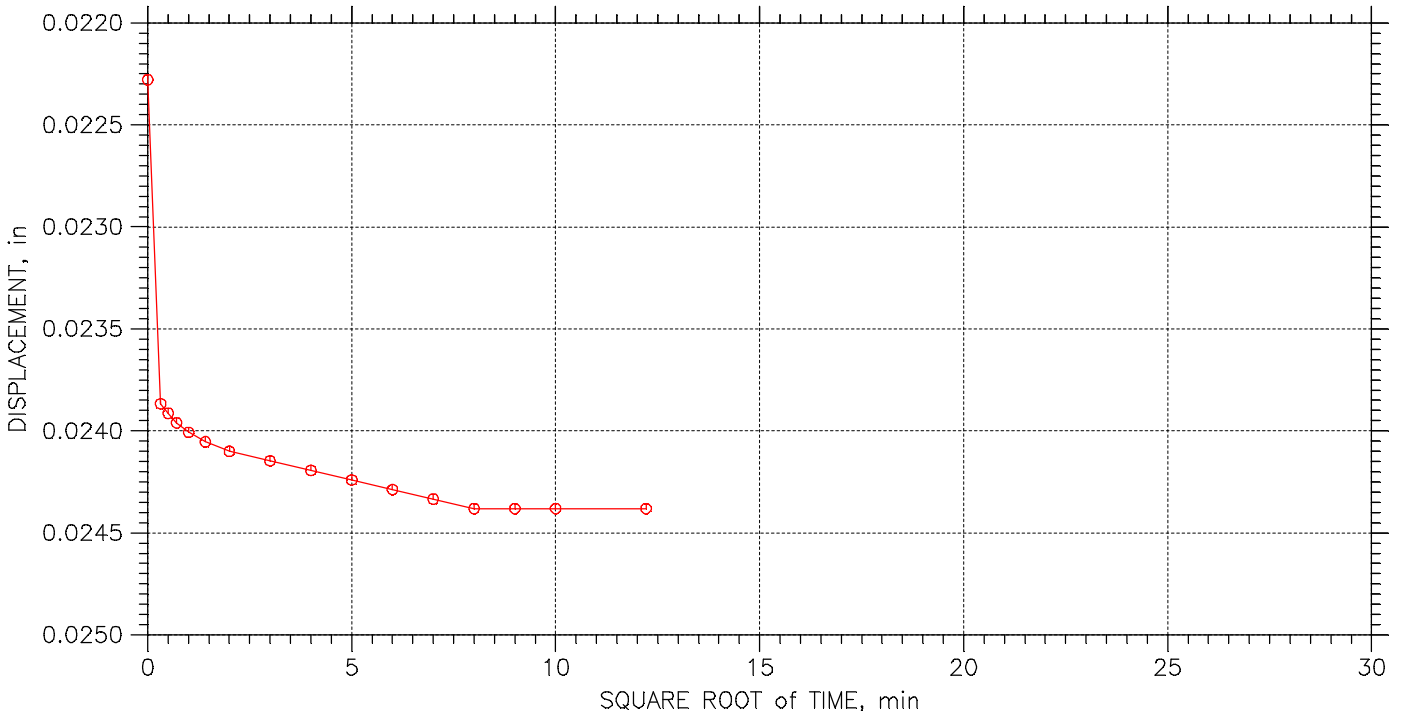
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 13 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	260		

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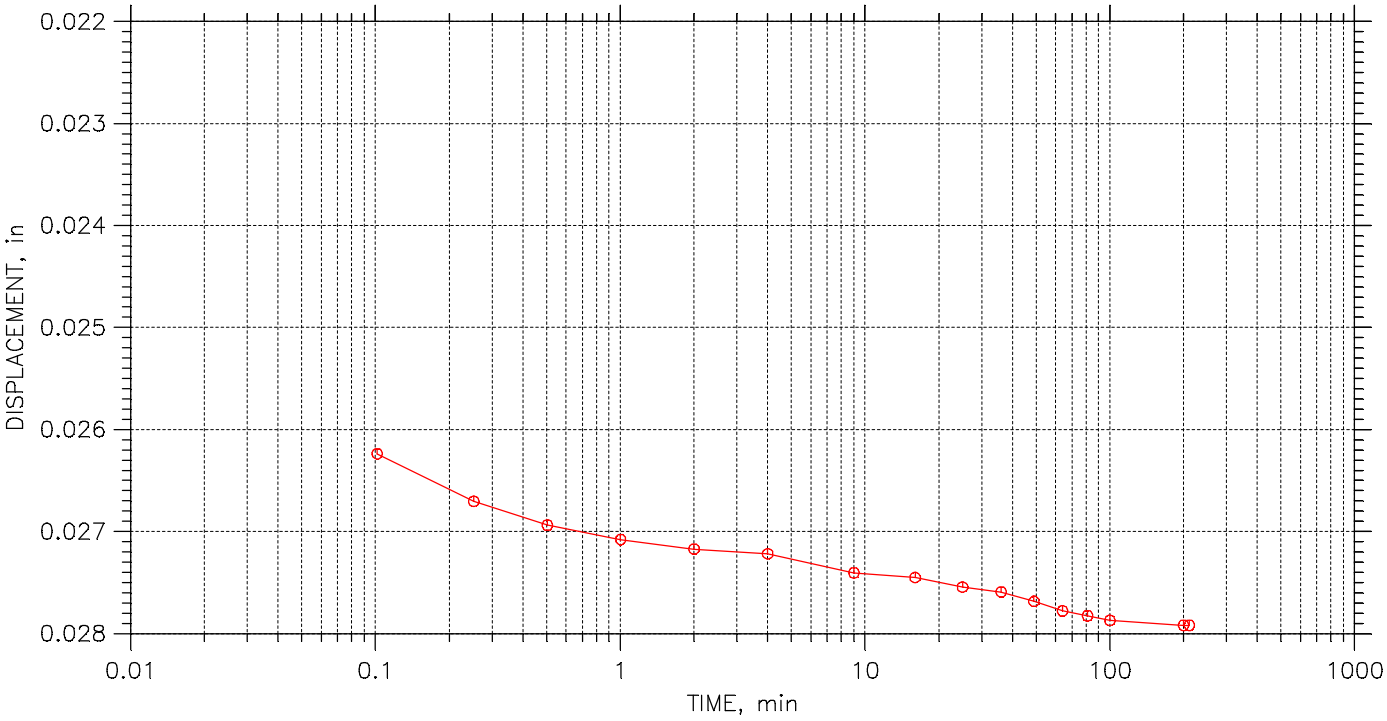
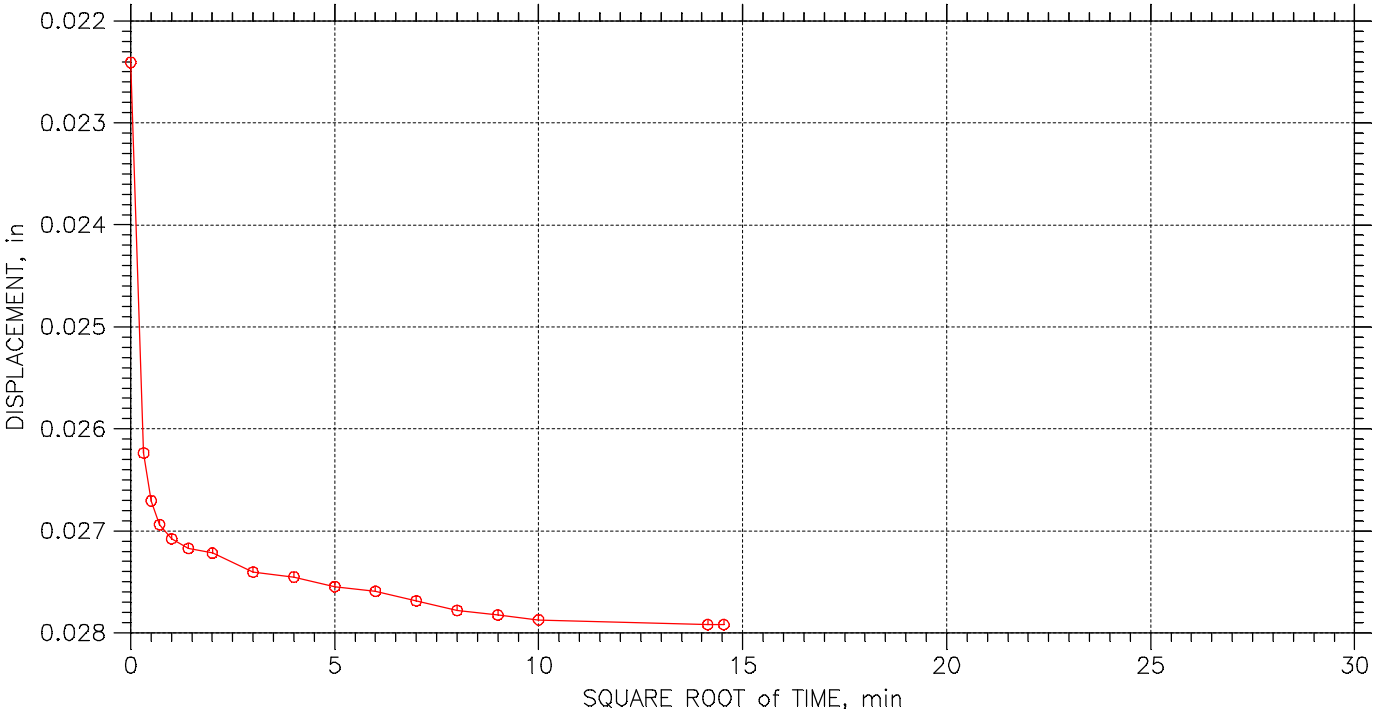
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 14 of 23

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	261		

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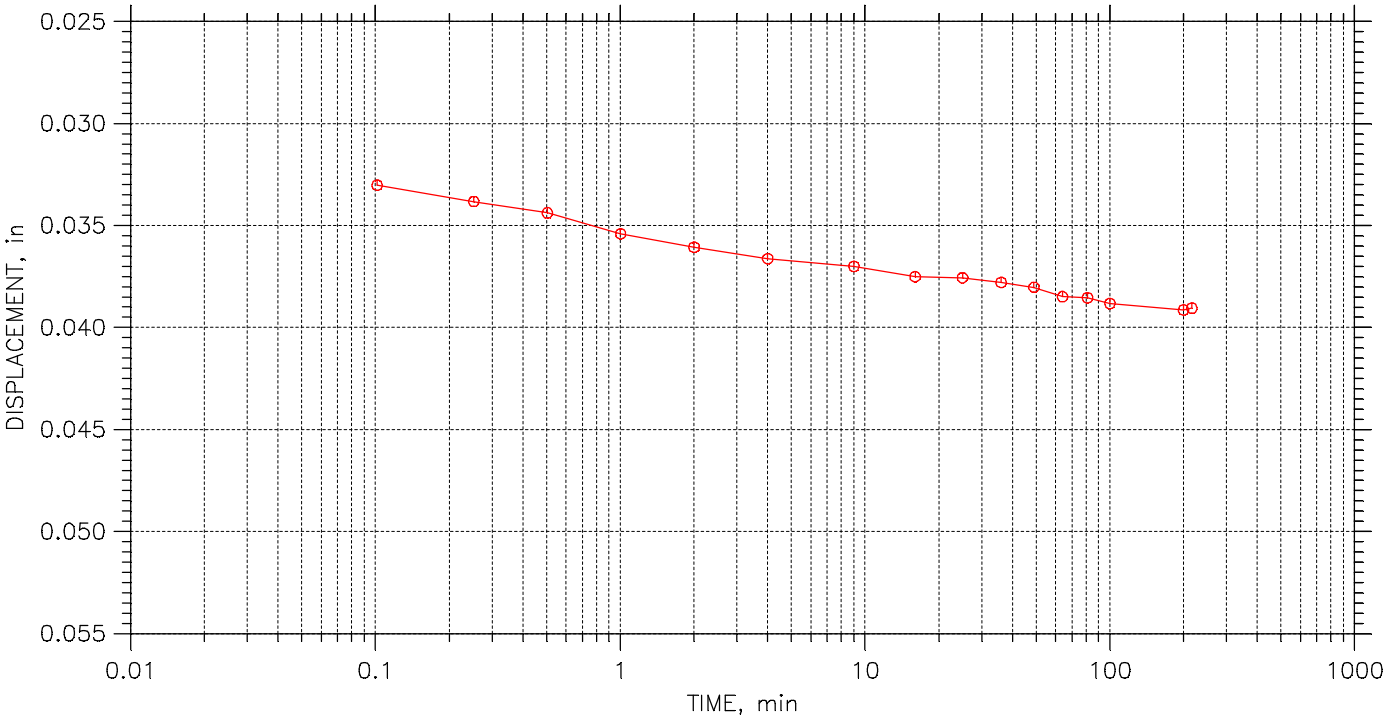
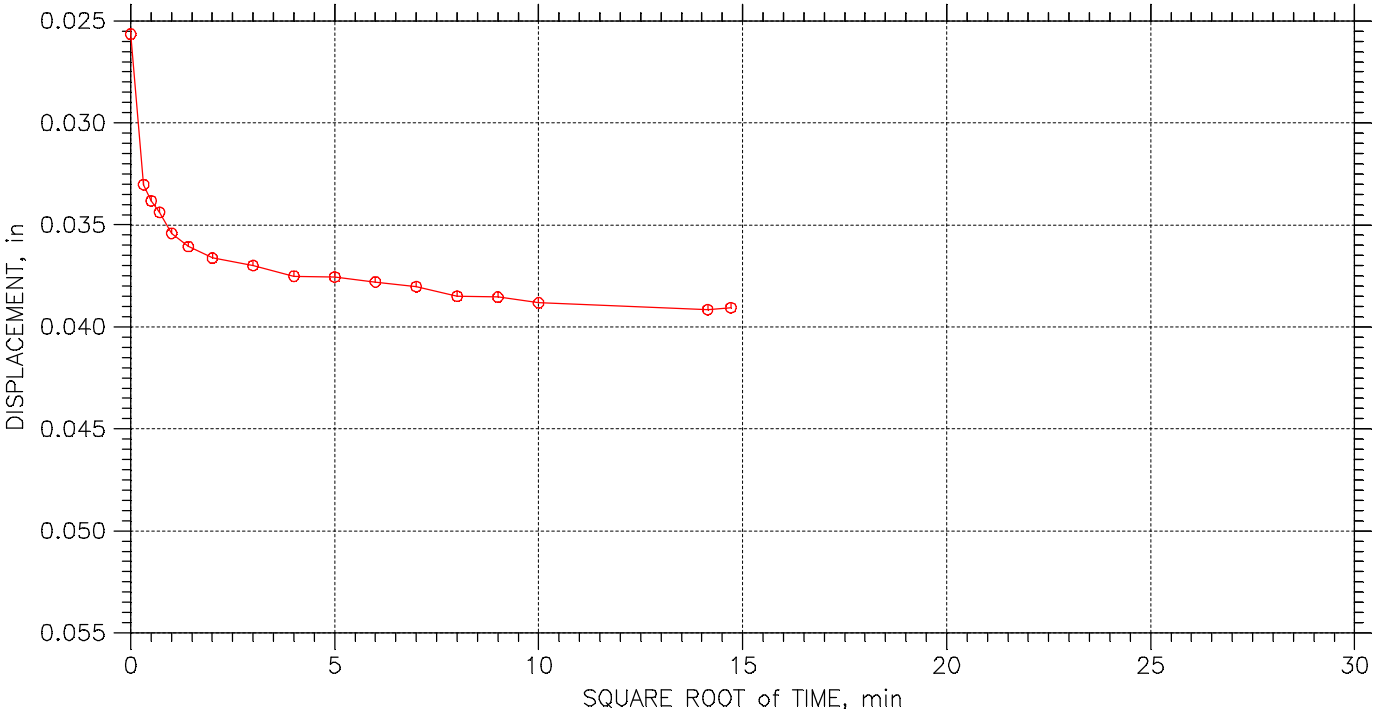
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 15 of 23

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	262		

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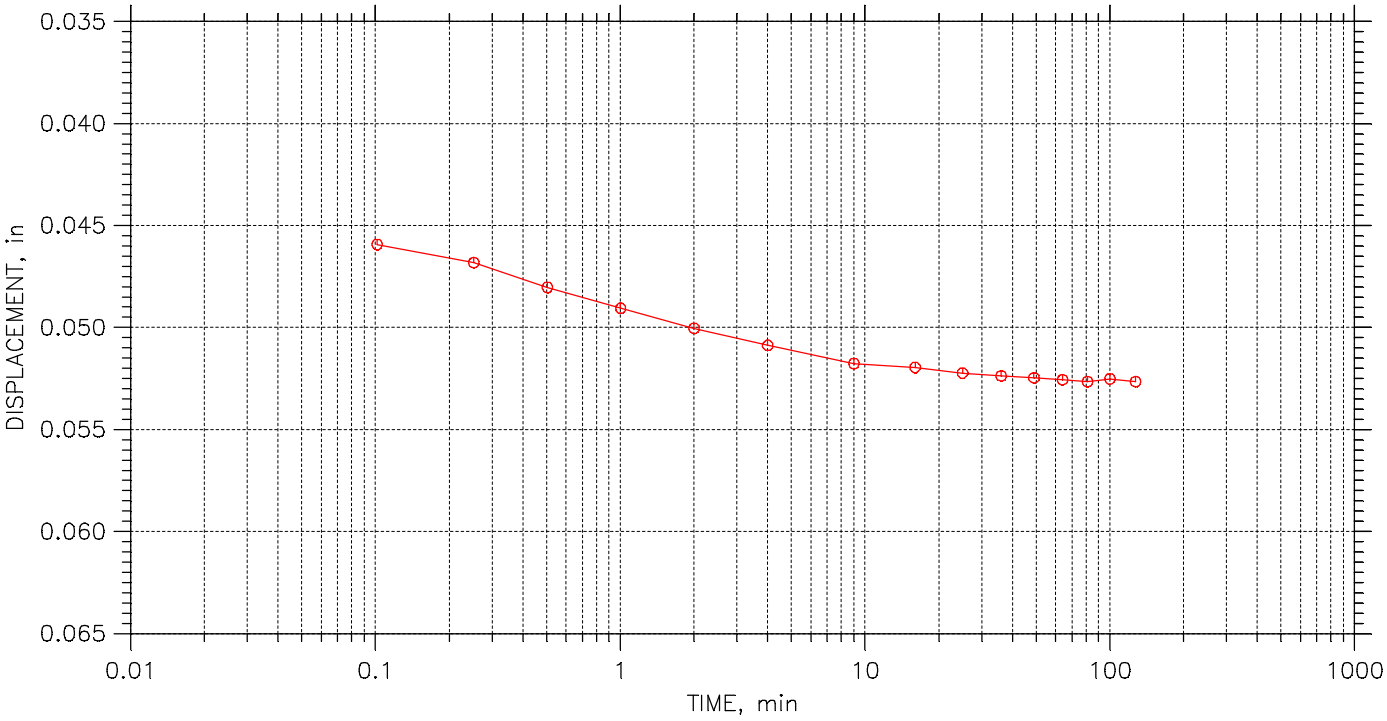
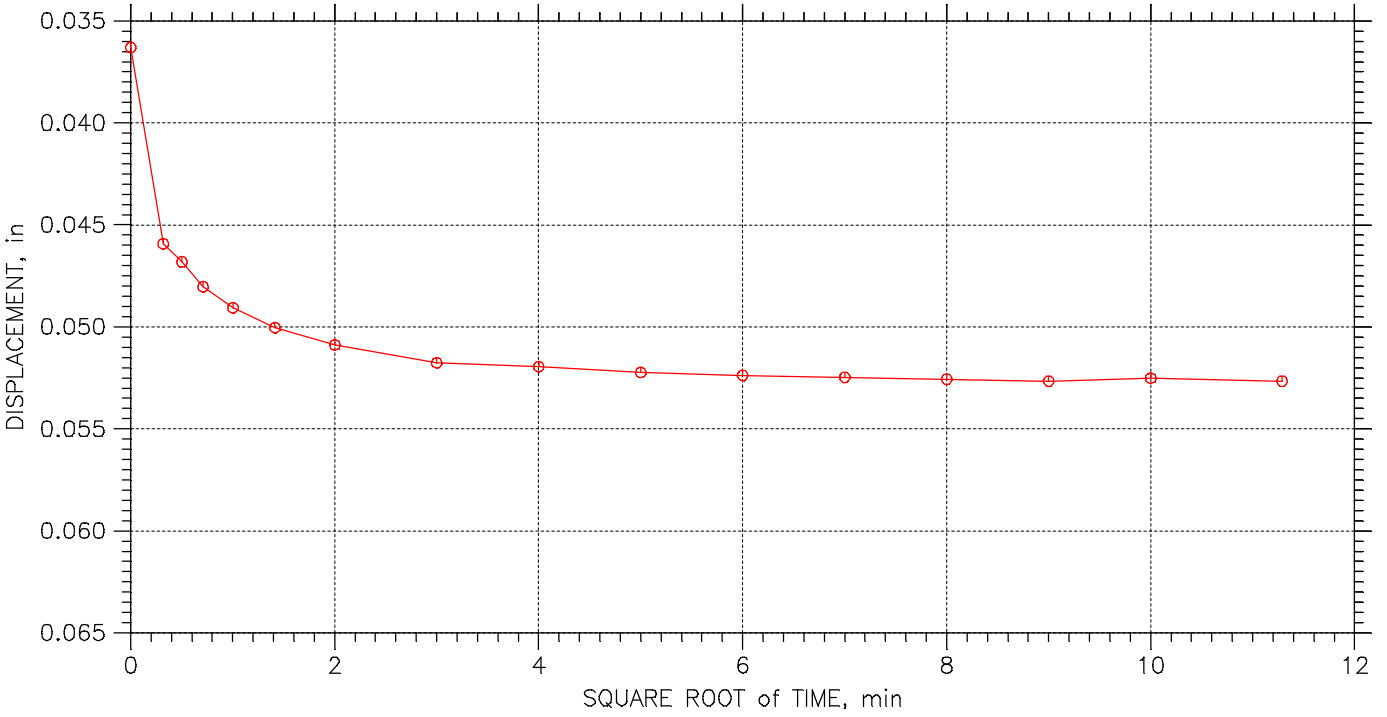
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 16 of 23

Stress: 8. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	263		

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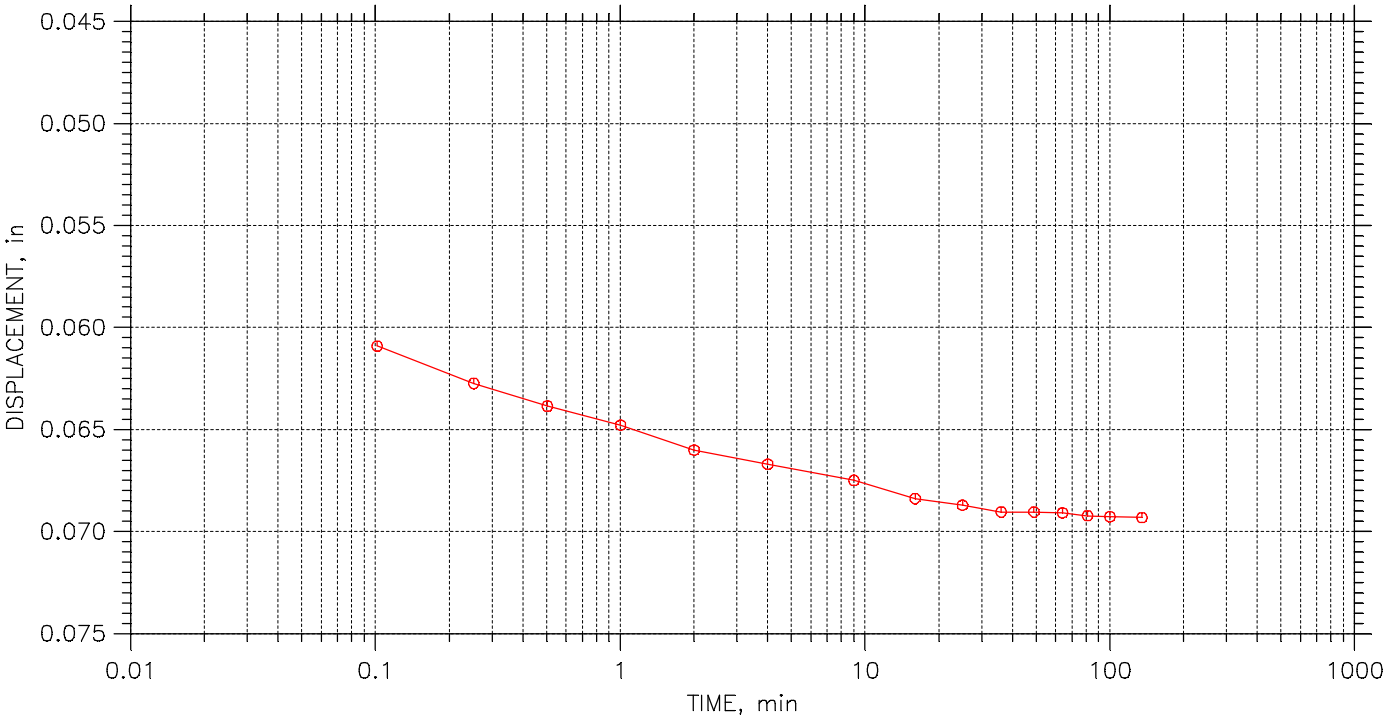
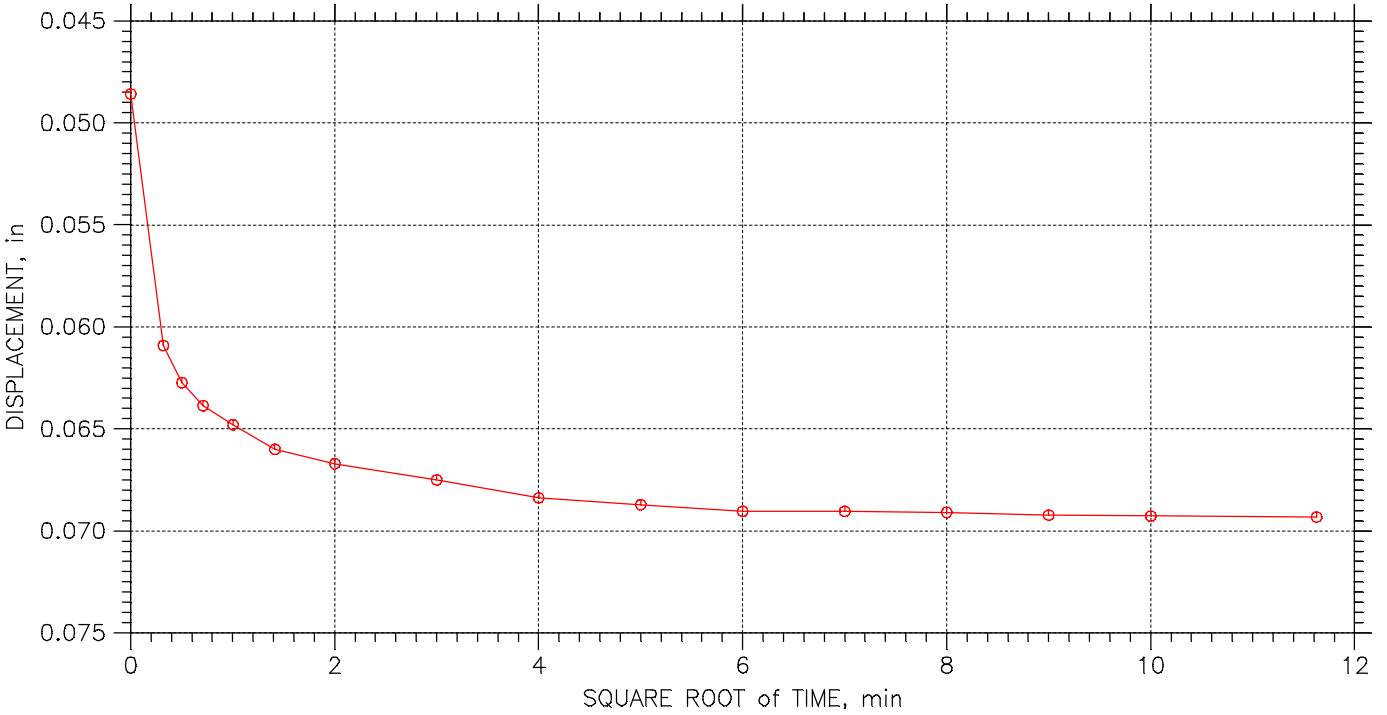
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 23

Stress: 16. tsf





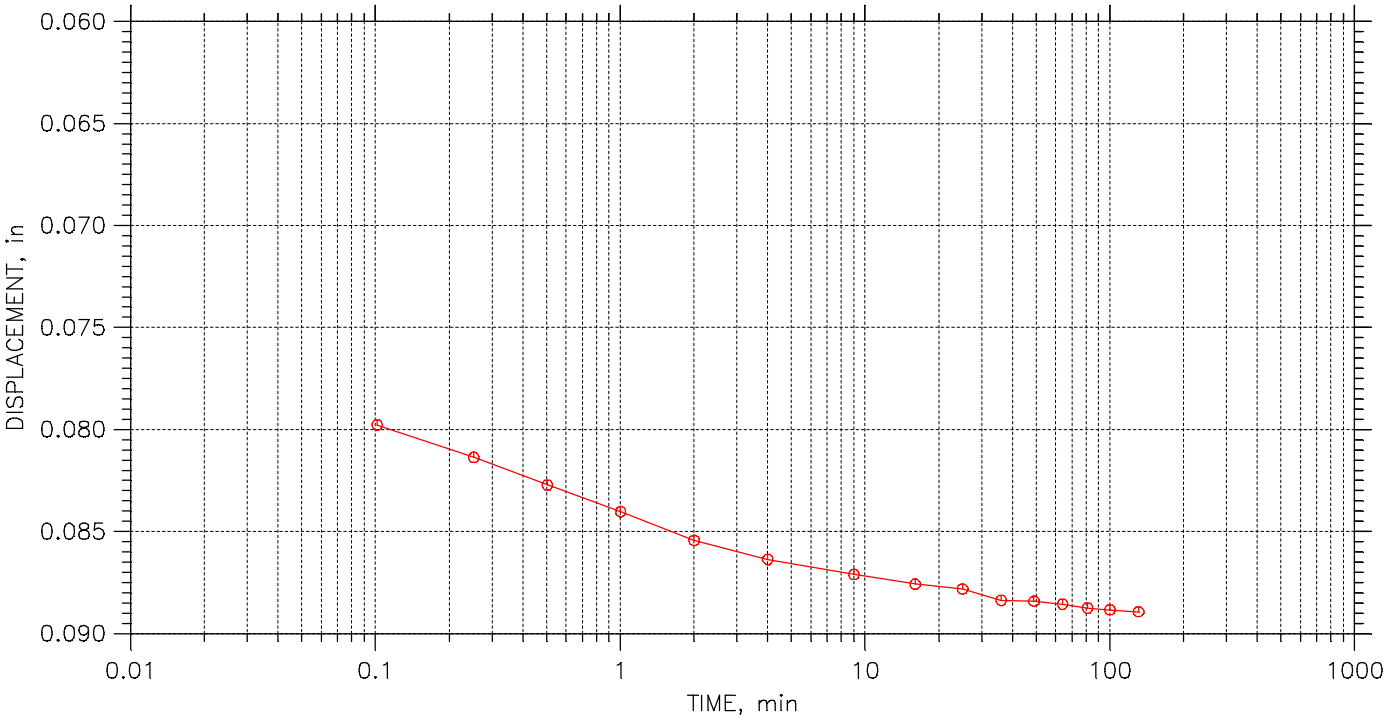
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	264		

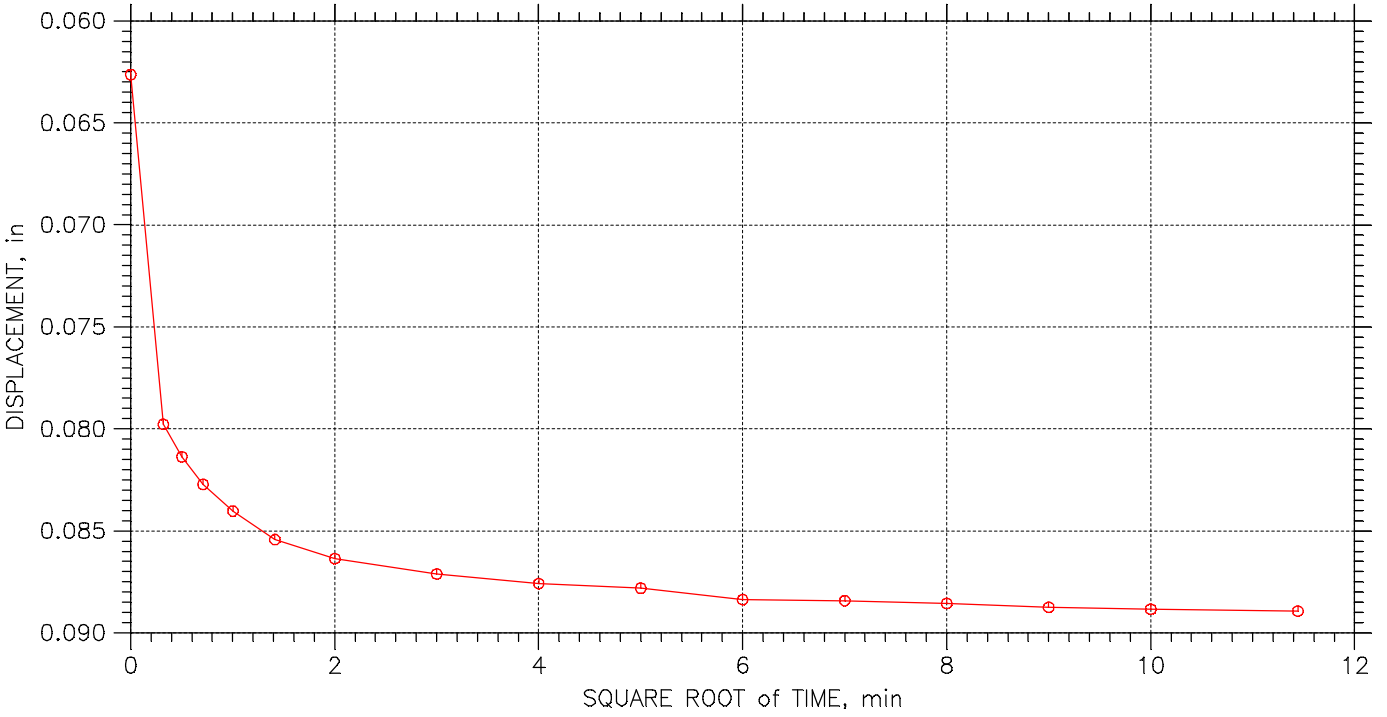
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 18 of 23

Stress: 32. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	265		

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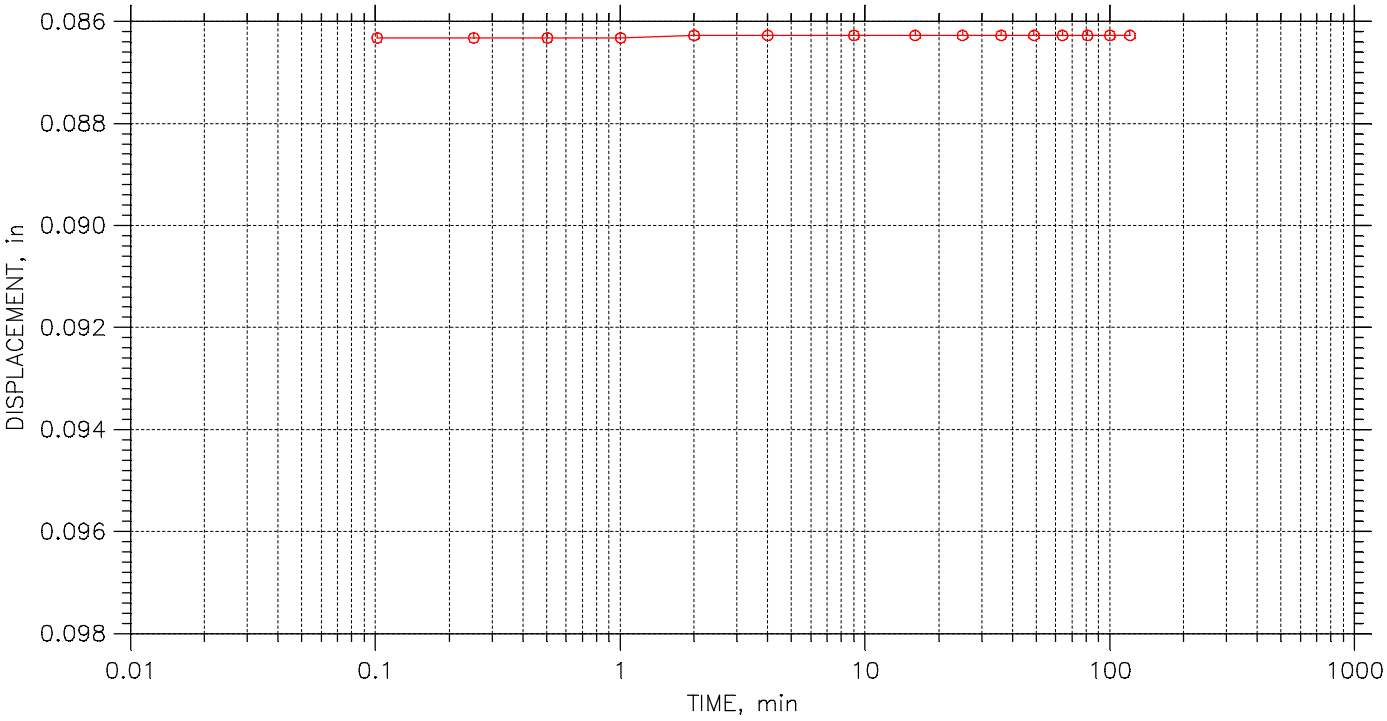
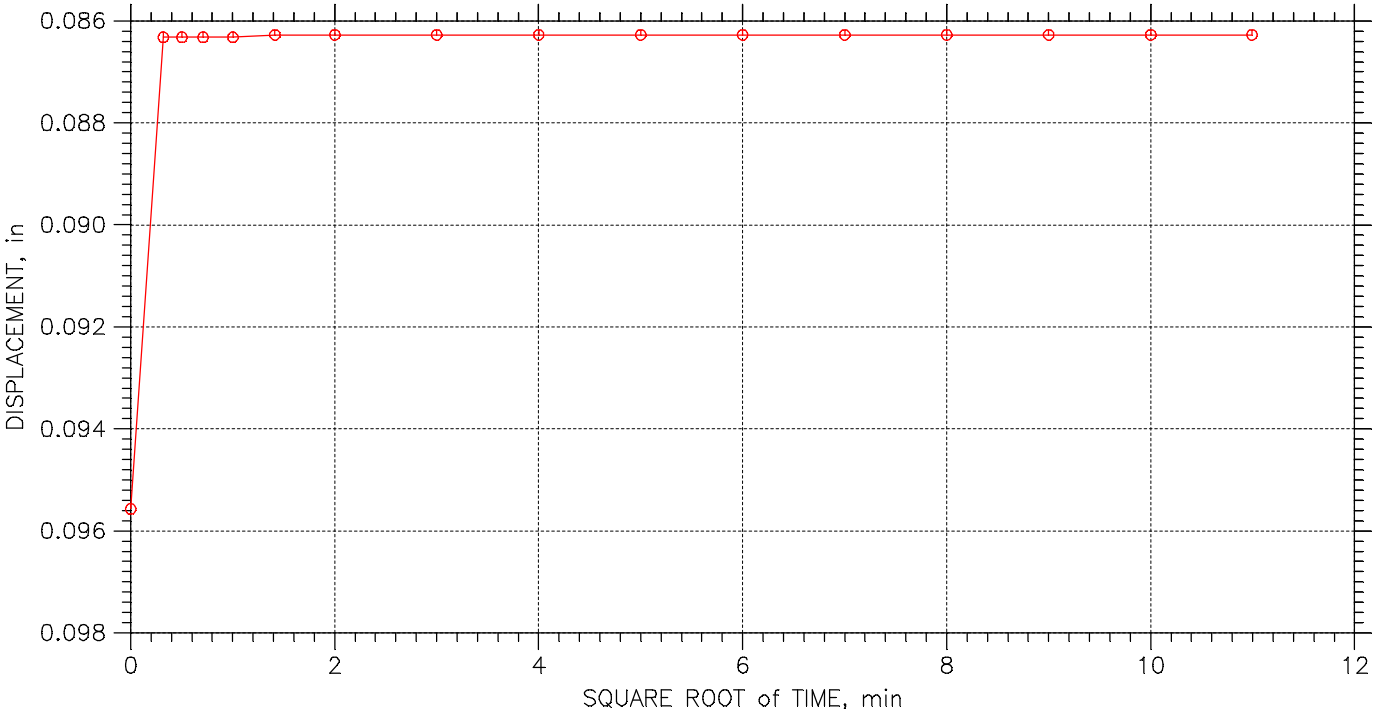
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 19 of 23

Stress: 16. tsf





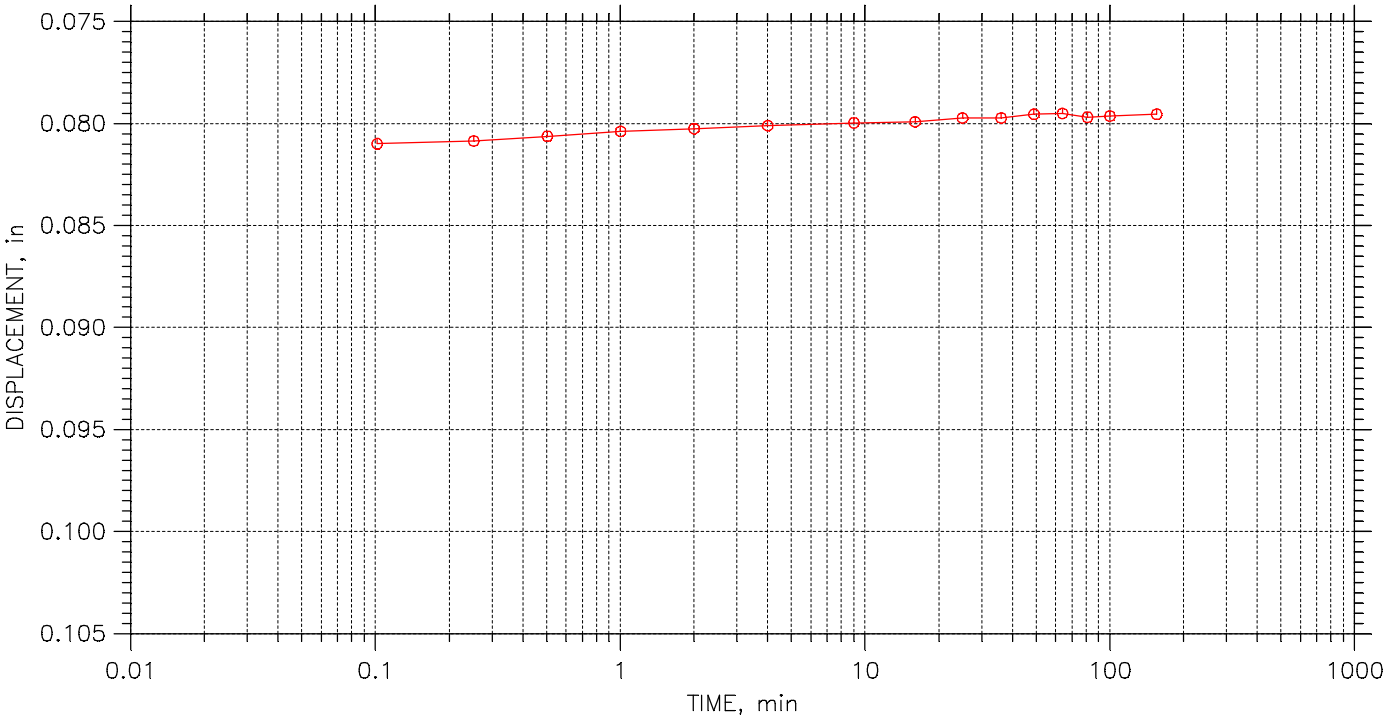
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	266		

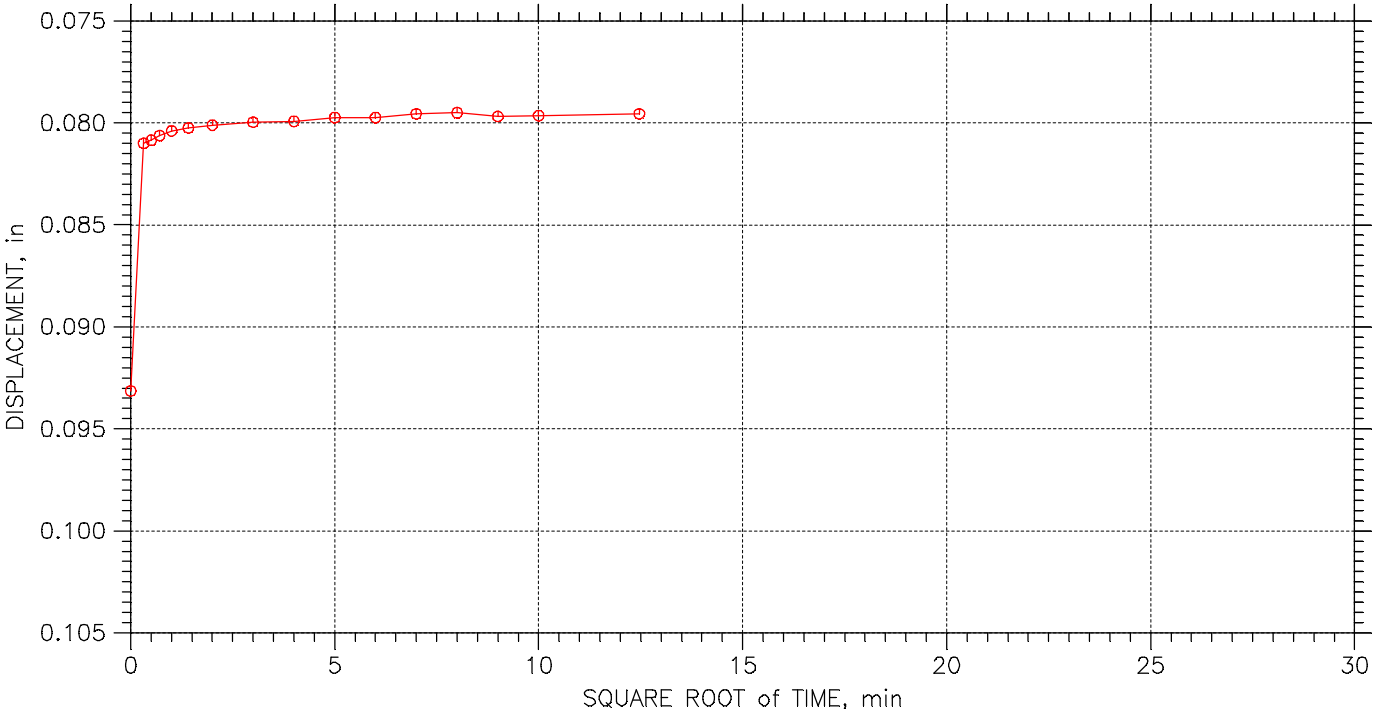
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 20 of 23

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	267		

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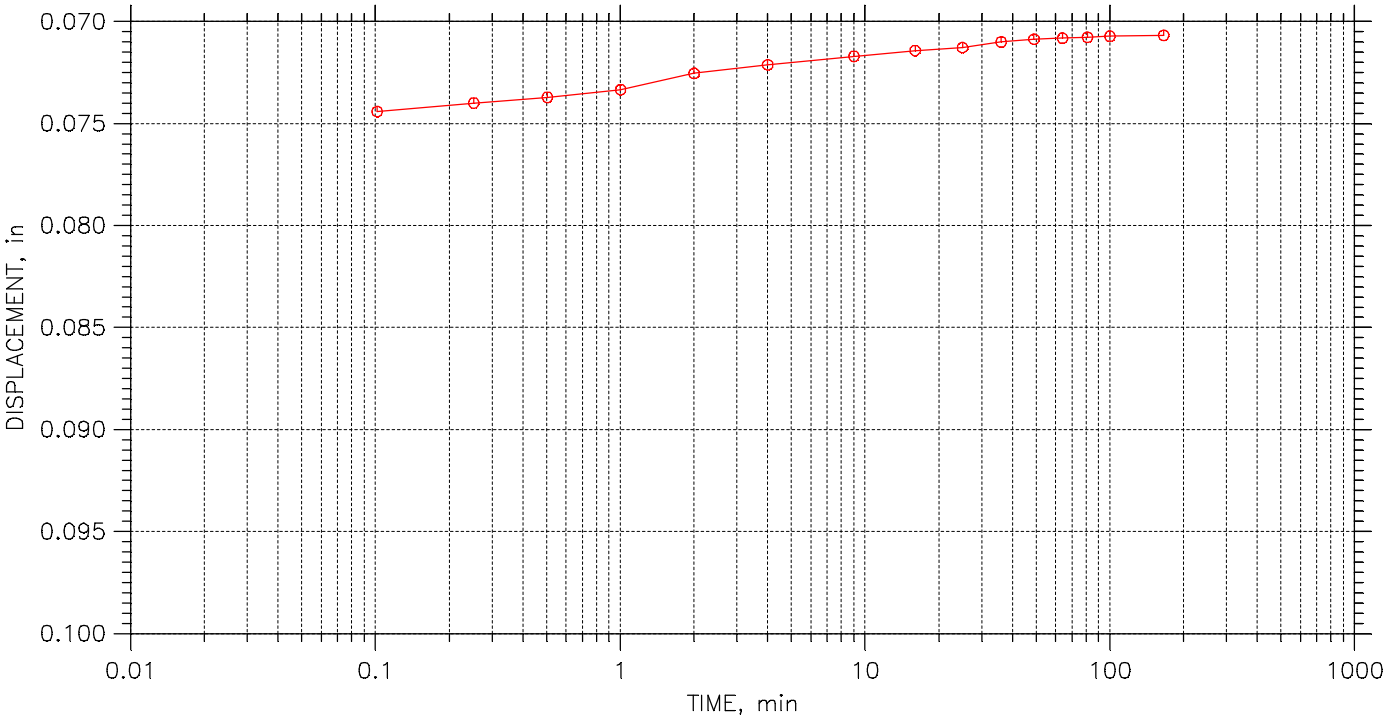
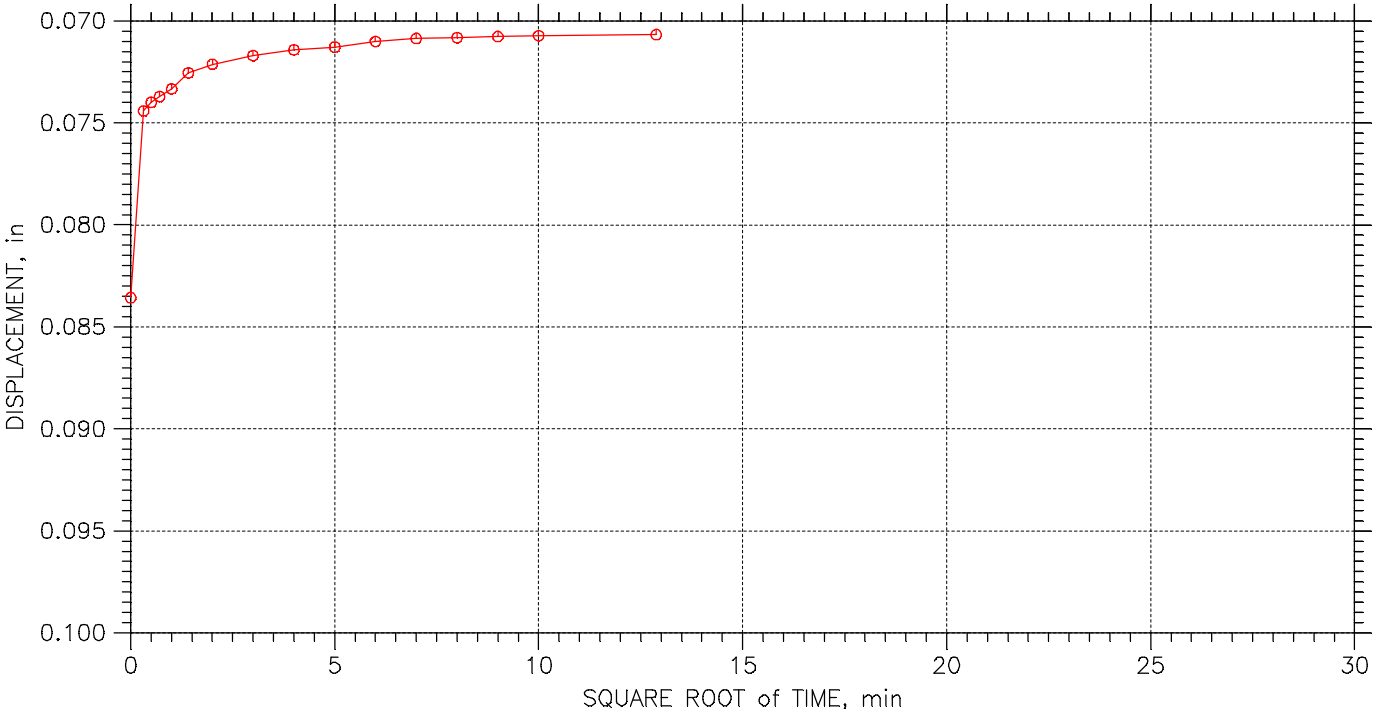
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 21 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	268		

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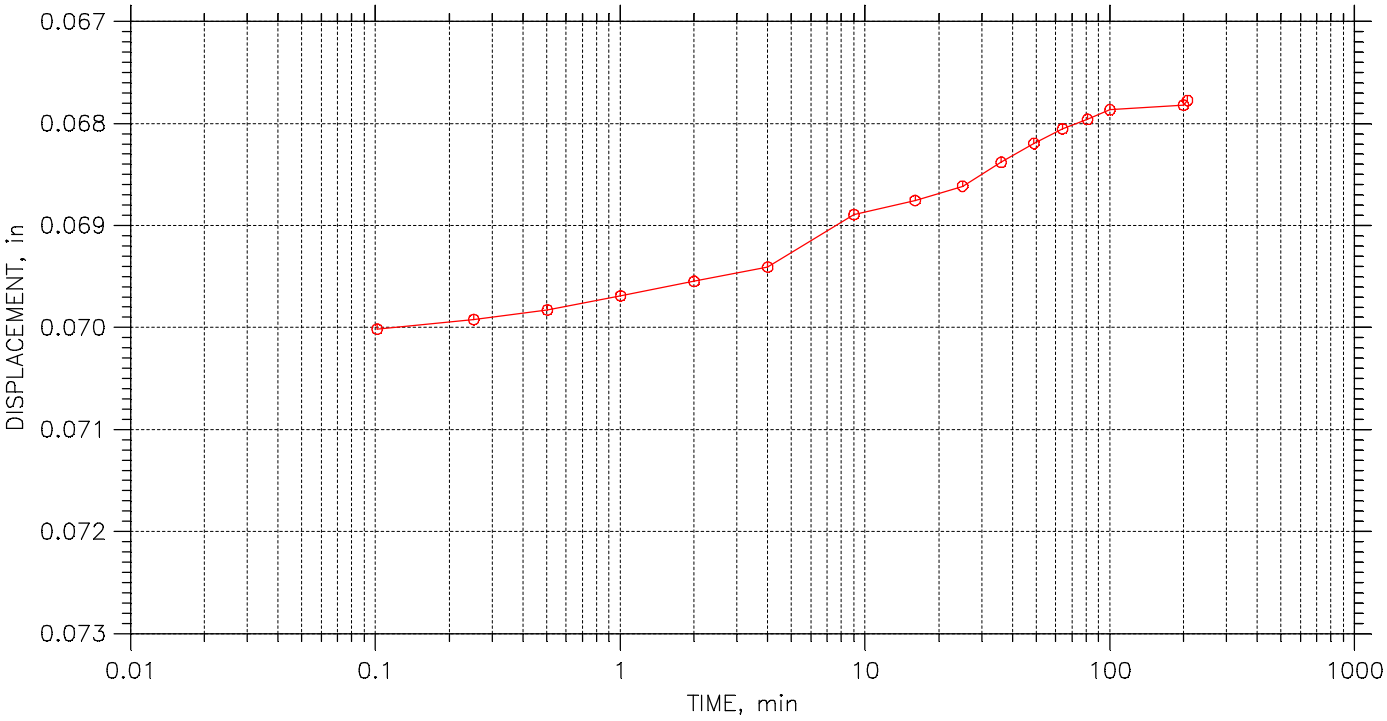
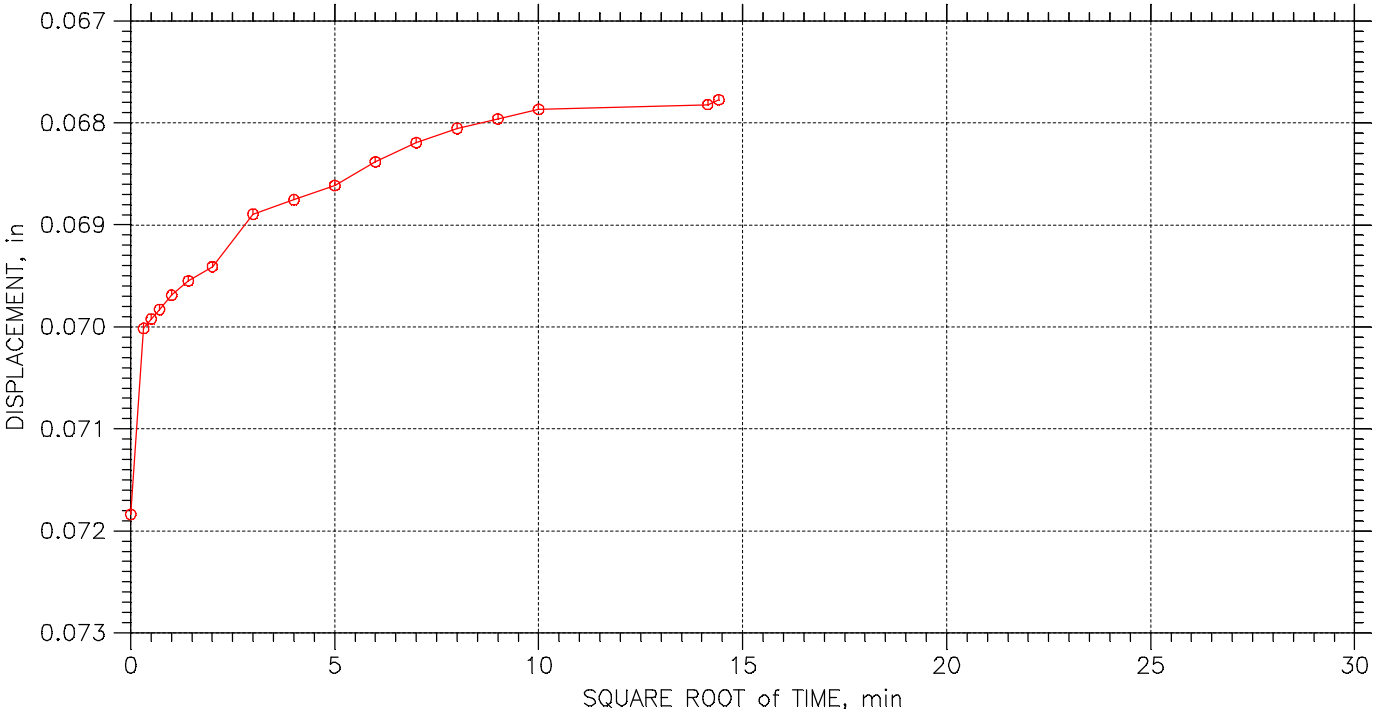
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	269		

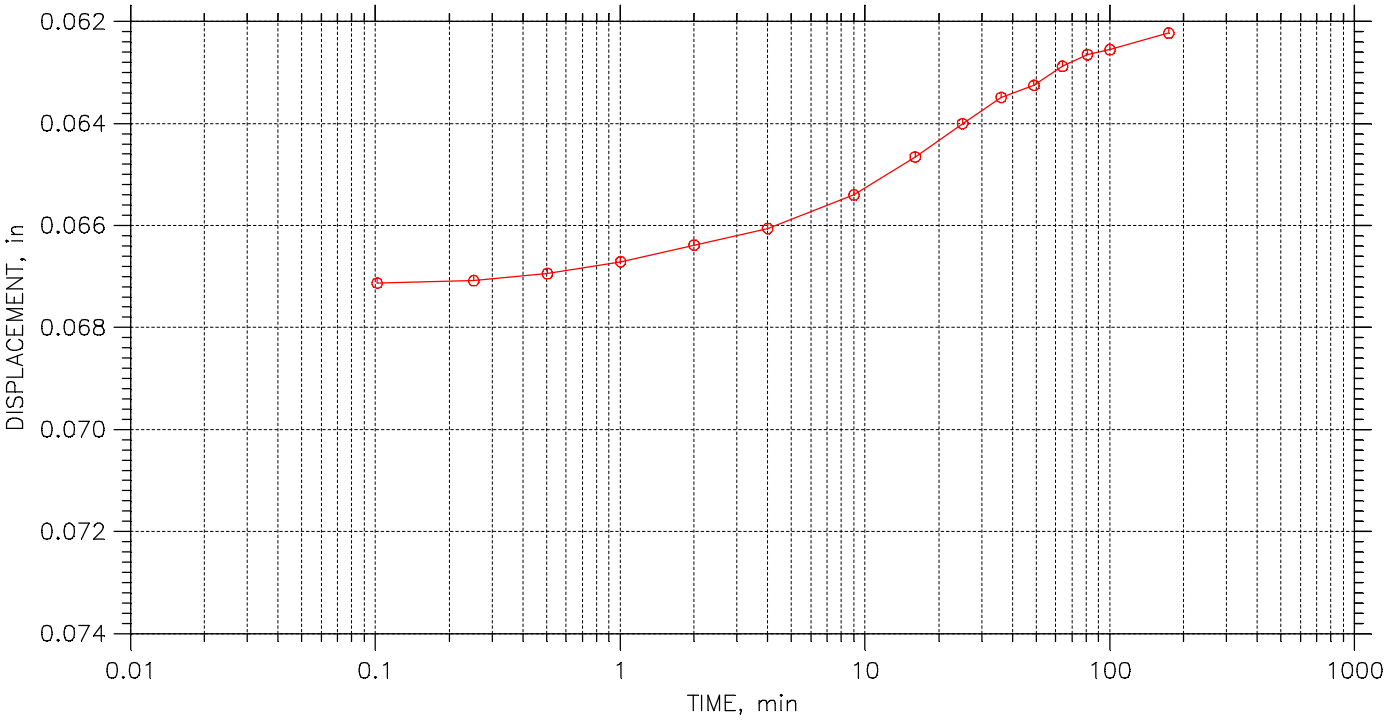
Mon, 21-DEC-2015 16:43:22

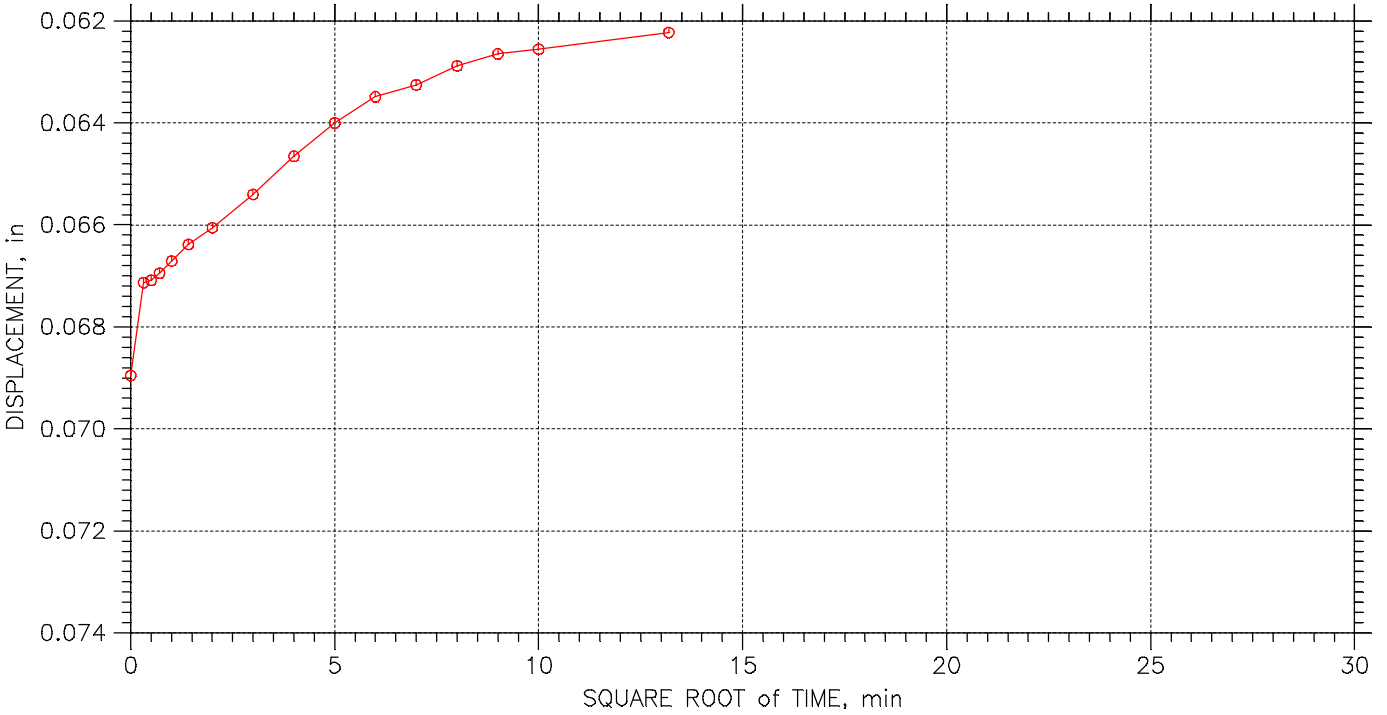
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 23

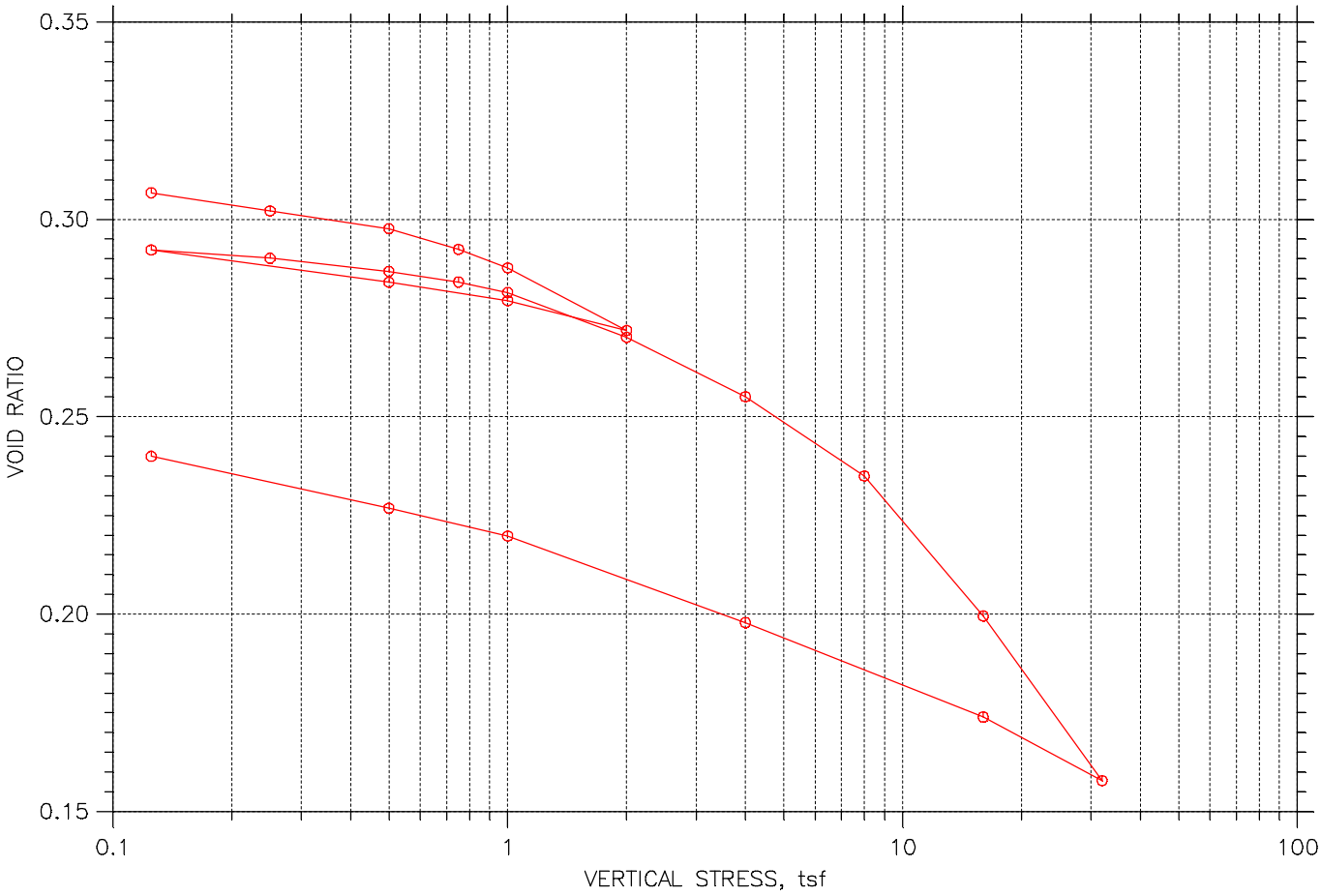
Stress: 0.125 tsf

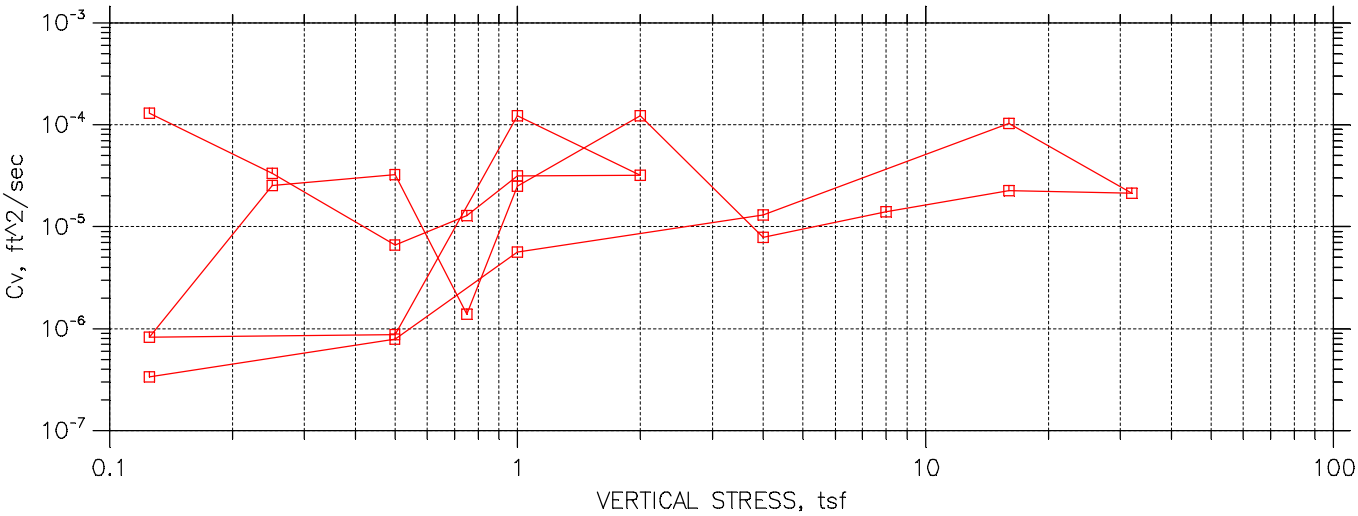




Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN B020	Tested By: HP	Checked By: BCM
	Sample No.: S-5	Test Date: 12/14/15	Depth: 9.5'-11.5'
	Test No.: HENB020	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN SANDY LEAN CLAY AND GRAVEL		
	Remarks: Pc = 1.8 tsf Cc = 0.116 Ccr = 0.021 TEST PERFORMED AS PER ASTM D2435		
	270		

ONE DIMENSIONAL CONSOLIDATION TEST
ASTM D2435





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	271		

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CONSOLIDATION TEST DATA

Terracon
Consulting Engineers & Scientists

Project: DYNERGY HENNEPIN | Location: HENNEPIN, IL | Project No.: MR155233
Boring No.: HEN-029 S-3 | Tested By: HP | Checked By: BCM
Sample No.: S-3 | Test Date: 12/14/15 | Depth: 5.0'-7.0'
Test No.: HENB029S3 | Sample Type: 3.0" ST | Elevation: -----

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435

Estimated Specific Gravity: 2.72 | Liquid Limit: 22 | Initial Height: 0.74 in
Initial Void Ratio: 0.31 | Plastic Limit: 15 | Specimen Diameter: 2.49 in
Final Void Ratio: 0.24 | Plasticity Index: 7

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	X-7	RING	RING	118
Wt. Container + Wet Soil, gm	167.52	207.79	207.7	156.24
Wt. Container + Dry Soil, gm	155.54	196.84	196.84	145.48
Wt. Container, gm	44.63	74.87	74.87	24.64
Wt. Dry Soil, gm	110.91	121.97	121.97	120.84
Water Content, %	10.80	8.98	8.90	8.90
Void Ratio	---	0.31	0.24	---
Degree of Saturation, %	---	77.94	100.93	---
Dry Unit Weight, pcf	---	129.29	136.94	---

CONSOLIDATION TEST DATA

Project: DYNERGY HENNEPIN | Location: HENNEPIN, IL | Project No.: MR155233
Boring No.: HEN-029 S-3 | Tested By: HP | Checked By: BCM
Sample No.: S-3 | Test Date: 12/14/15 | Depth: 5.0'-7.0'
Test No.: HENB029S3 | Sample Type: 3.0" ST | Elevation: -----

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435

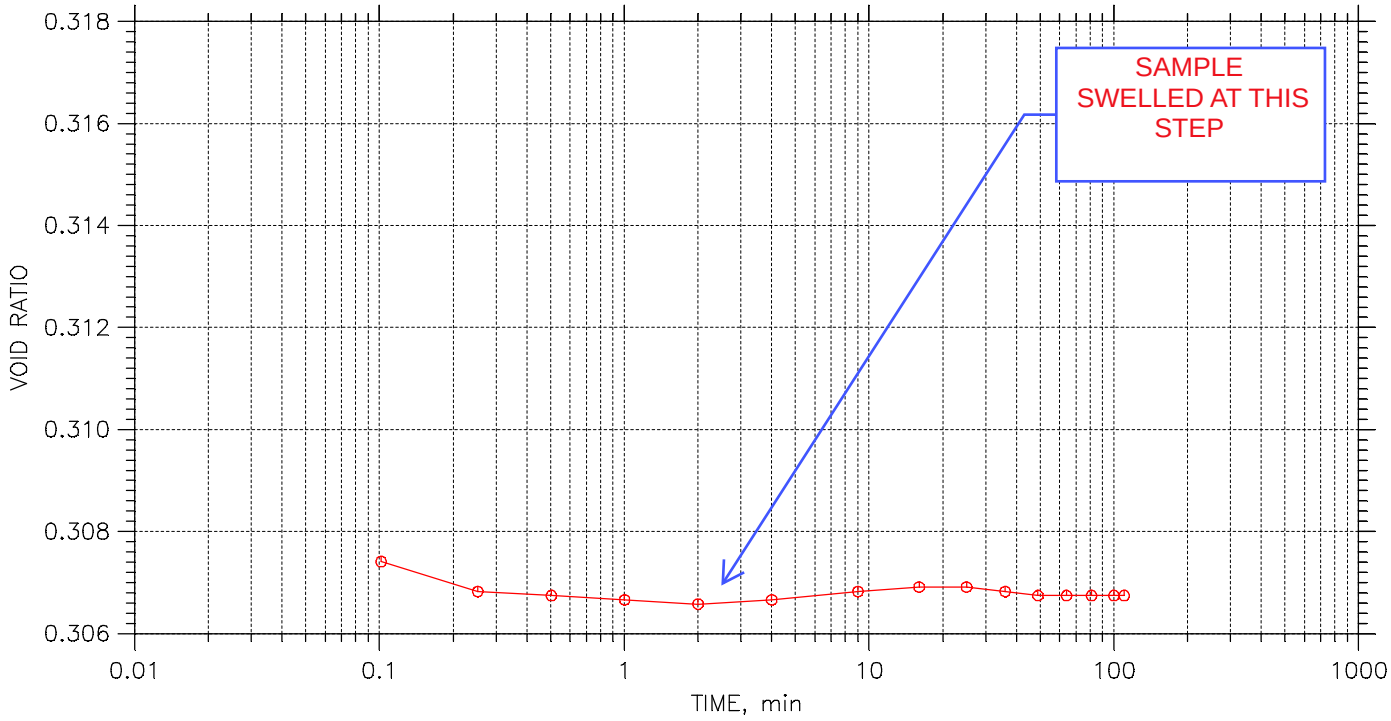
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting Sq.Rt. min	T50 Fitting Log min	Coefficient of Consolidation Sq.Rt. ft^2/sec	Coefficient of Consolidation Log ft^2/sec	Coefficient of Consolidation Ave. ft^2/sec
1	0.125	0.00369	0.307	0.50	0.0	0.0	1.30e-004	0.00e+000	1.30e-004
2	0.25	0.006259	0.302	0.85	0.1	0.0	3.32e-005	0.00e+000	3.32e-005
3	0.5	0.008782	0.298	1.19	0.5	0.0	6.59e-006	0.00e+000	6.59e-006
4	0.75	0.01172	0.292	1.59	0.2	0.0	1.28e-005	0.00e+000	1.28e-005
5	1	0.01434	0.288	1.95	0.1	0.0	3.13e-005	0.00e+000	3.13e-005
6	2	0.02322	0.272	3.16	0.1	0.0	3.18e-005	0.00e+000	3.18e-005
7	1	0.01901	0.279	2.58	0.0	0.0	1.23e-004	0.00e+000	1.23e-004
8	0.5	0.0164	0.284	2.23	3.4	0.0	8.69e-007	0.00e+000	8.69e-007
9	0.125	0.01182	0.292	1.61	3.6	0.0	8.29e-007	0.00e+000	8.29e-007
10	0.25	0.01299	0.290	1.76	0.1	0.0	2.54e-005	0.00e+000	2.54e-005
11	0.5	0.01485	0.287	2.02	0.1	0.0	3.22e-005	0.00e+000	3.22e-005
12	0.75	0.01635	0.284	2.22	2.1	0.0	1.38e-006	0.00e+000	1.38e-006
13	1	0.01784	0.281	2.43	0.1	0.0	2.51e-005	0.00e+000	2.51e-005
14	2	0.0242	0.270	3.29	0.0	0.0	1.23e-004	0.00e+000	1.23e-004
15	4	0.03265	0.255	4.44	0.4	0.0	7.87e-006	0.00e+000	7.87e-006
16	8	0.04391	0.235	5.97	0.2	0.0	1.39e-005	0.00e+000	1.39e-005
17	16	0.06376	0.200	8.67	0.1	0.0	2.26e-005	0.00e+000	2.26e-005
18	32	0.08712	0.158	11.84	0.1	0.0	2.12e-005	0.00e+000	2.12e-005
19	16	0.0781	0.174	10.61	0.0	0.0	1.03e-004	0.00e+000	1.03e-004
20	4	0.0647	0.198	8.79	0.2	0.0	1.30e-005	0.00e+000	1.30e-005
21	1	0.05241	0.220	7.12	0.5	0.0	5.63e-006	0.00e+000	5.63e-006
22	0.5	0.04844	0.227	6.58	3.4	0.0	7.92e-007	0.00e+000	7.92e-007
23	0.125	0.04111	0.240	5.59	8.1	0.0	3.37e-007	0.00e+000	3.37e-007

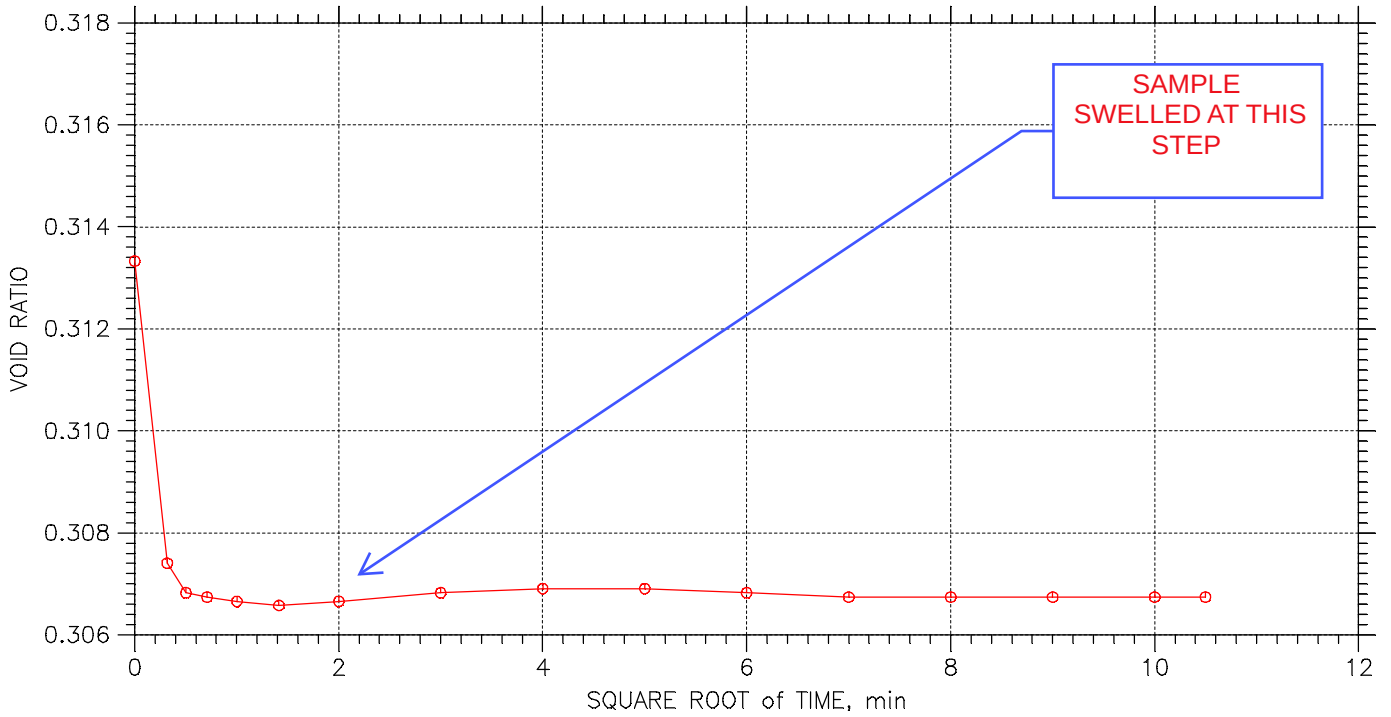
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 23

Stress: 0.125 tsf





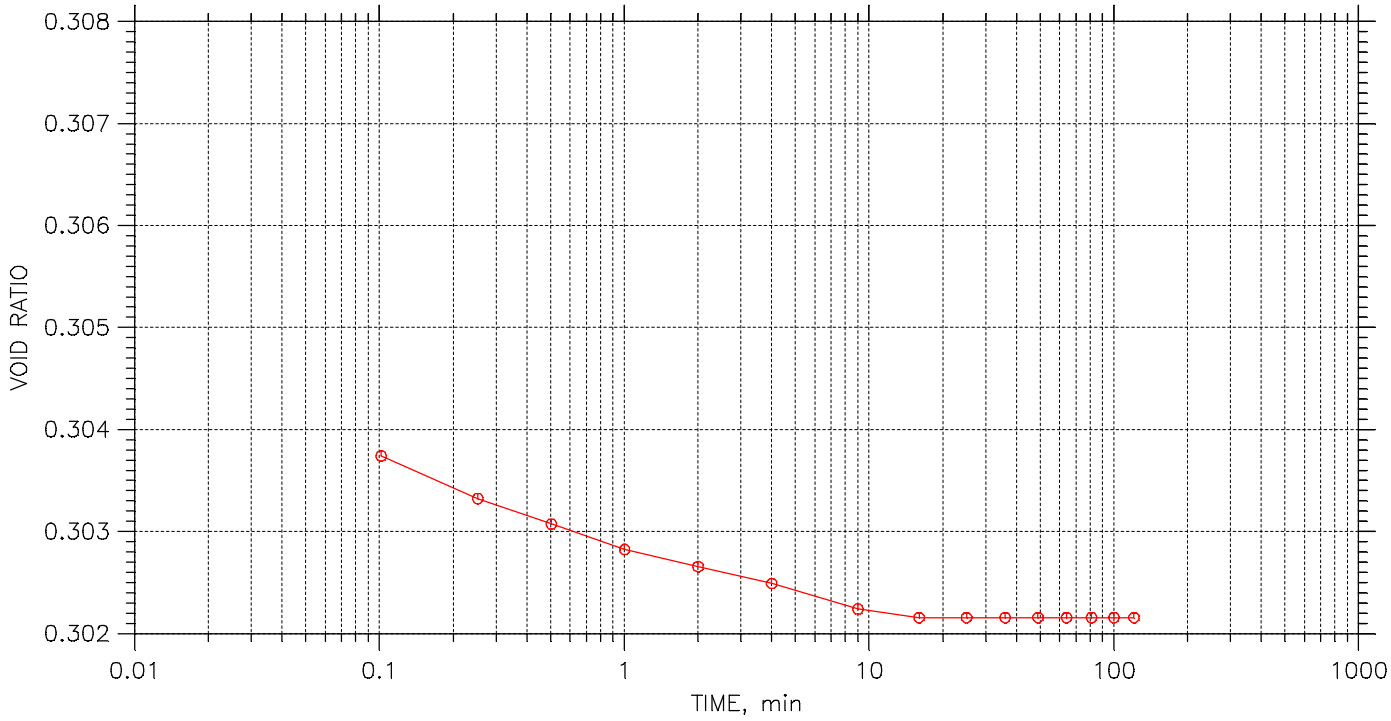
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	274		

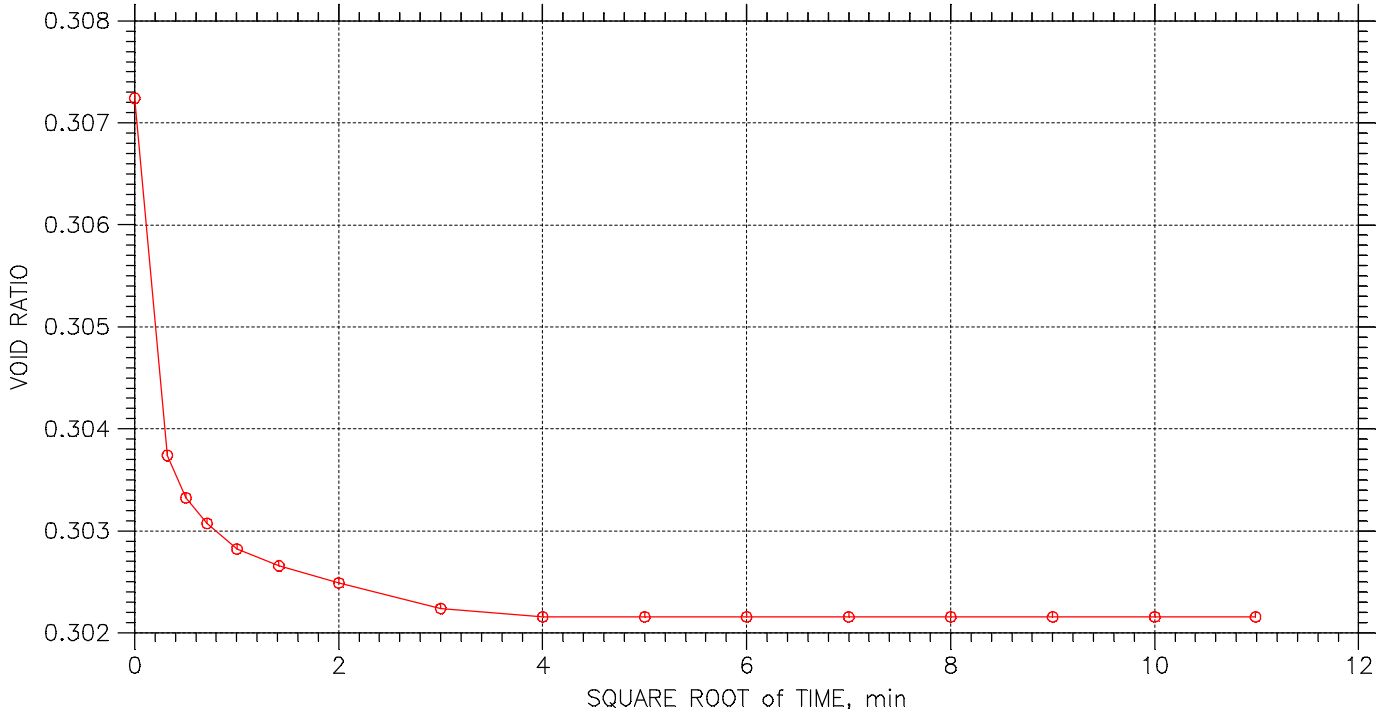
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 23

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	275		

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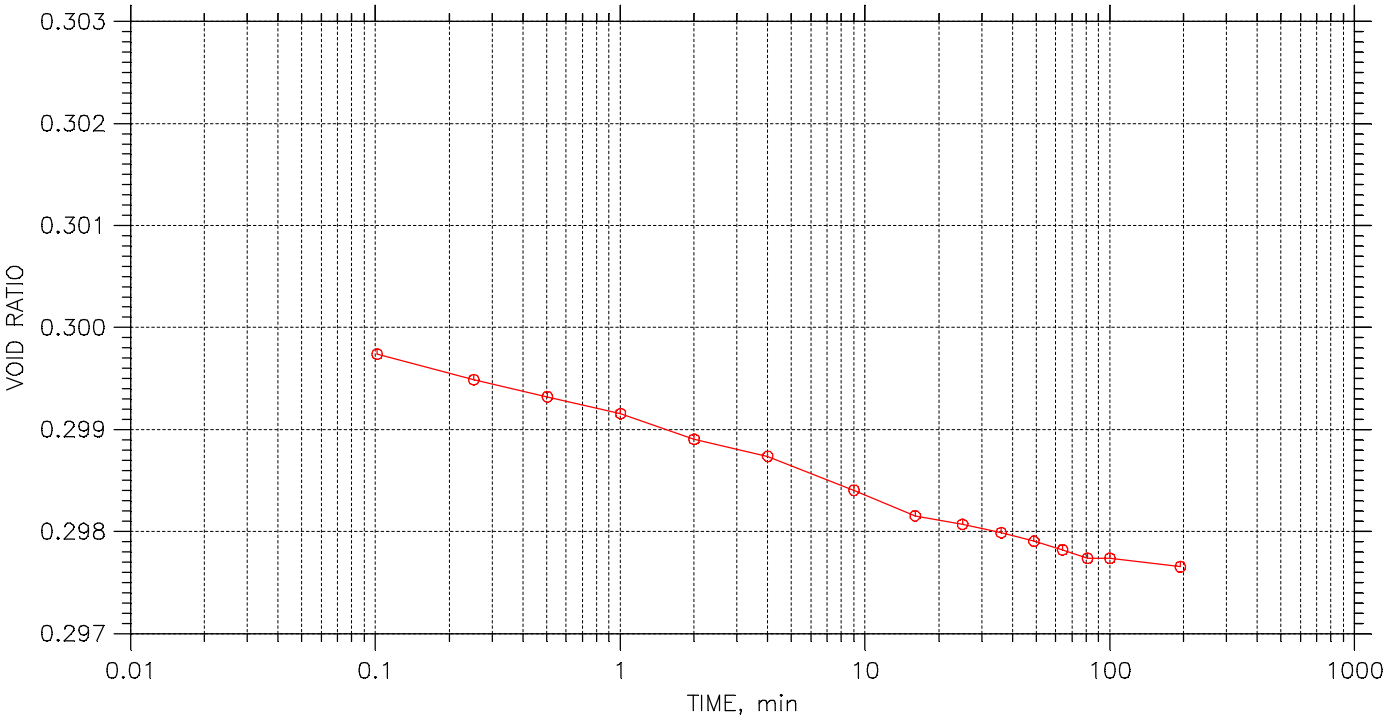
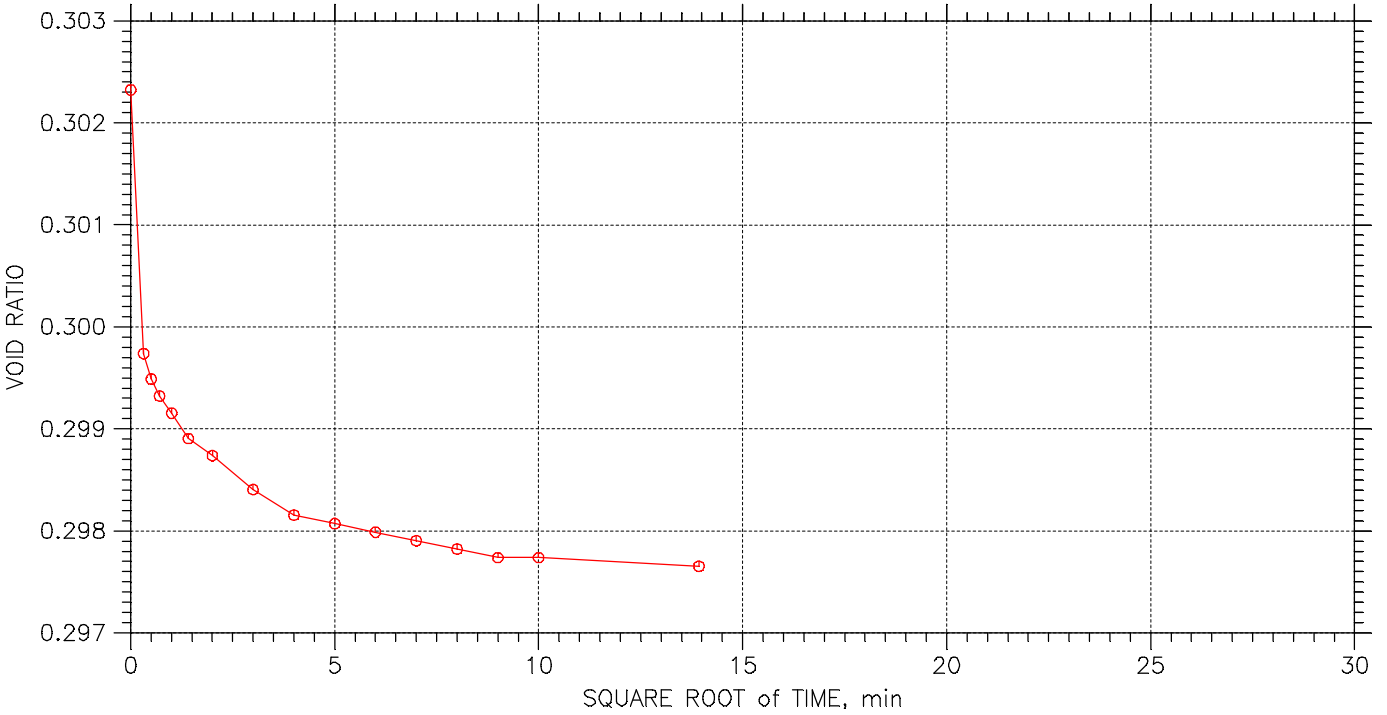
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	276		

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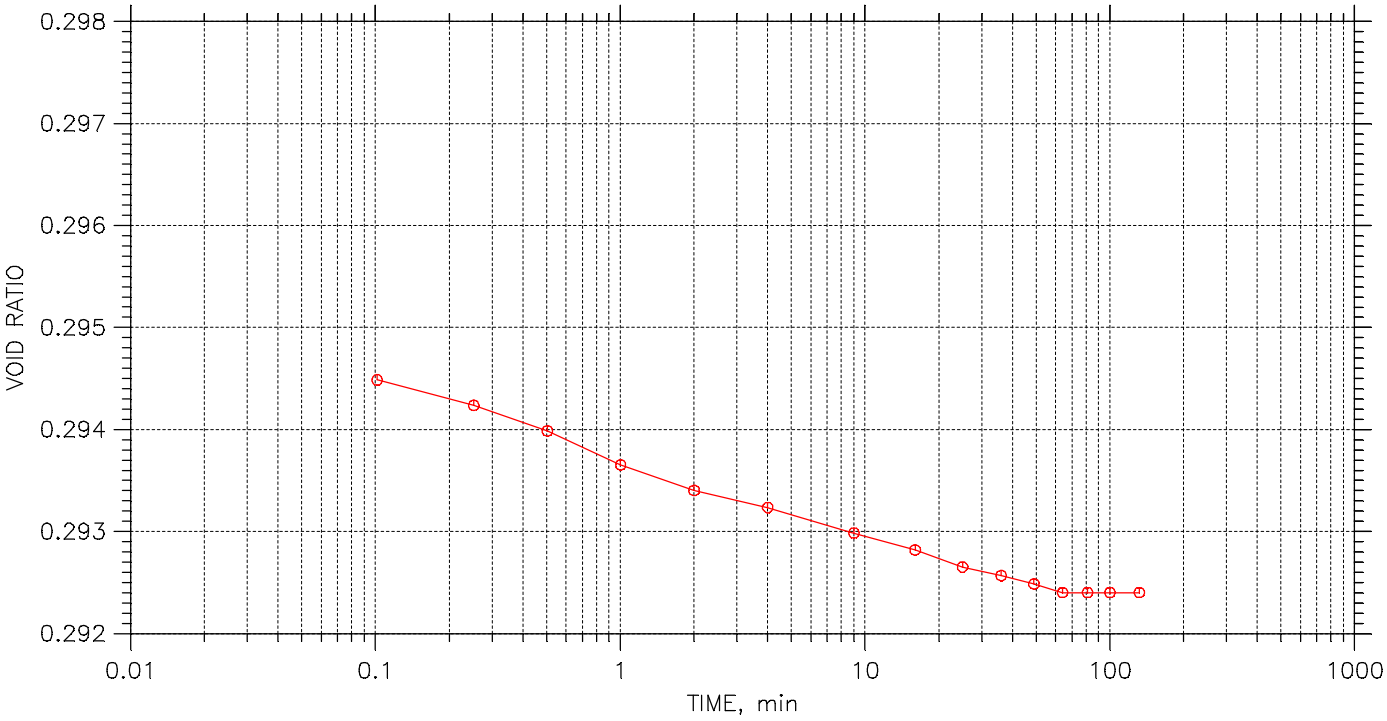
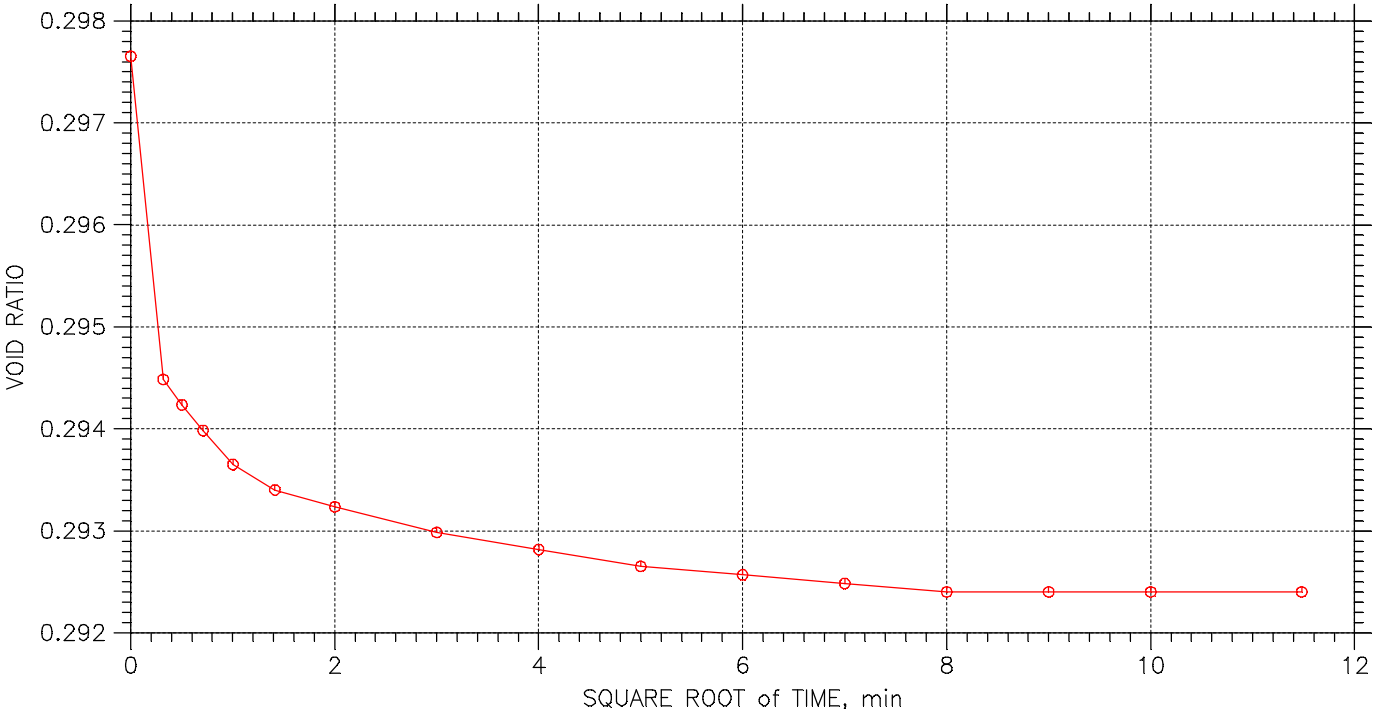
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 4 of 23

Stress: 0.75 tsf





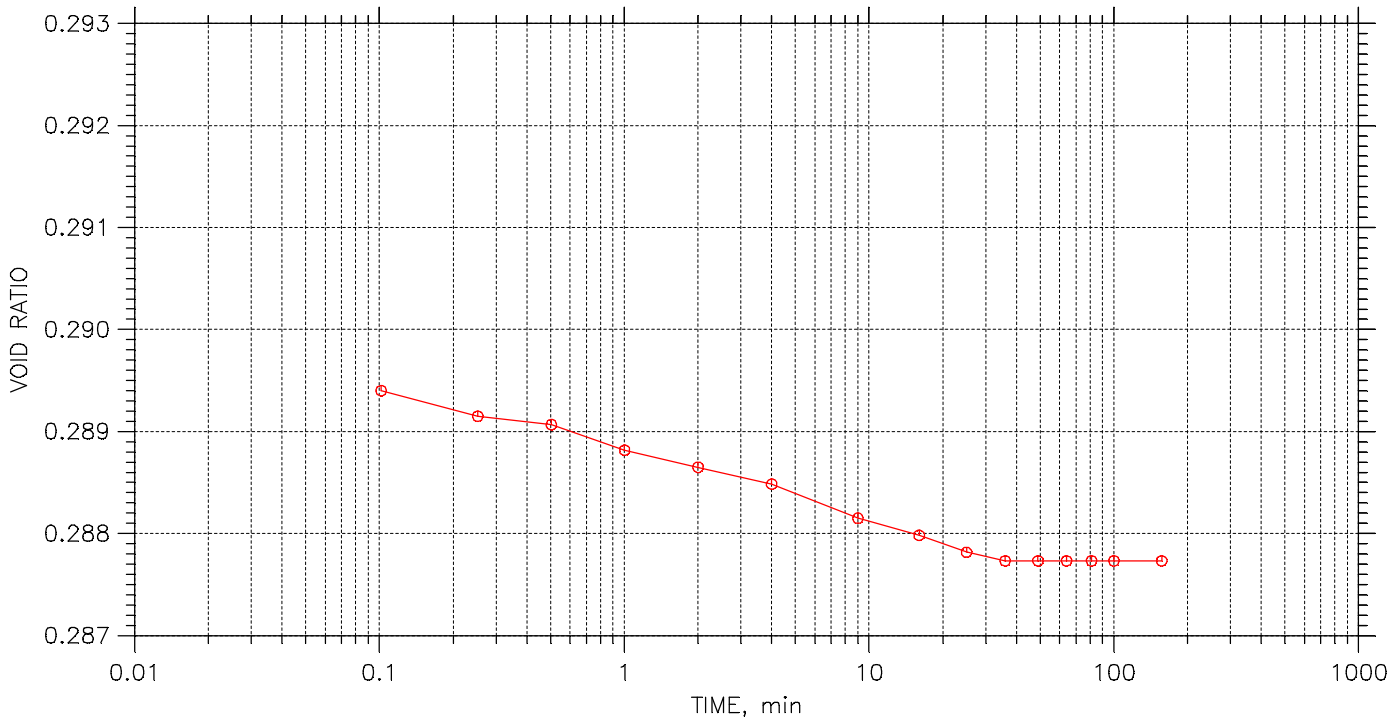
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	277		

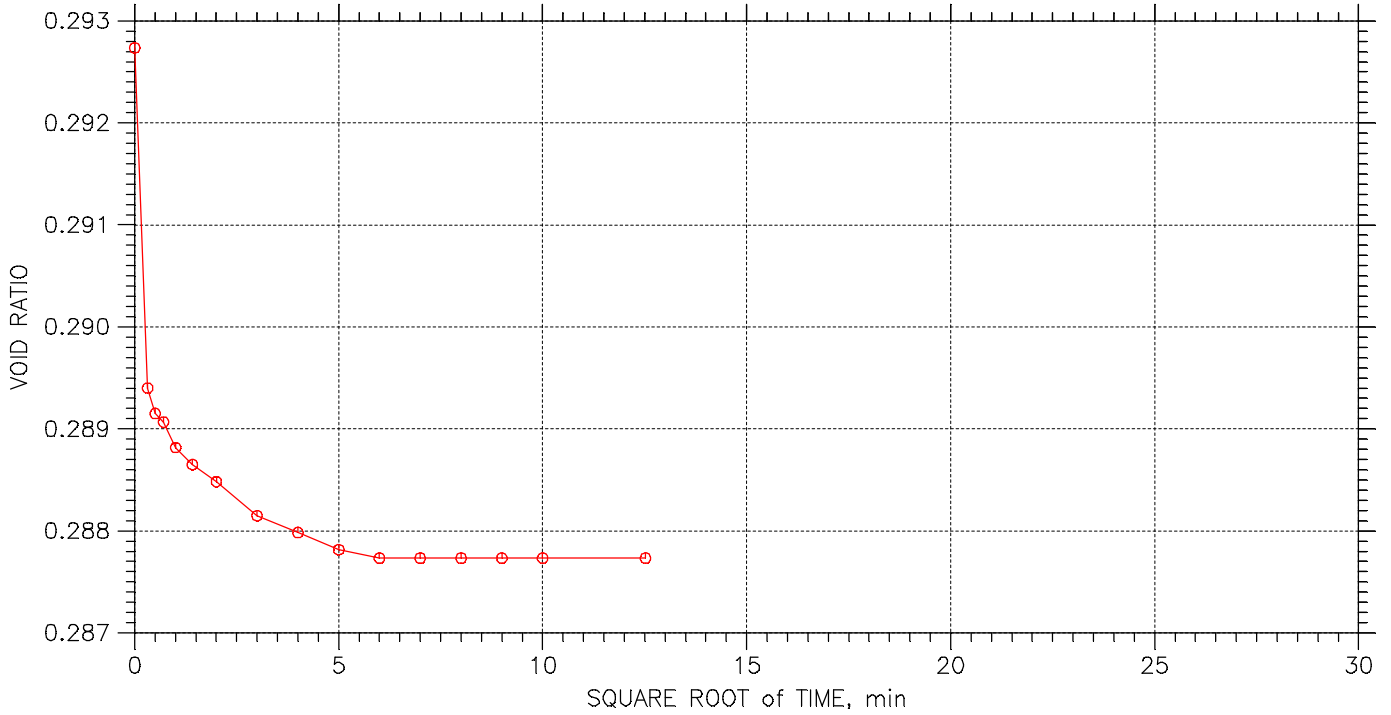
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	278		

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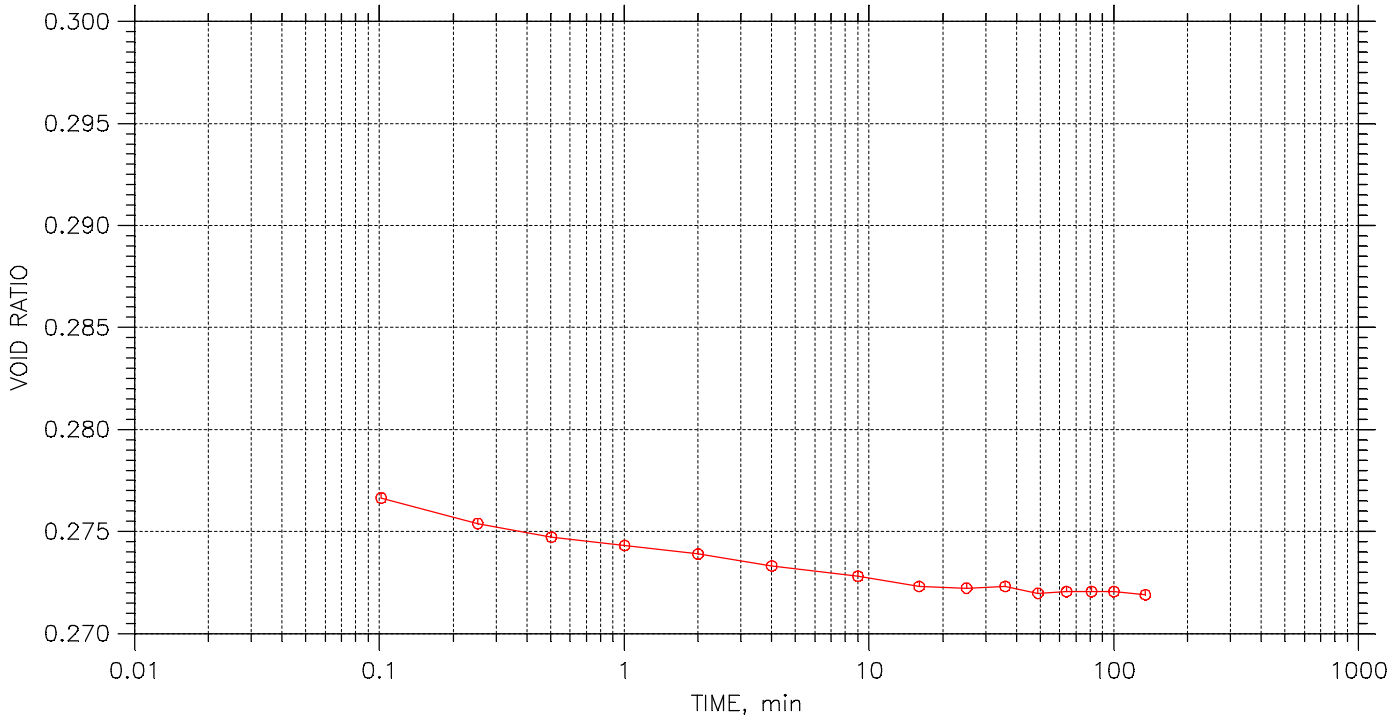
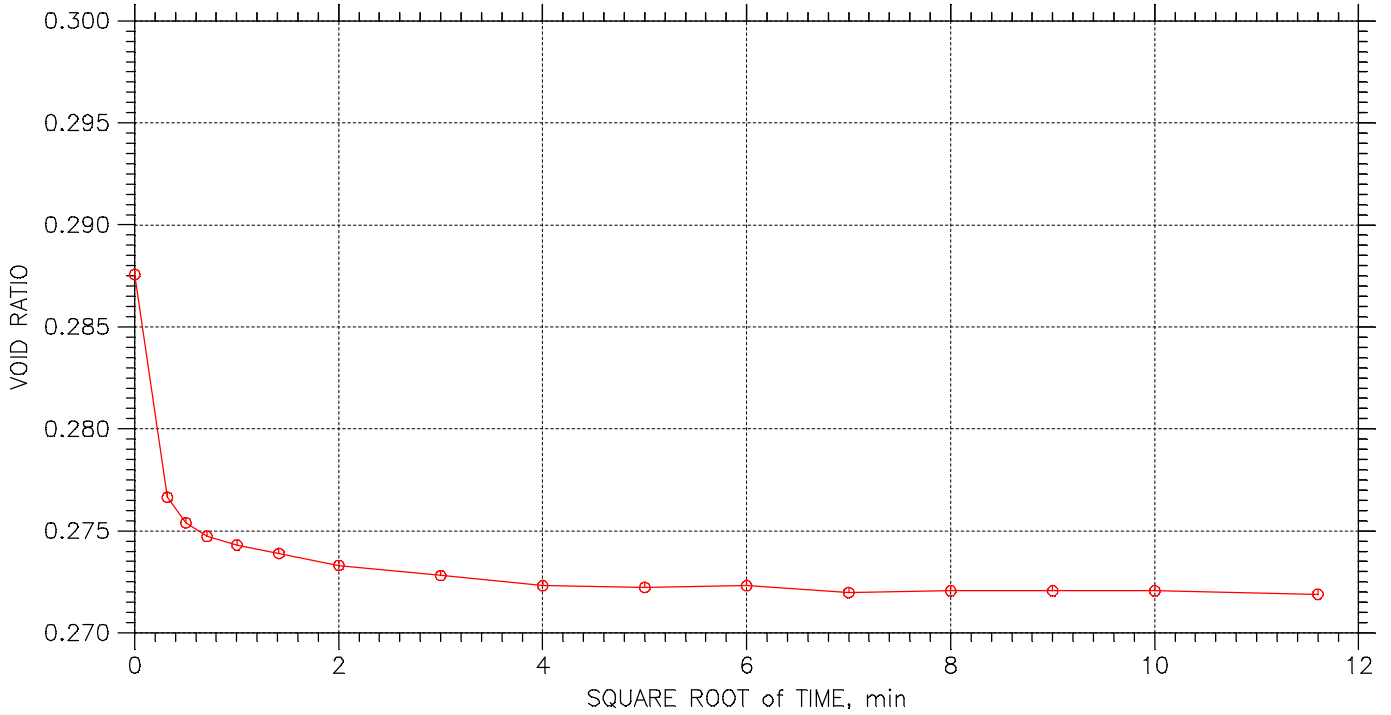
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 23

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	279		

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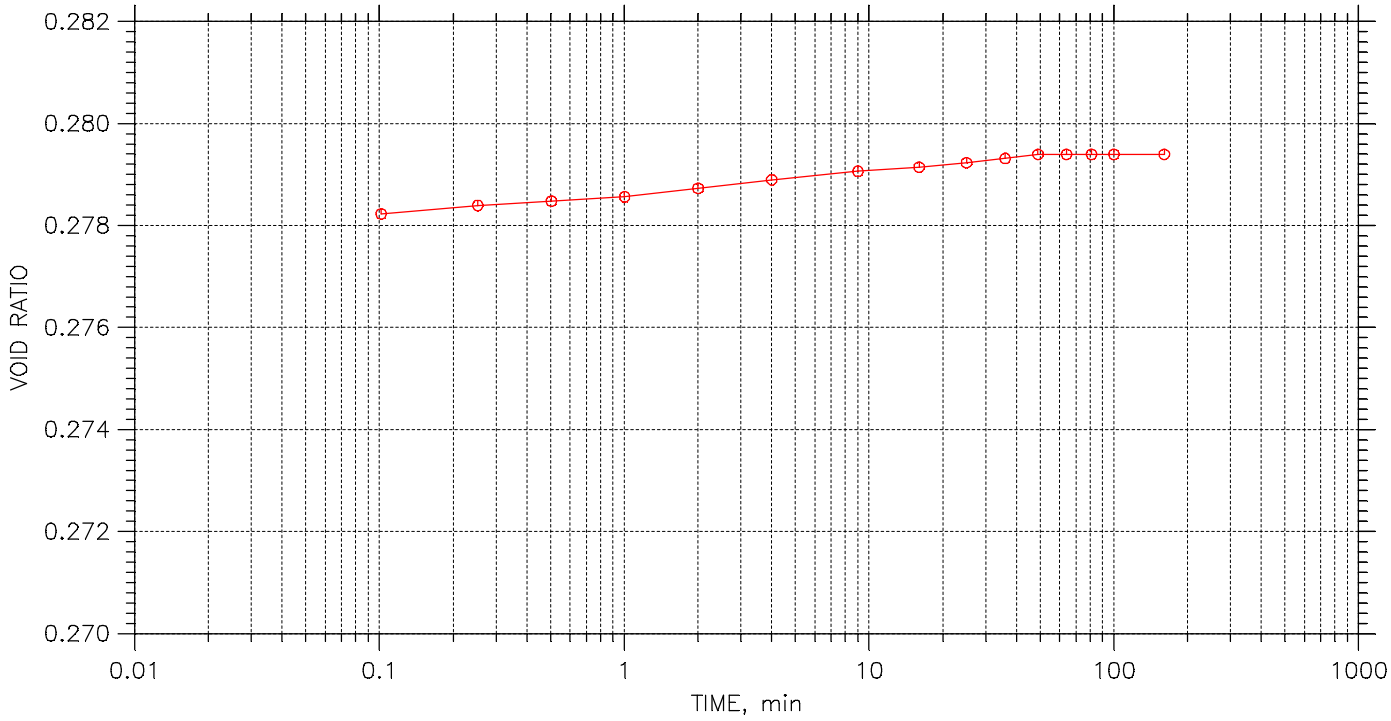
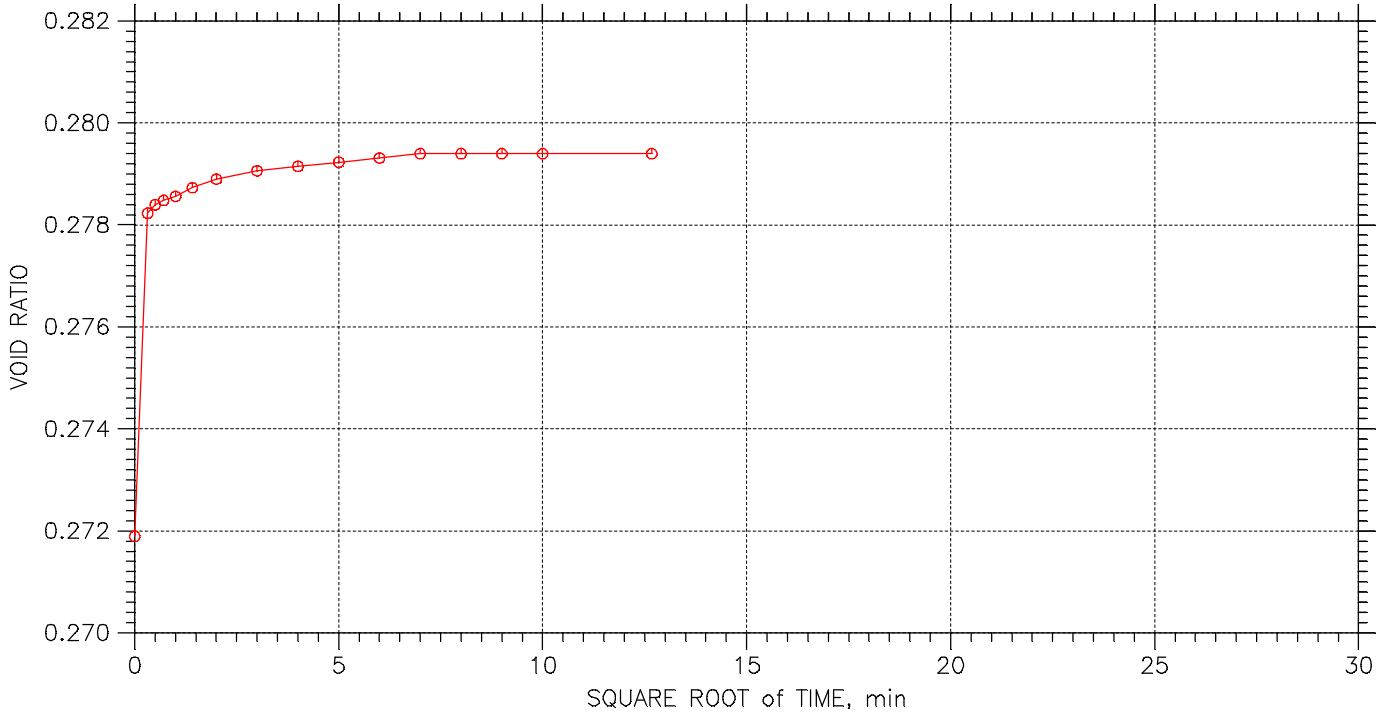
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 7 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	280		

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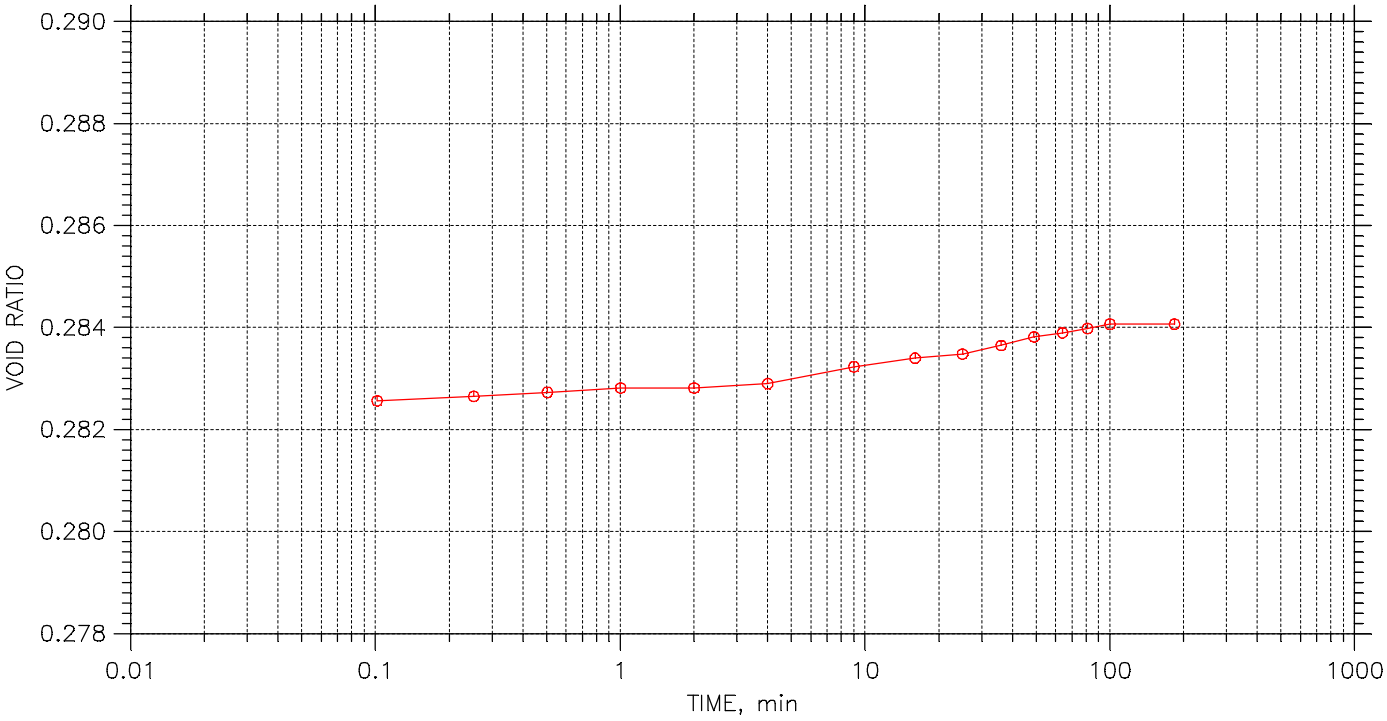
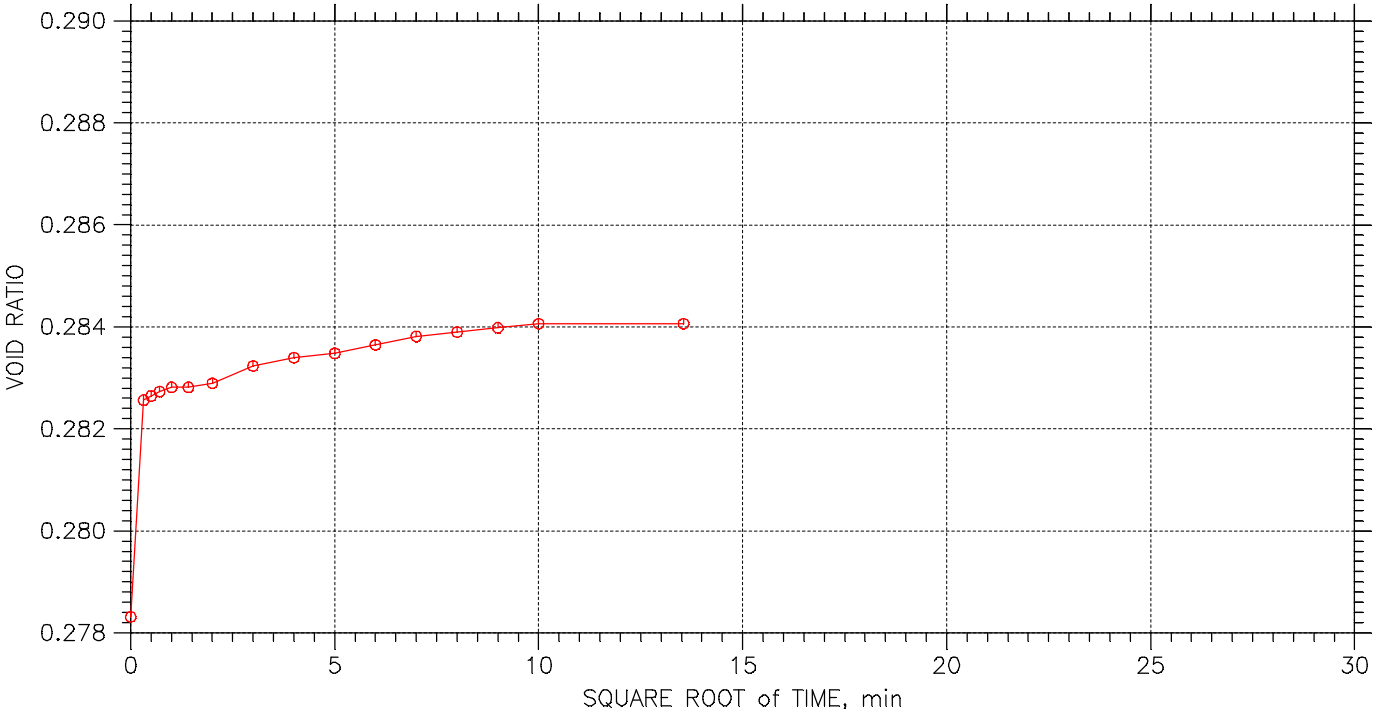
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	281		

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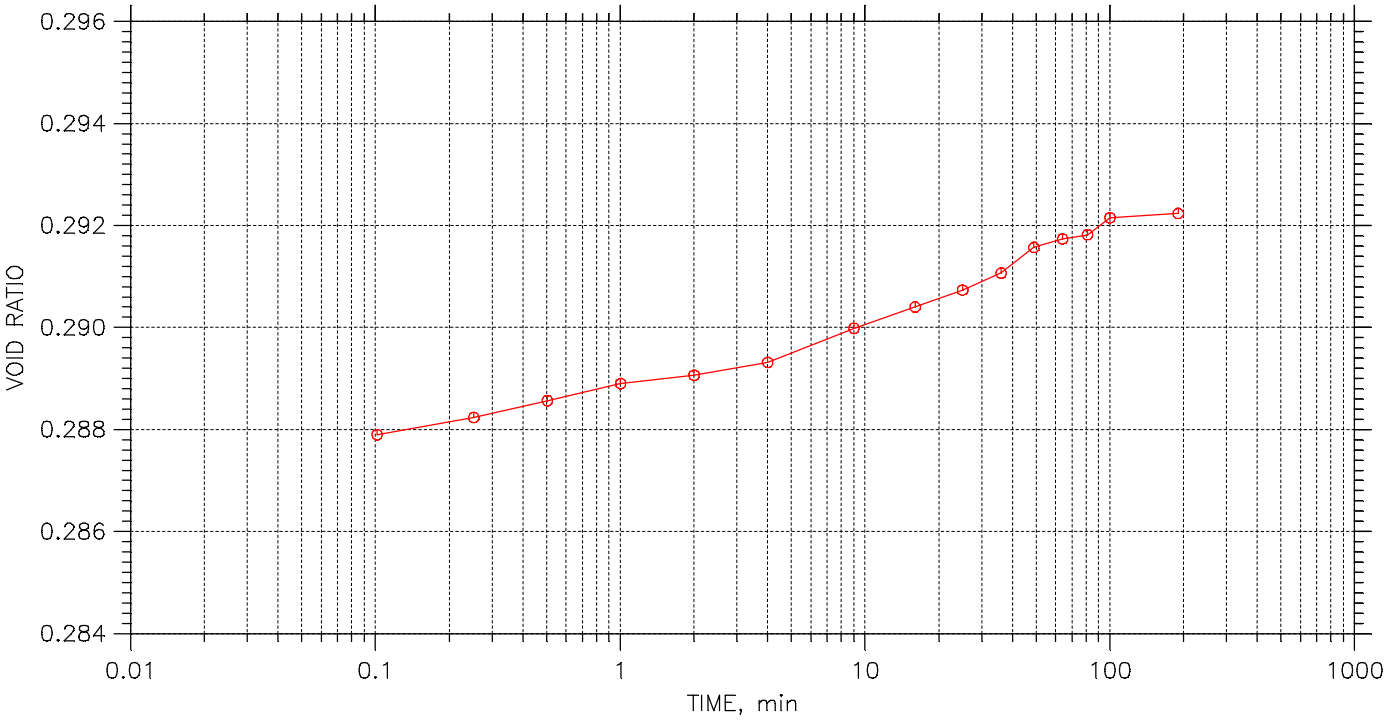
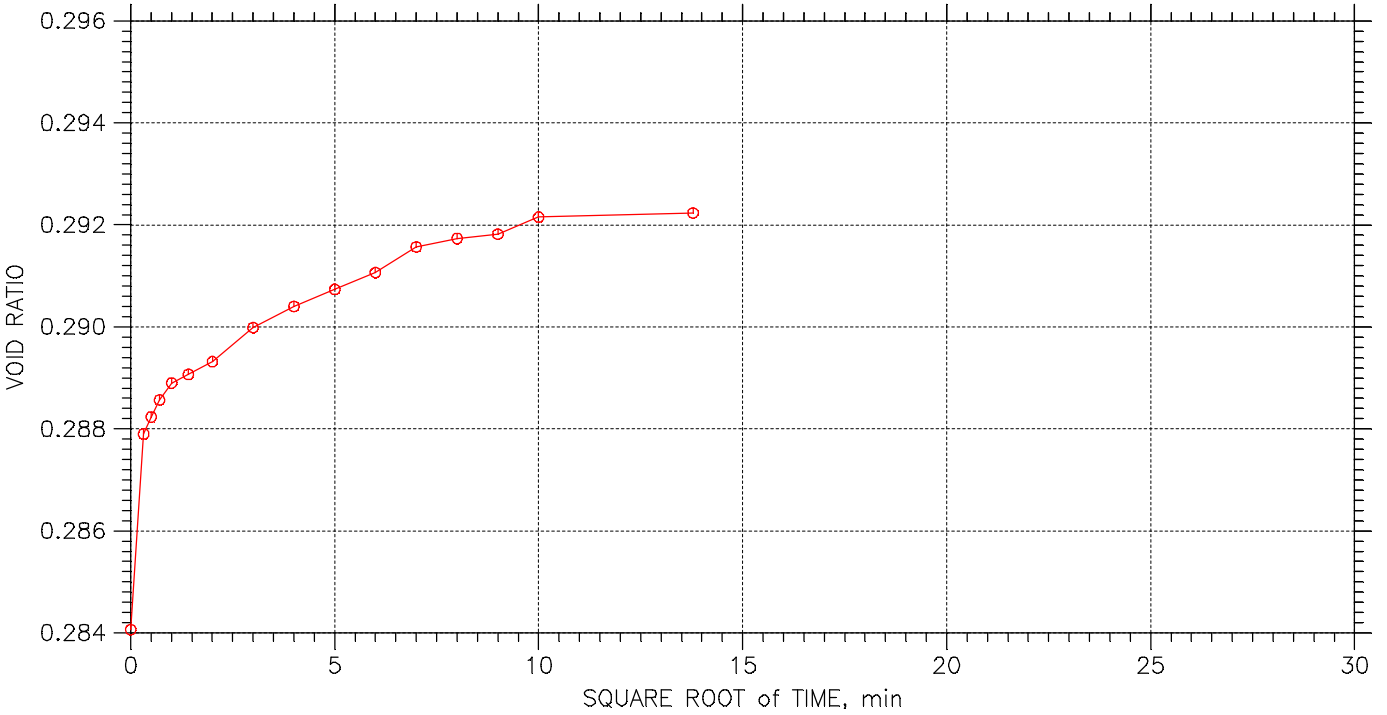
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 9 of 23

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	282		

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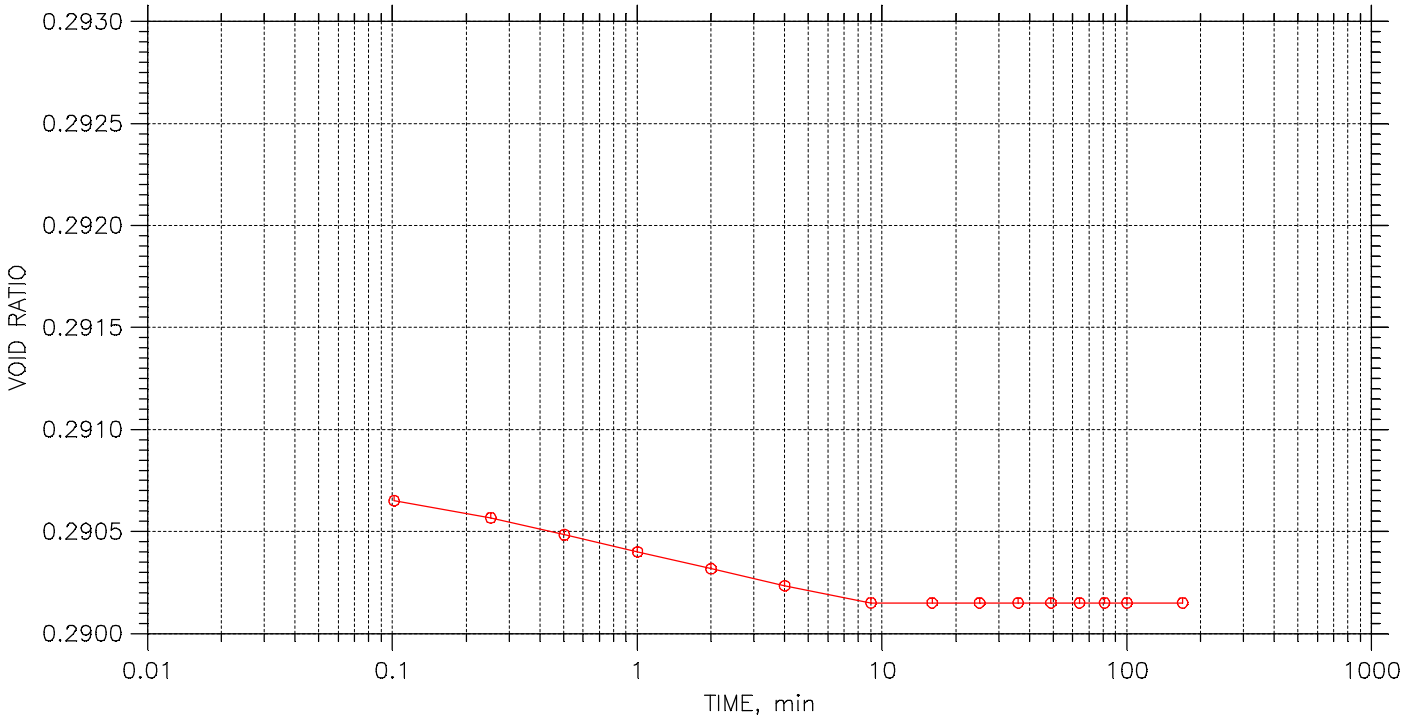
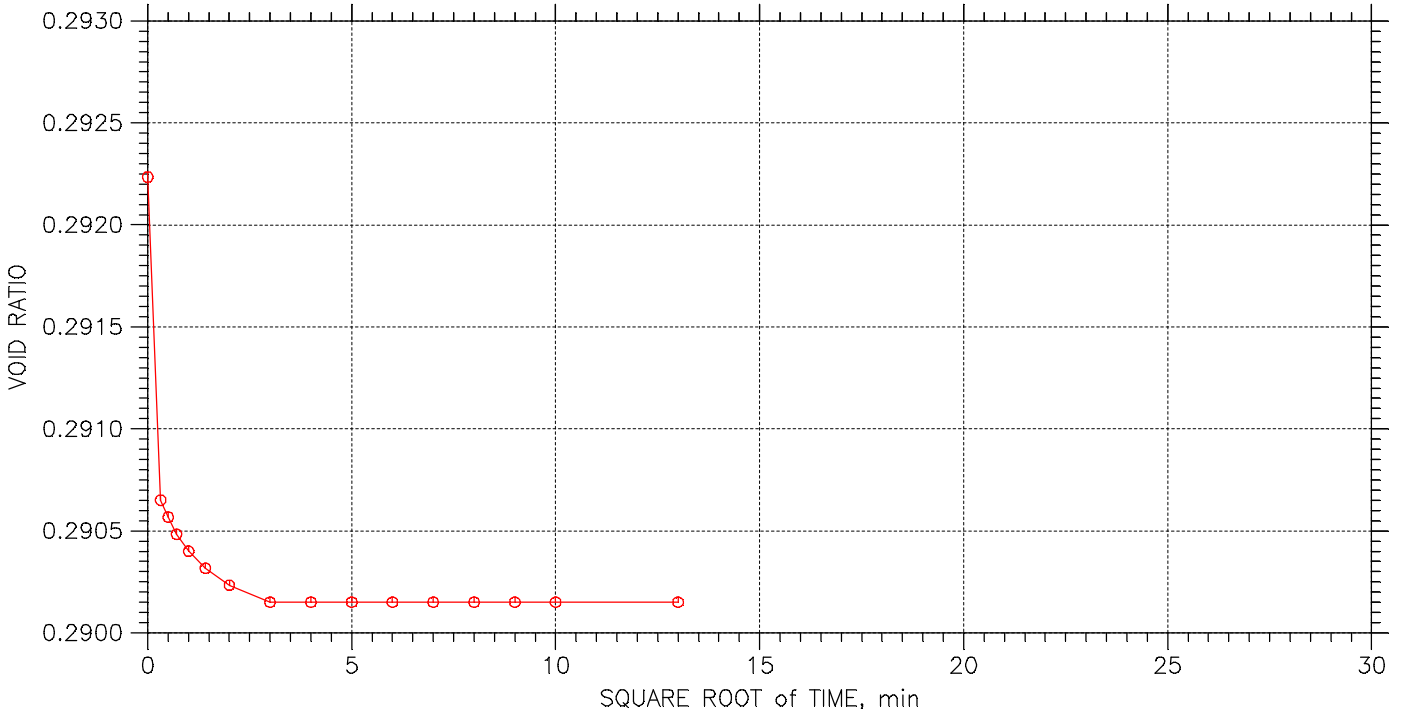
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 23

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	283		

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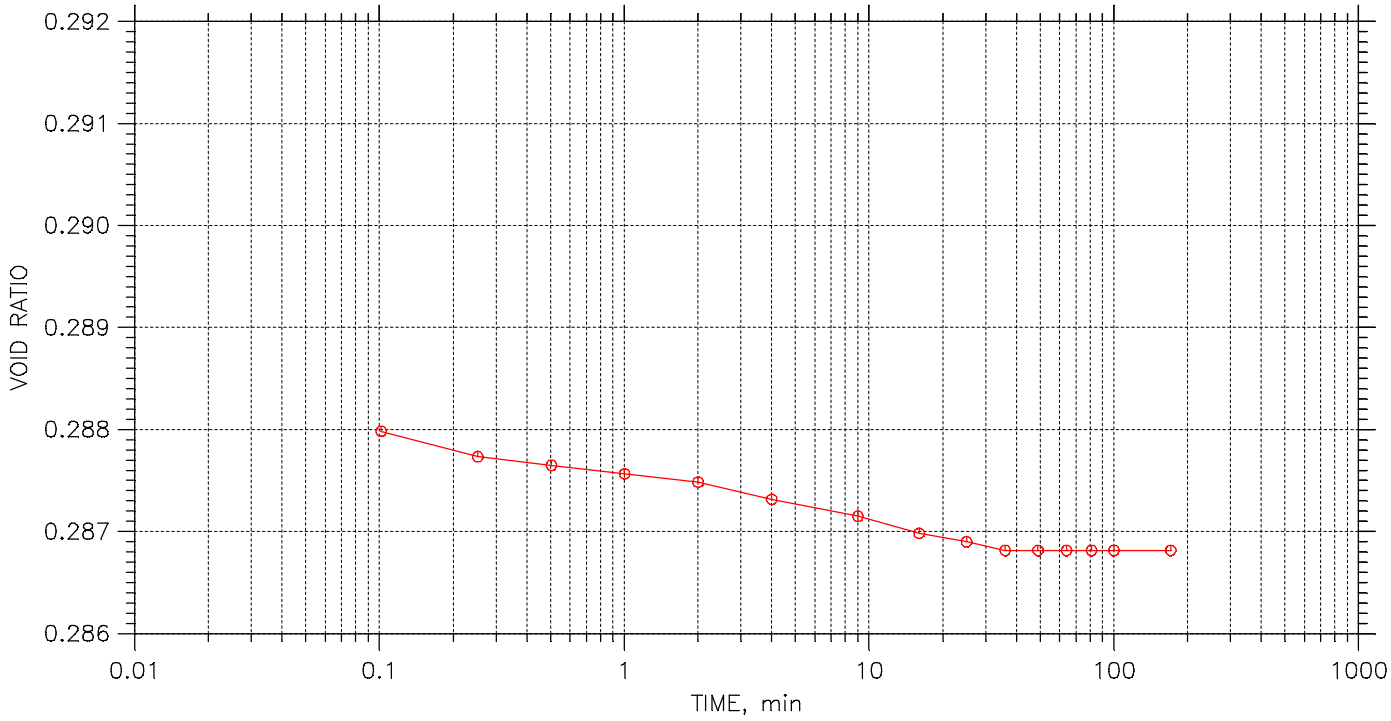
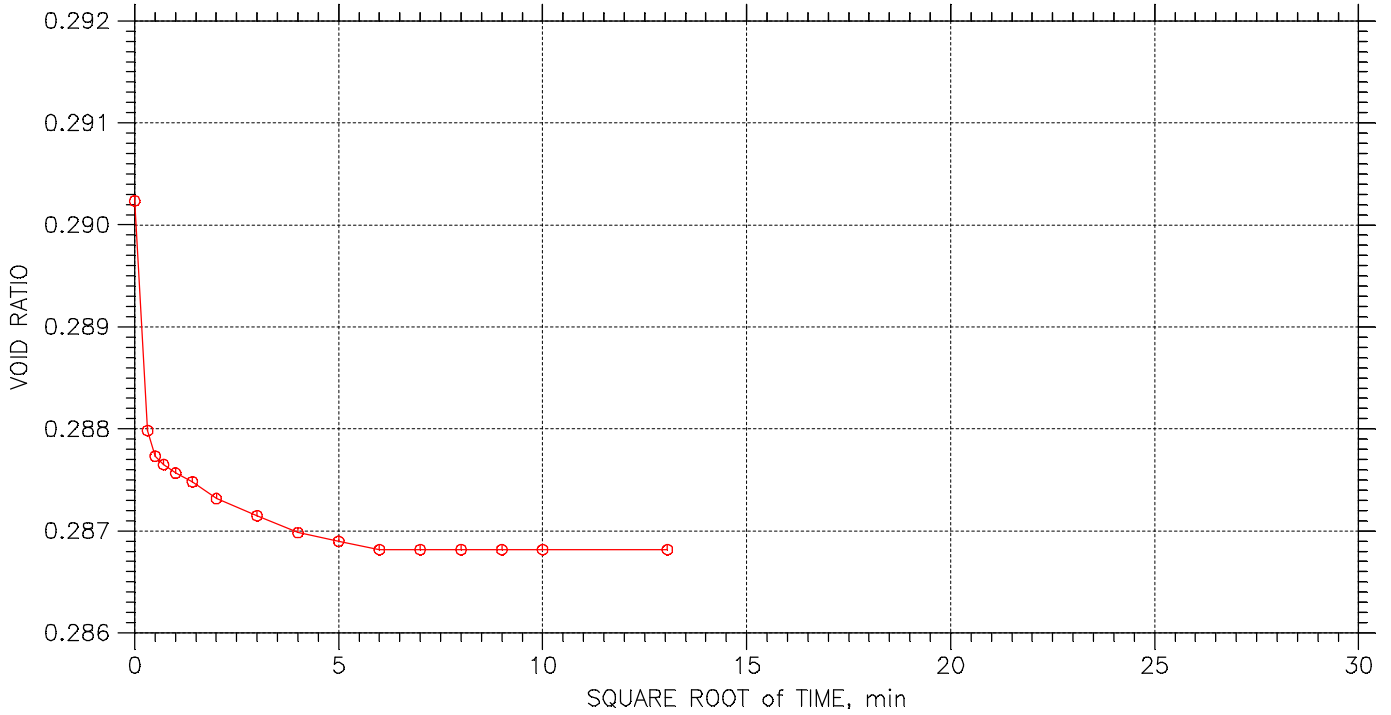
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 11 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	284		

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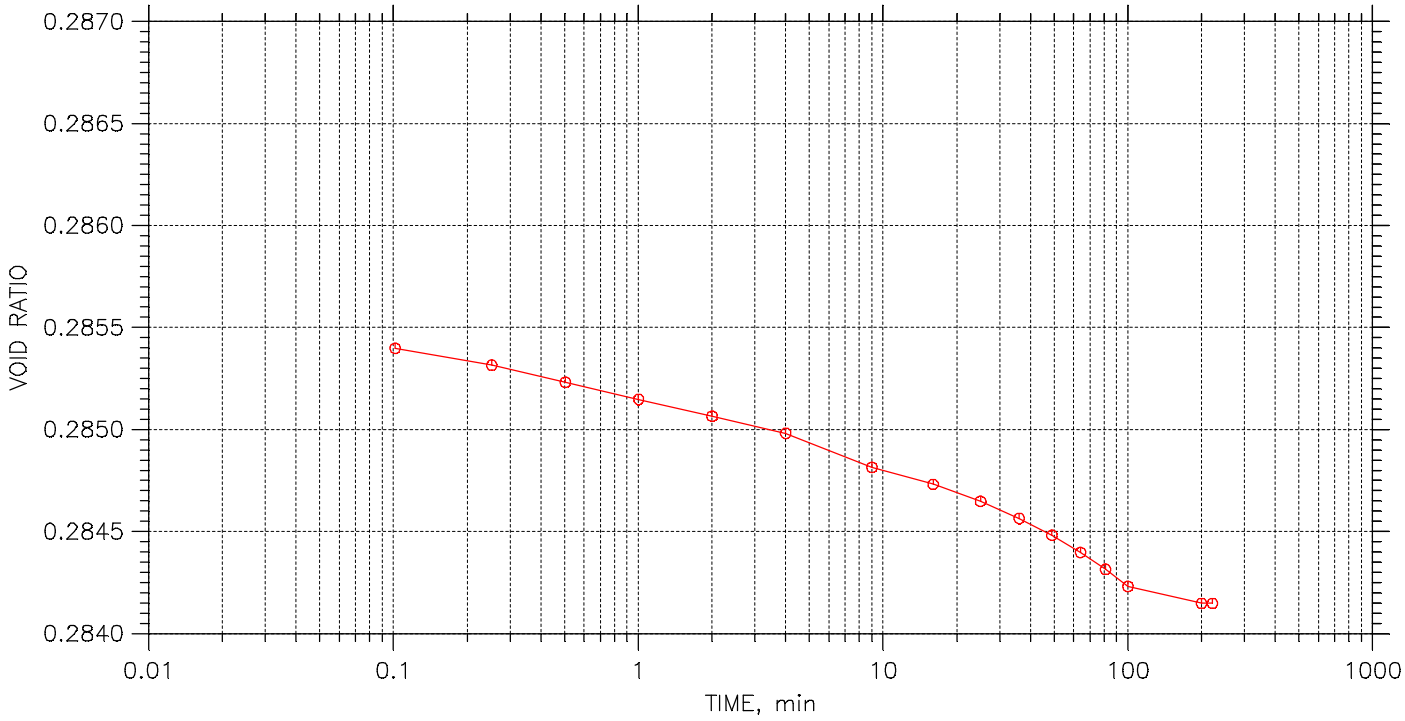
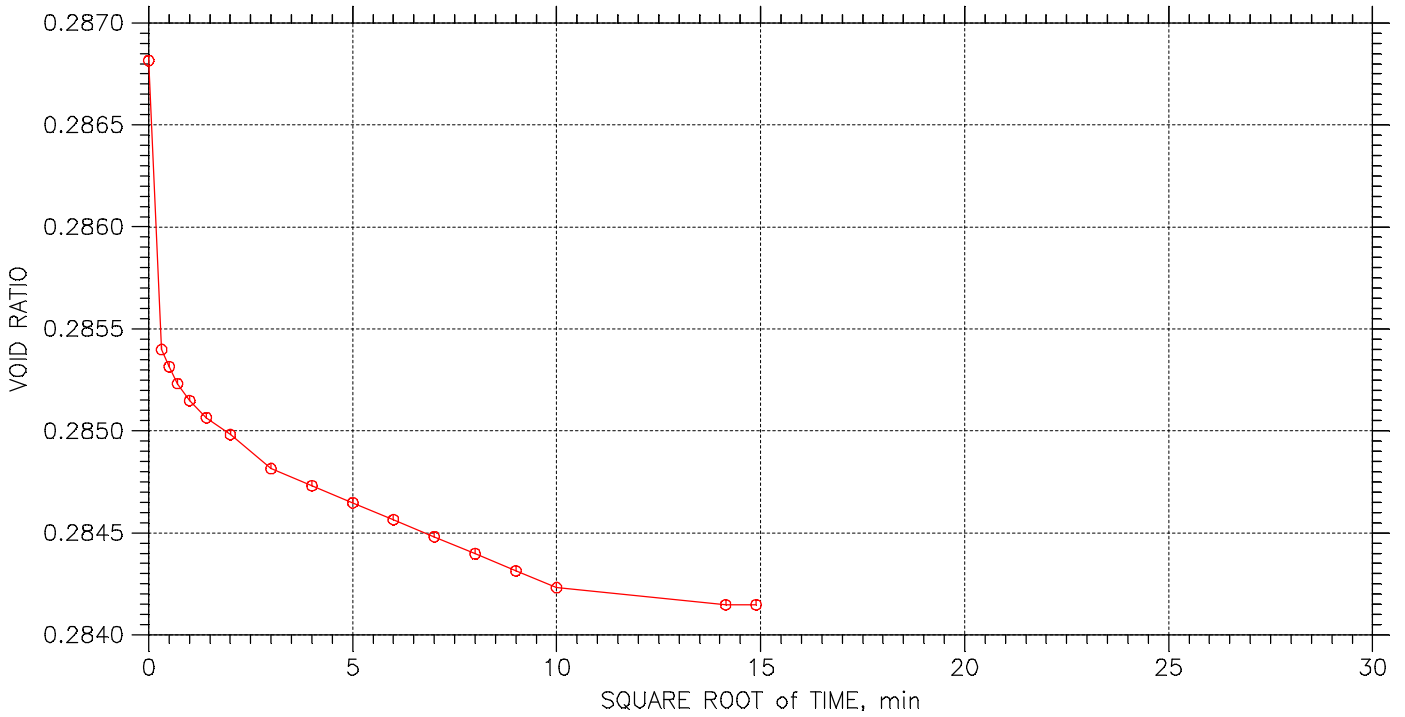
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 23

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	285		

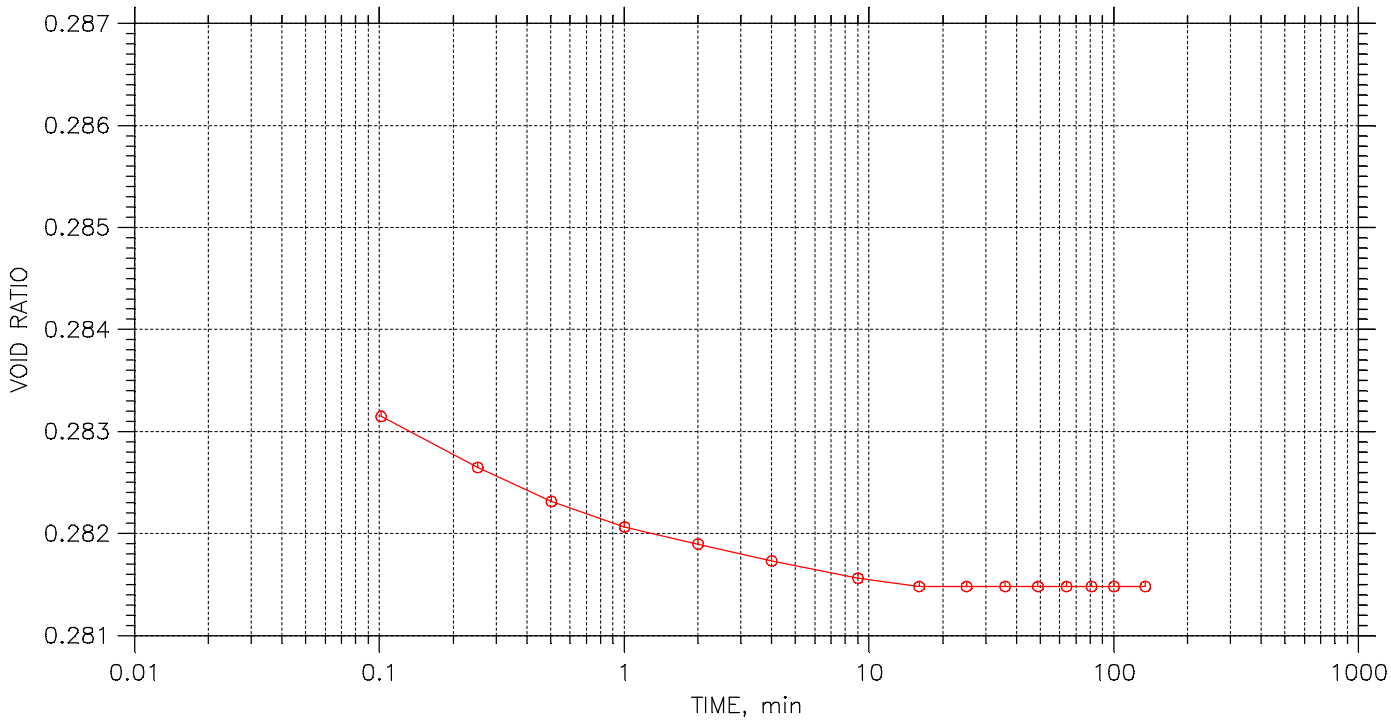
Mon, 21-DEC-2015 16:48:30

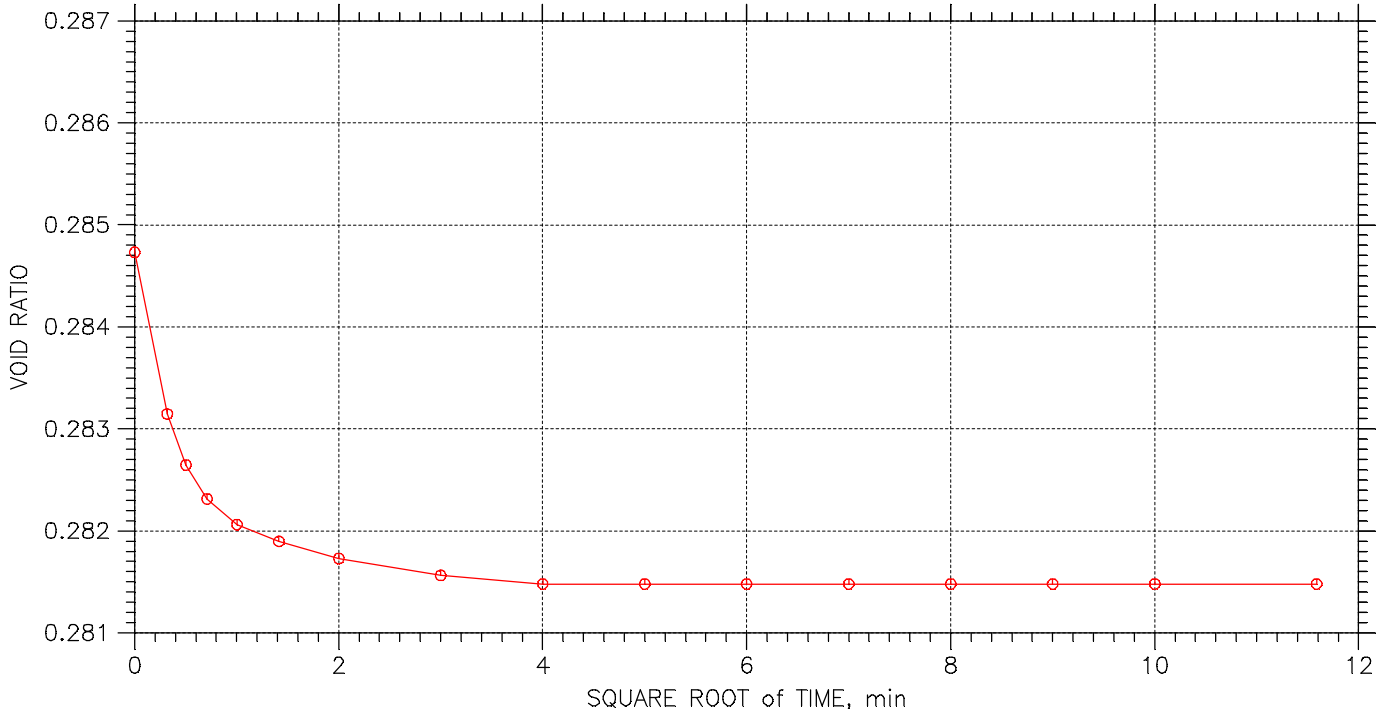
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 13 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	286		

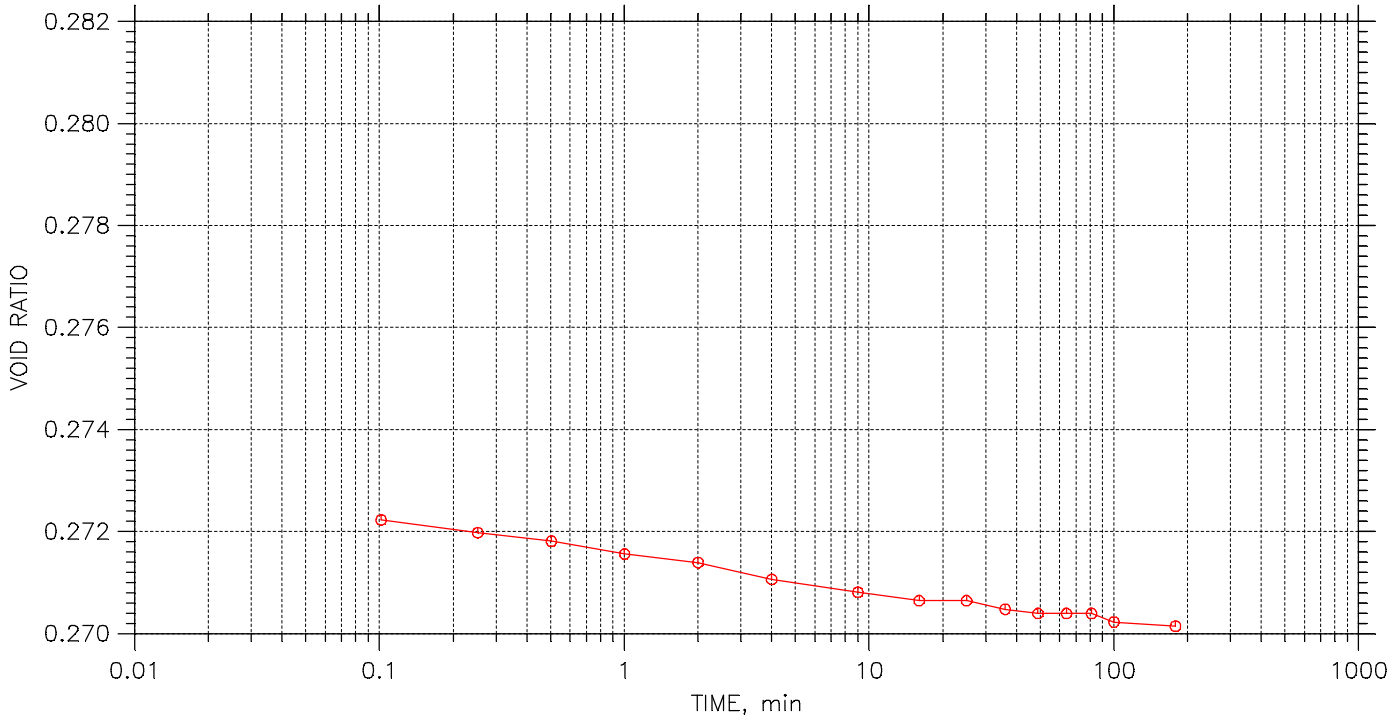
Mon, 21-DEC-2015 16:48:31

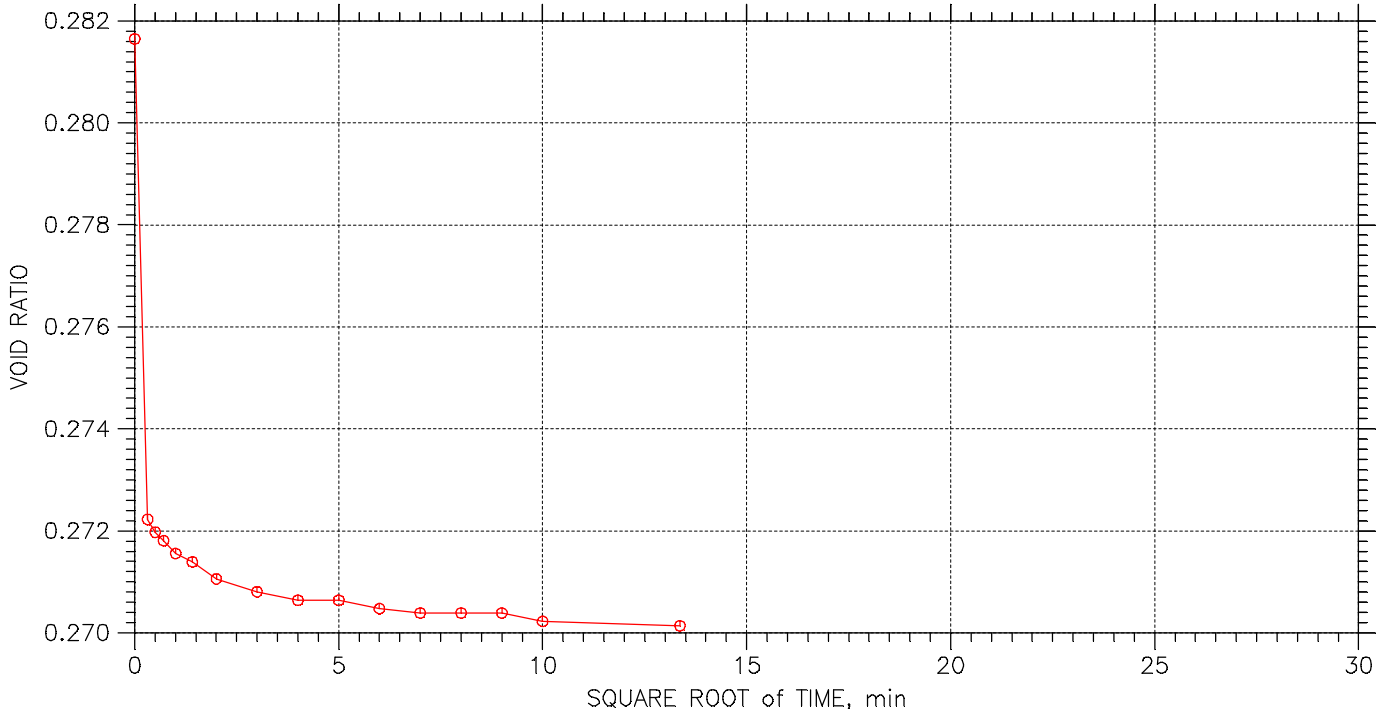
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 14 of 23

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	287		

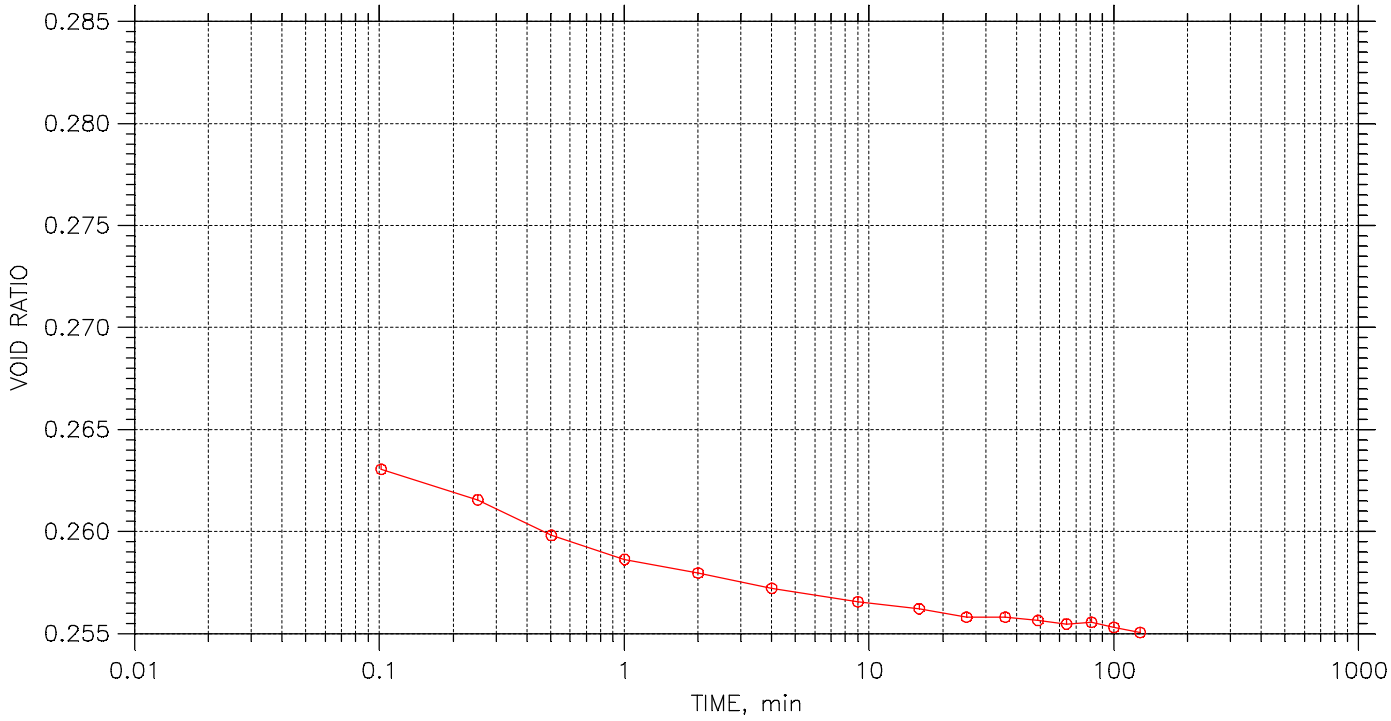
Mon, 21-DEC-2015 16:48:33

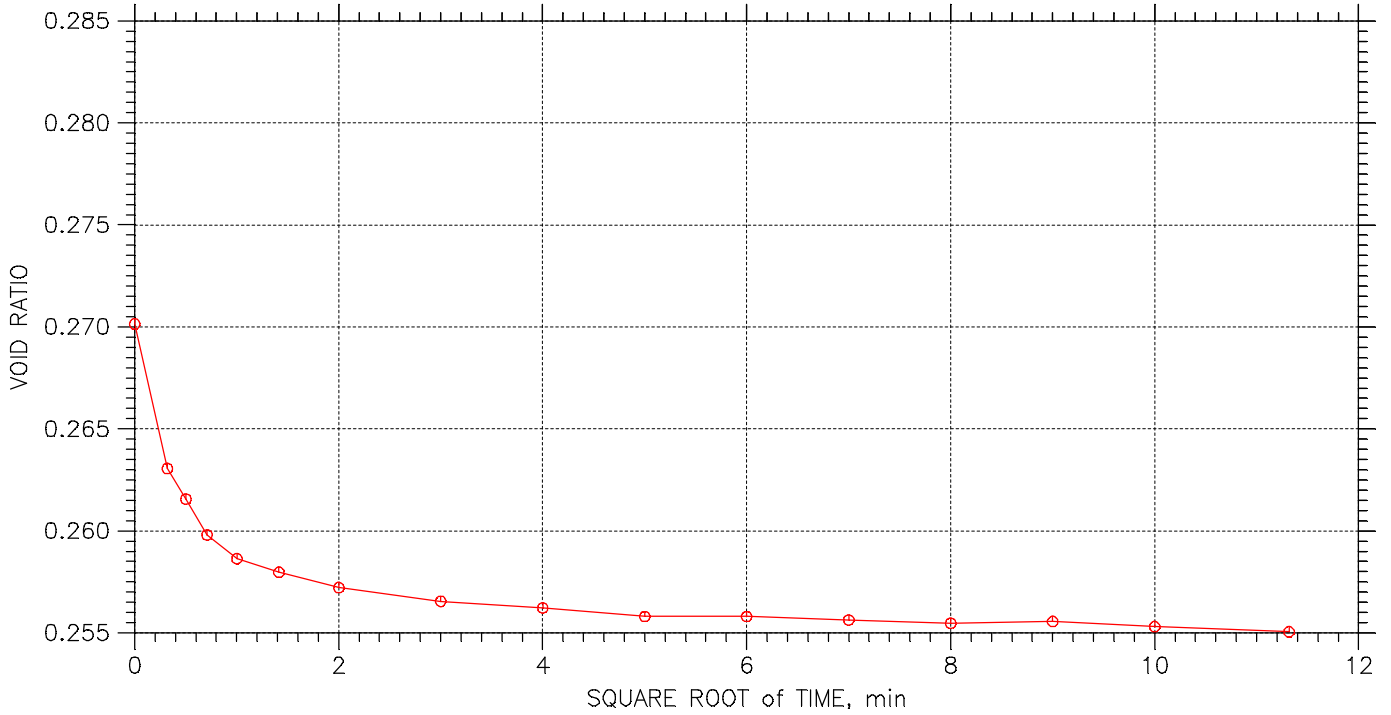
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 15 of 23

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	288		

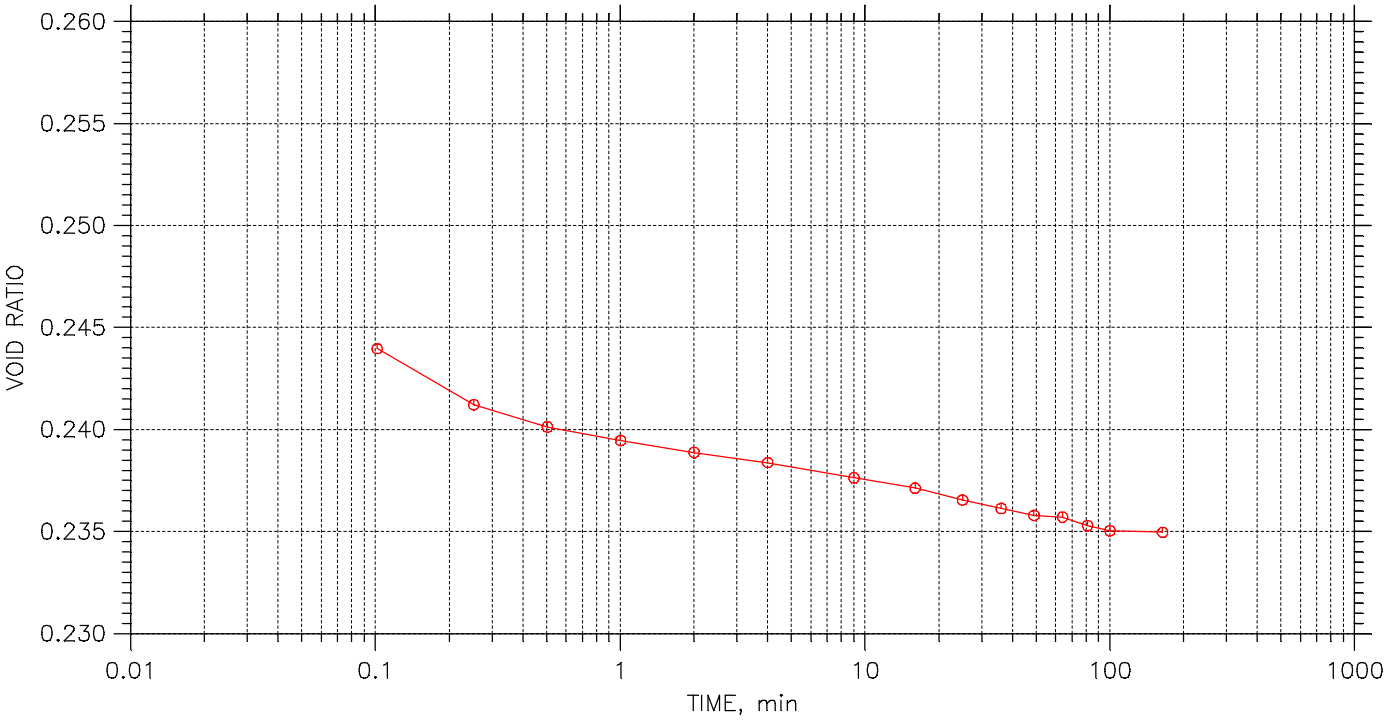
Mon, 21-DEC-2015 16:48:34

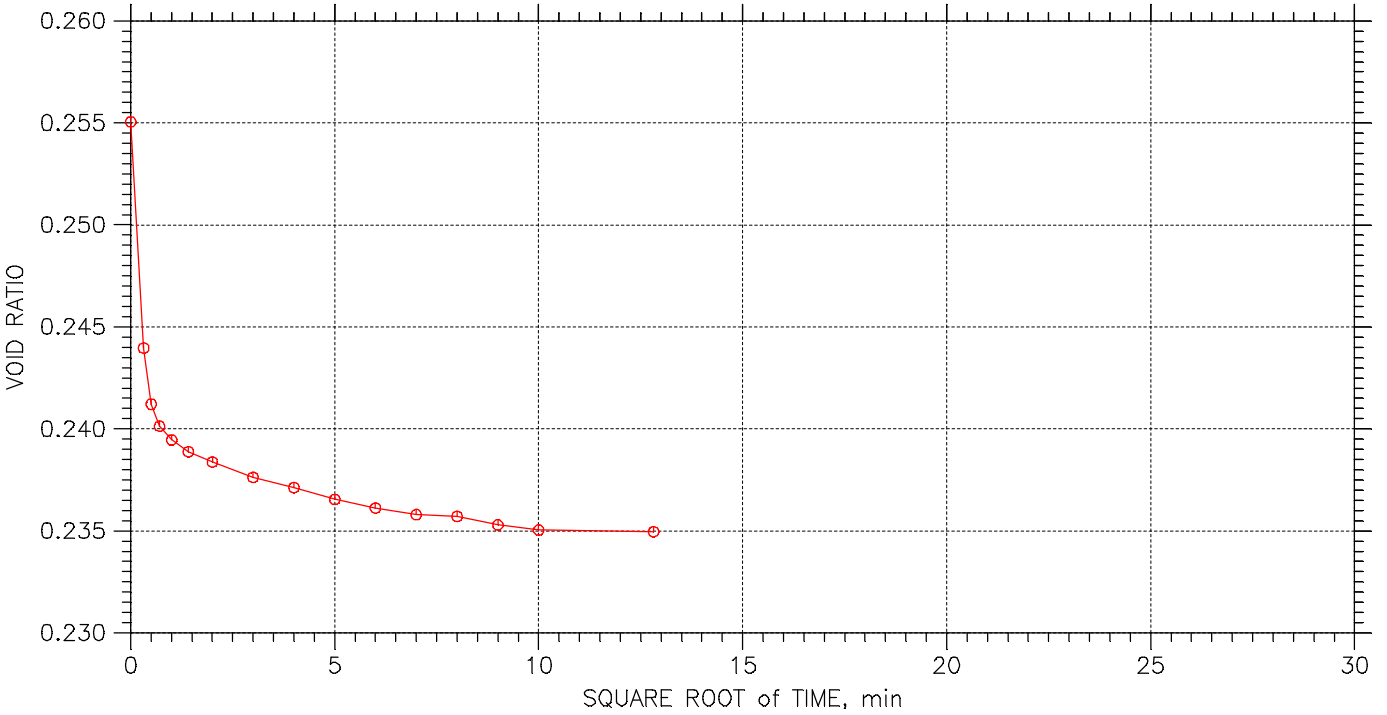
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 16 of 23

Stress: 8. tsf





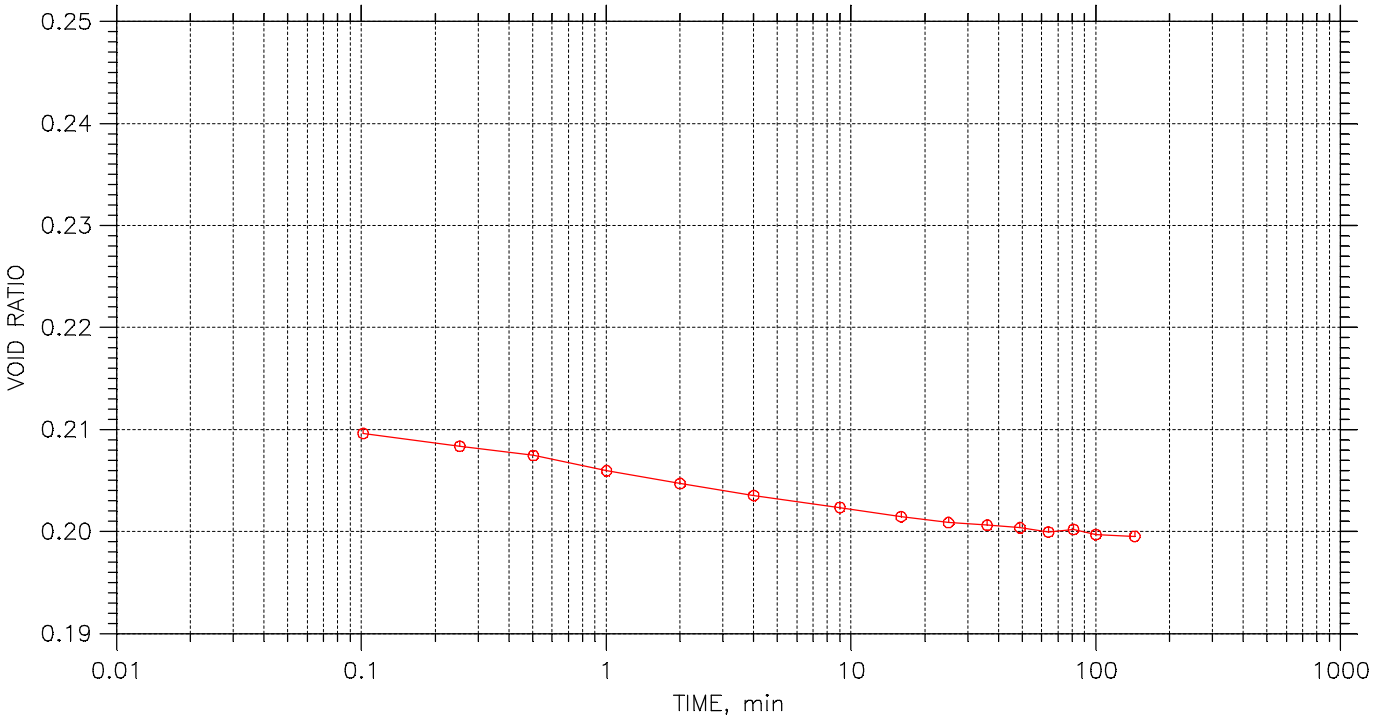
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	289		

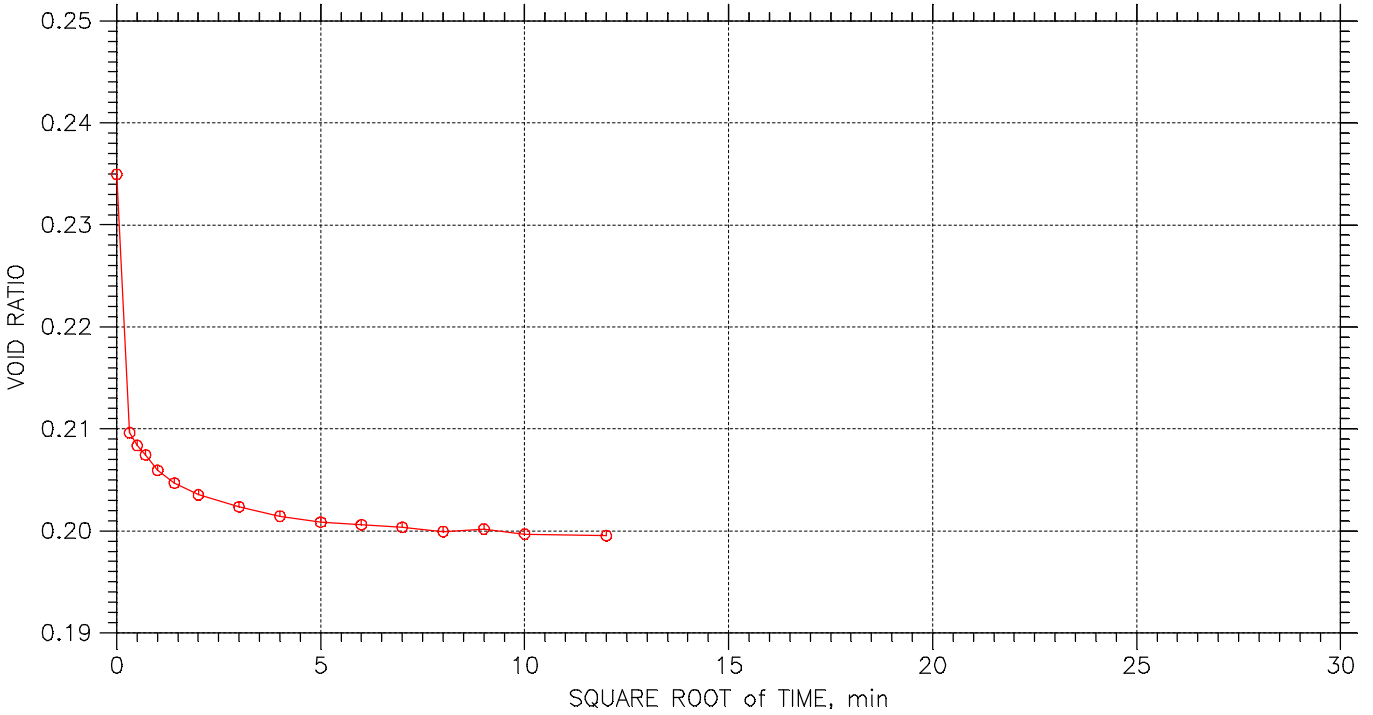
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 23

Stress: 16. tsf





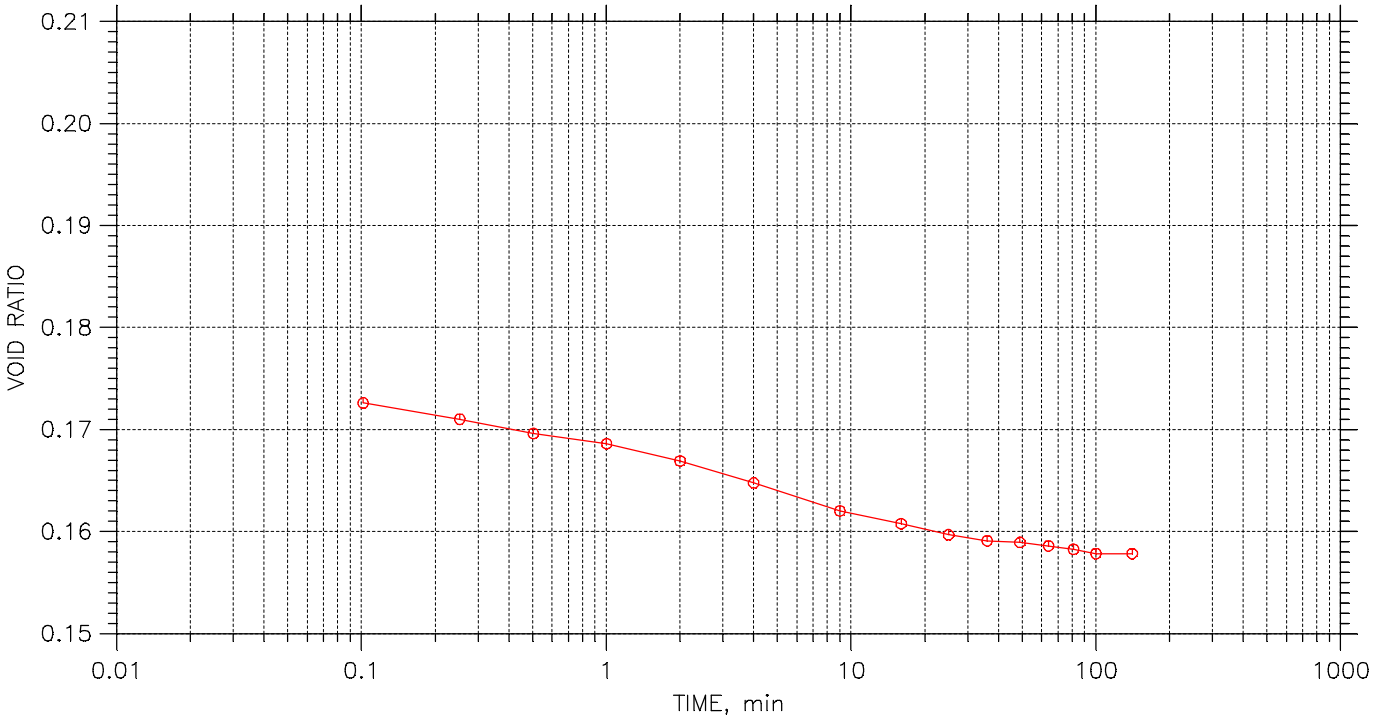
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	290		

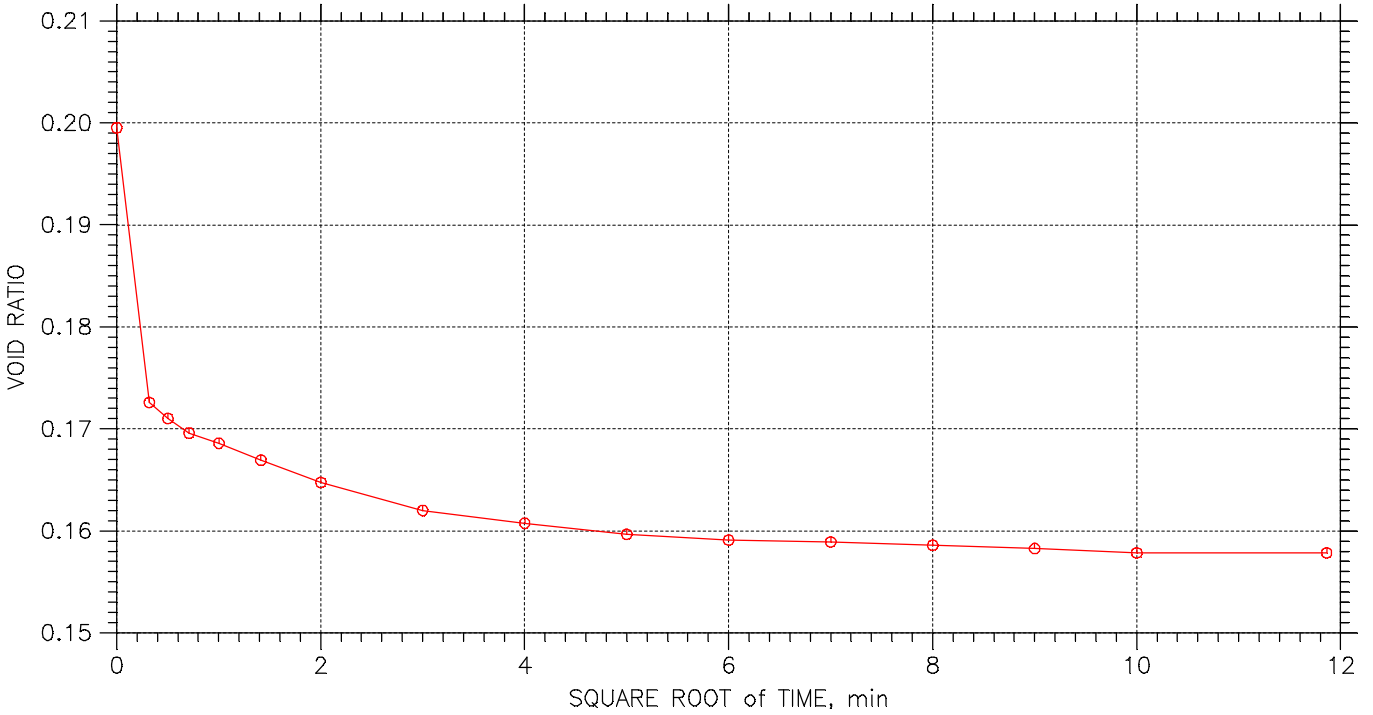
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 18 of 23

Stress: 32. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	291		

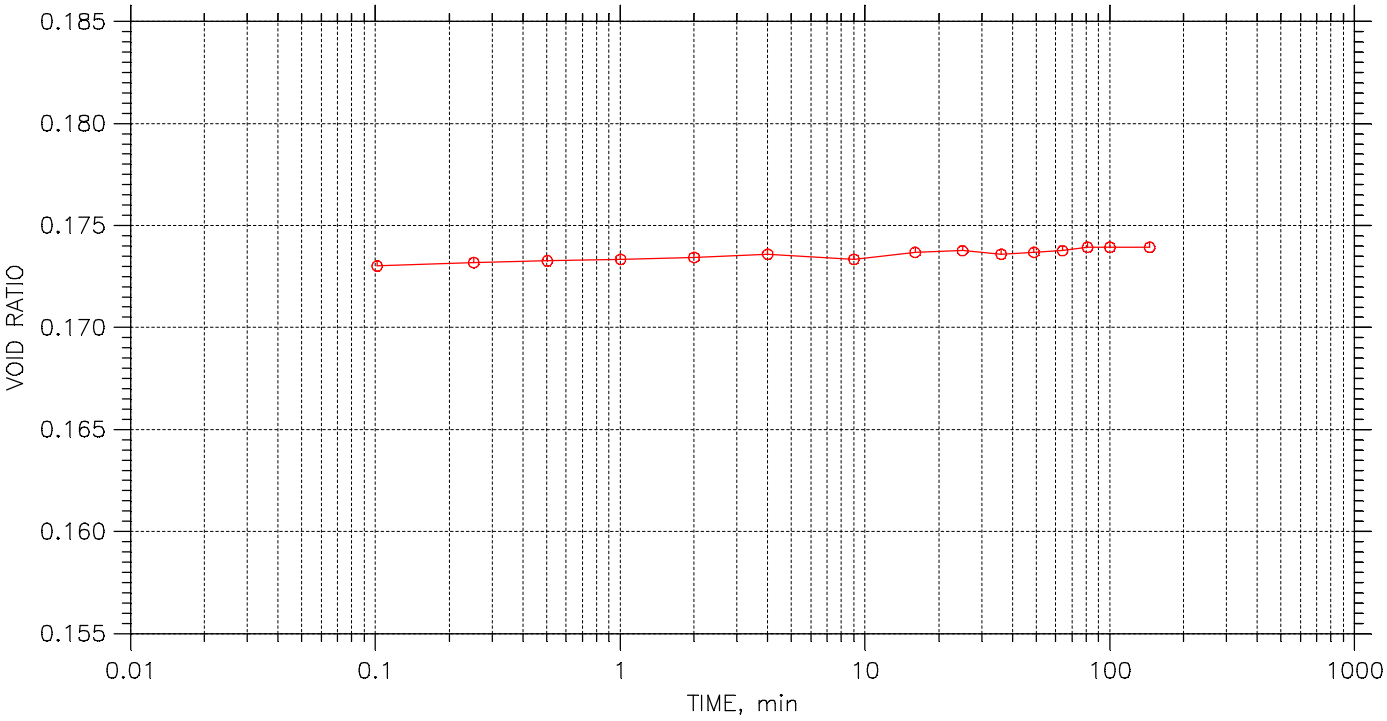
Mon, 21-DEC-2015 16:48:38

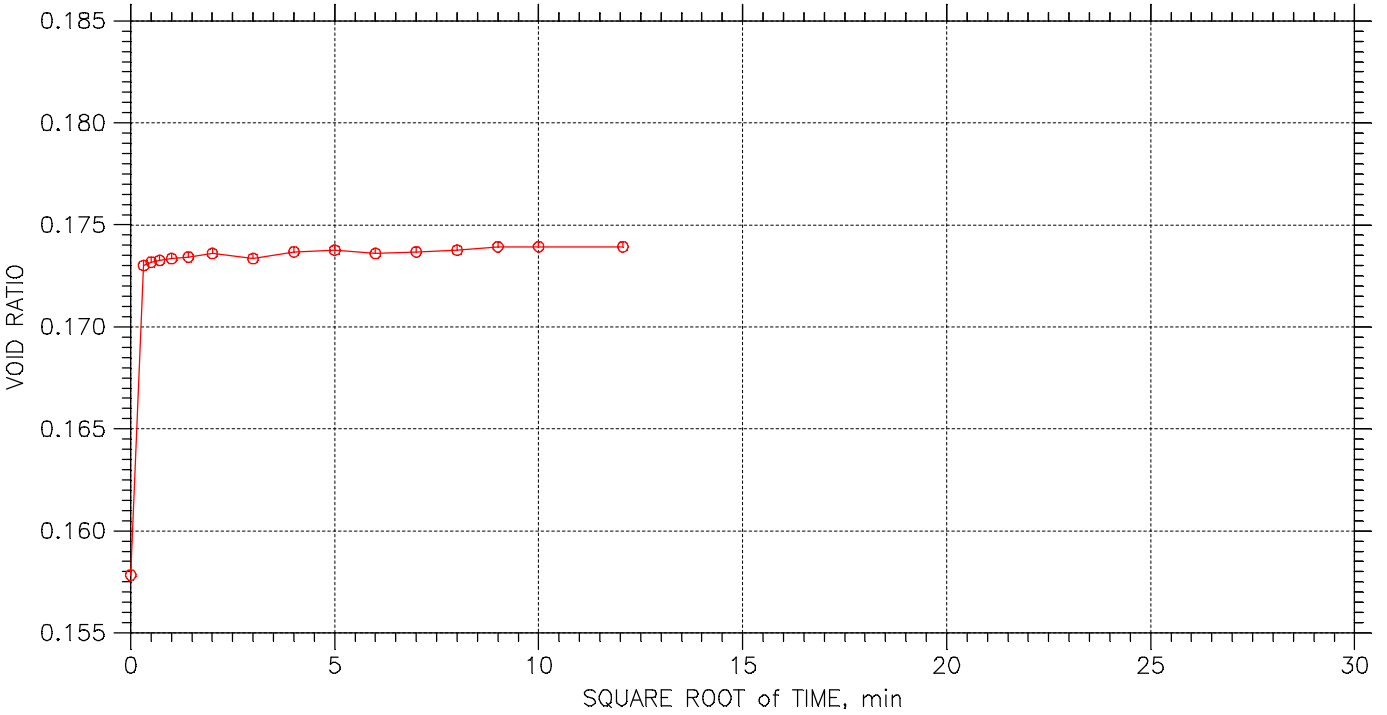
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 19 of 23

Stress: 16. tsf





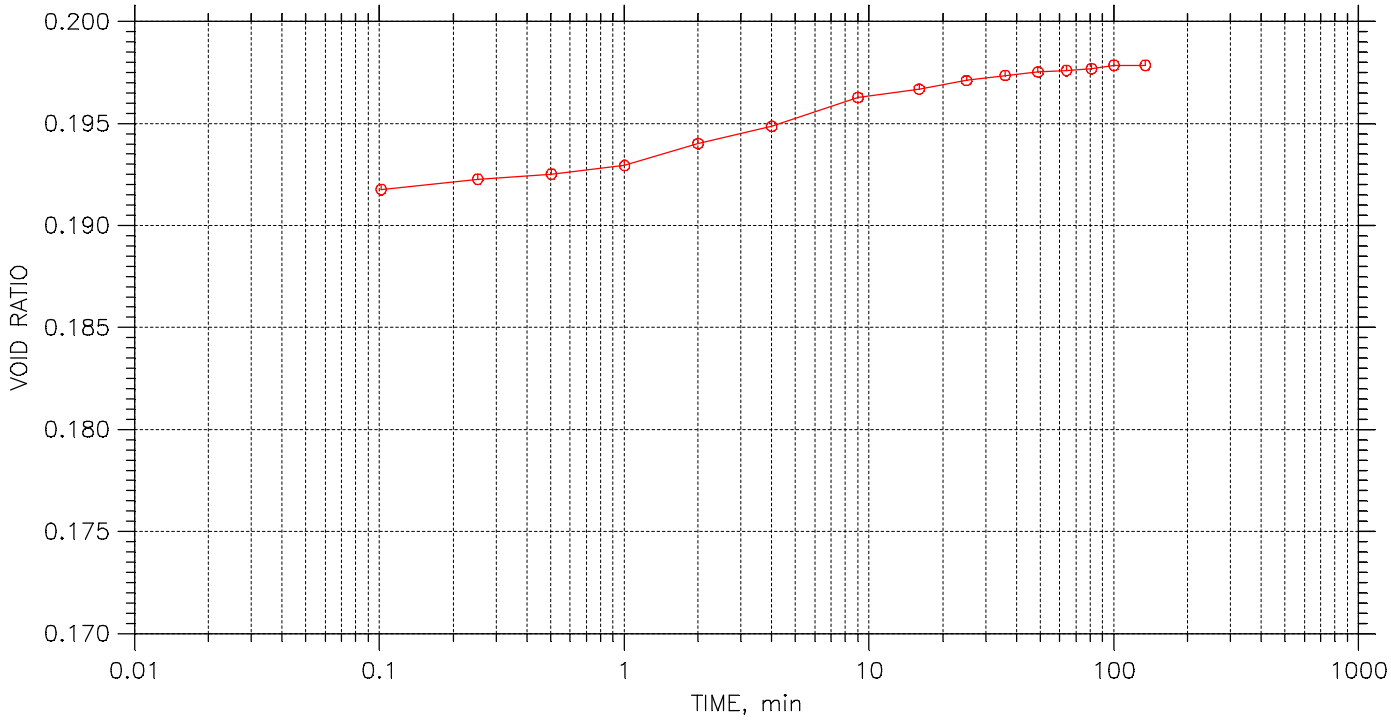
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	292		

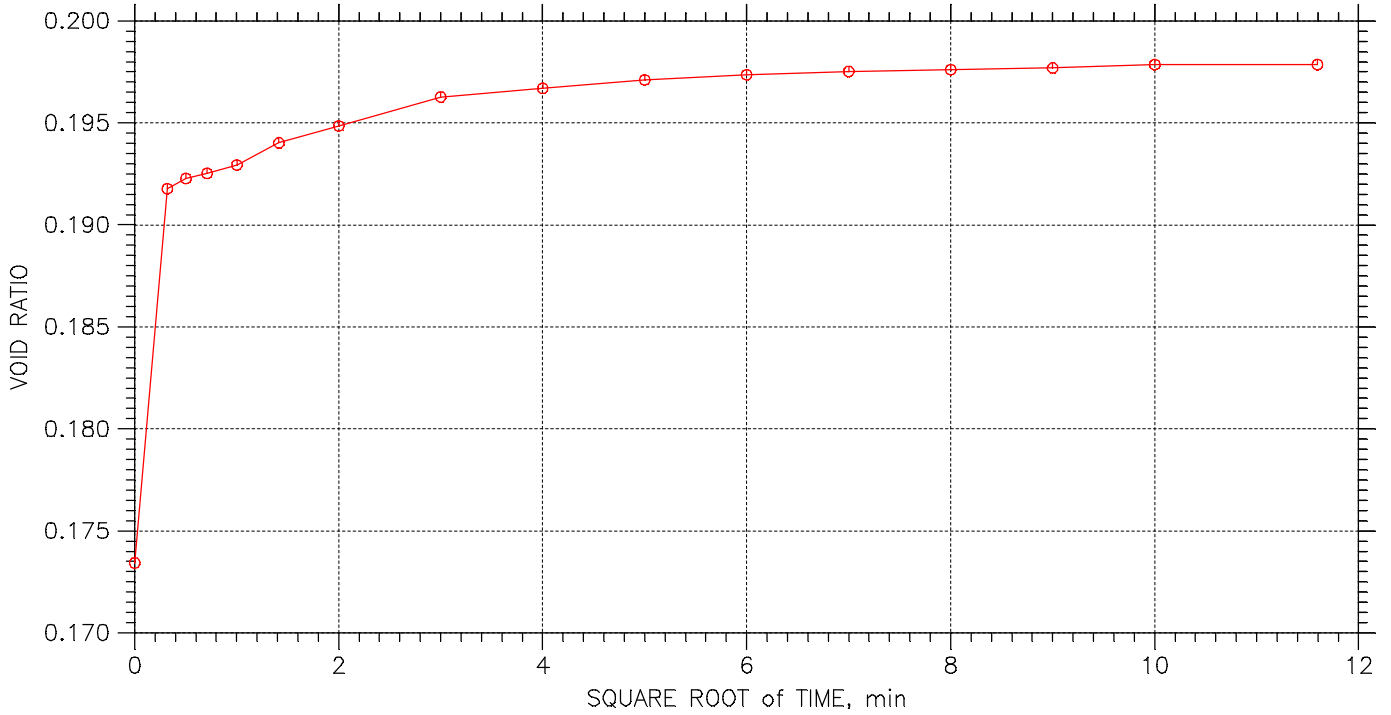
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 20 of 23

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	293		

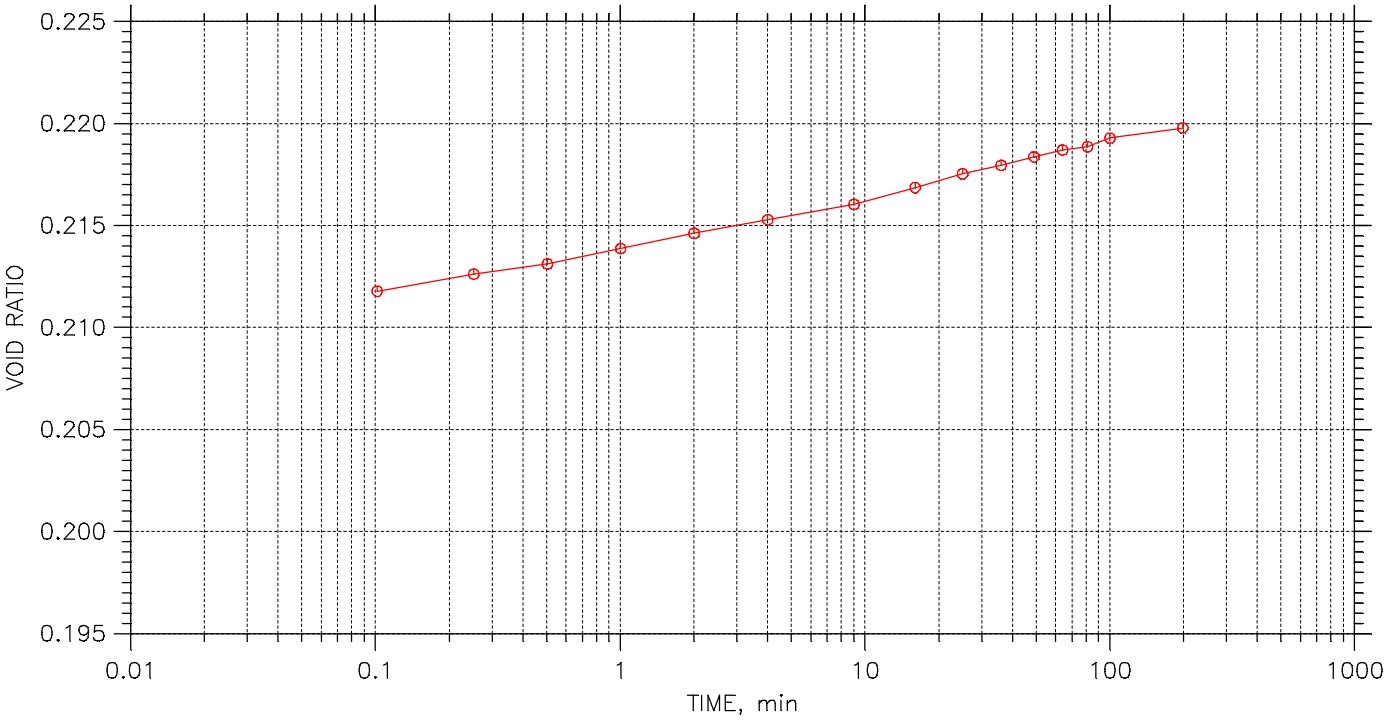
Mon, 21-DEC-2015 16:48:41

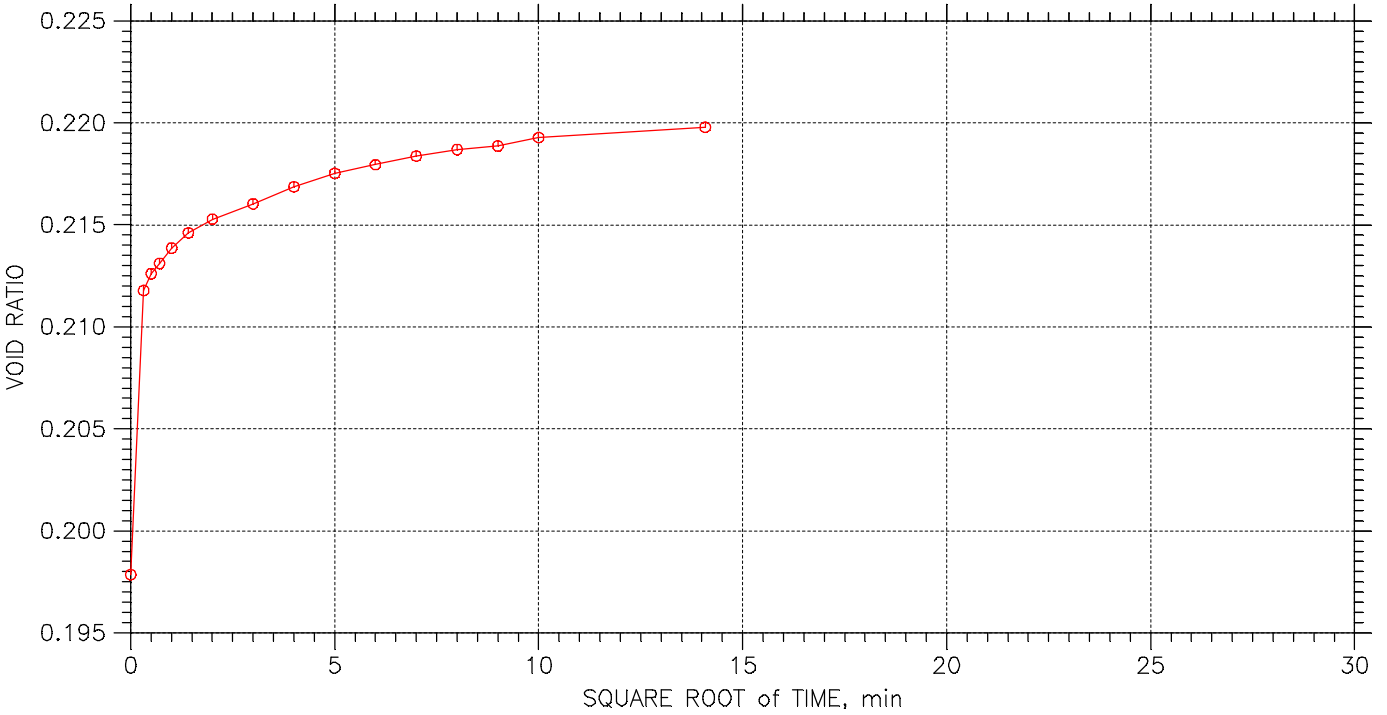
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 21 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	294		

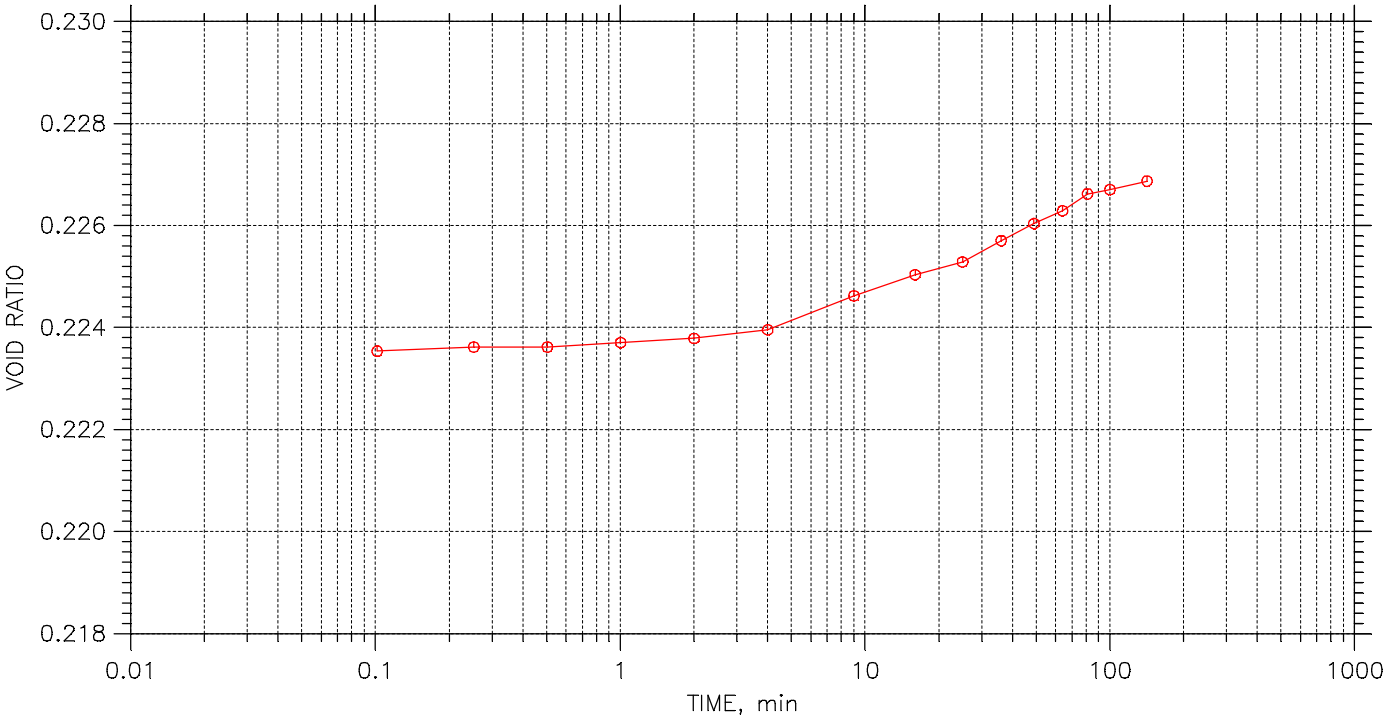
Mon, 21-DEC-2015 16:48:42

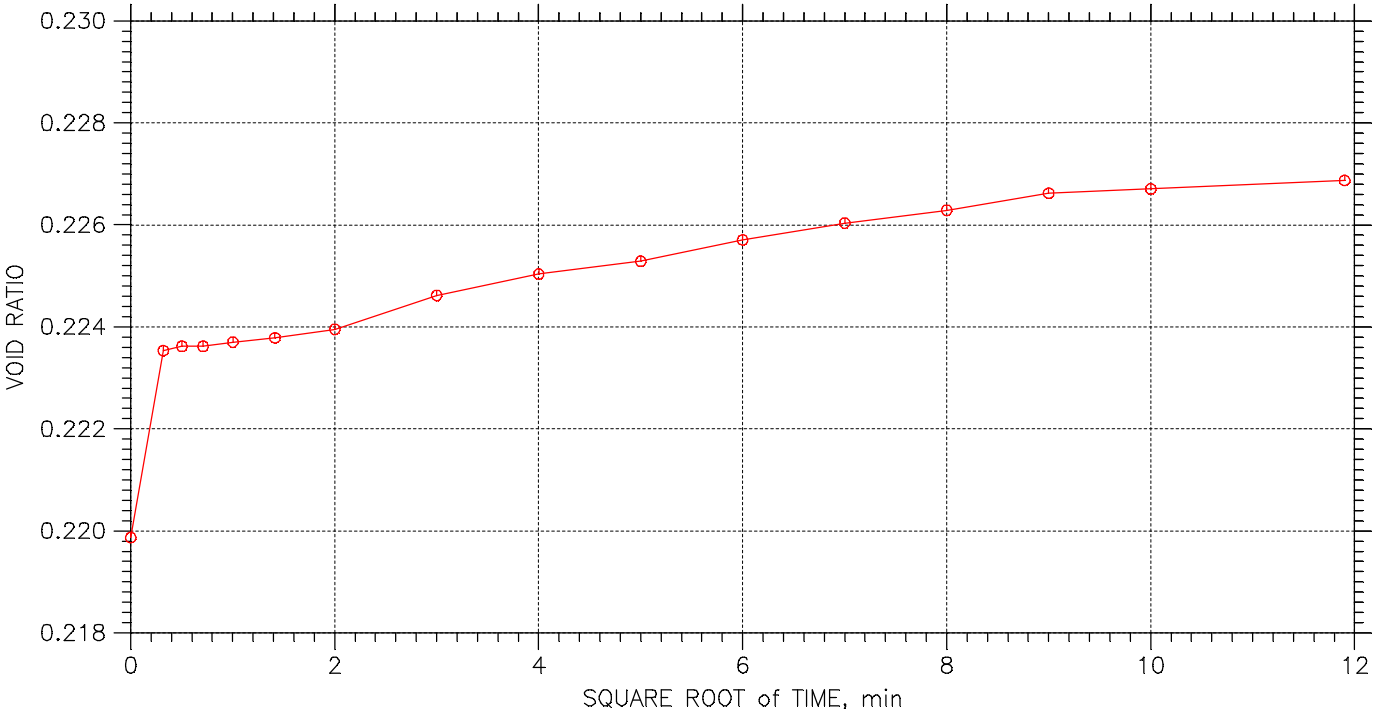
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	295		

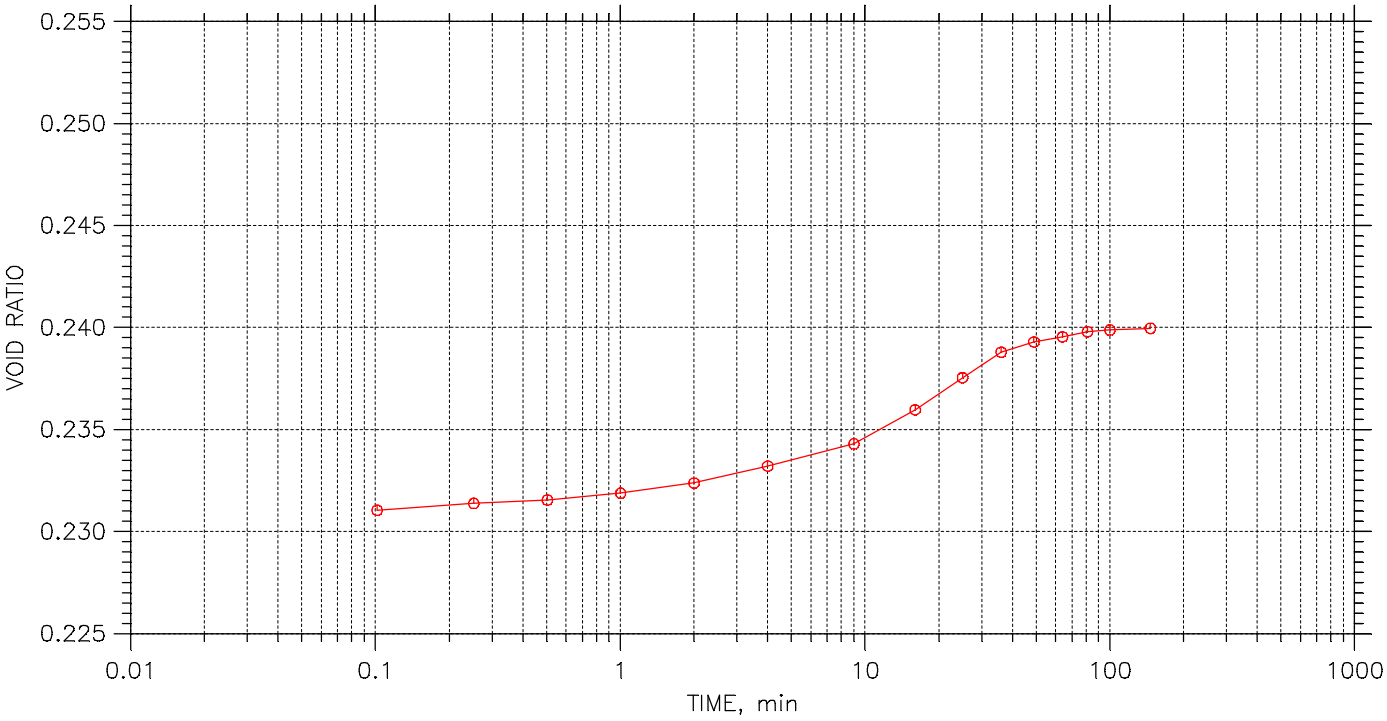
Mon, 21-DEC-2015 16:48:44

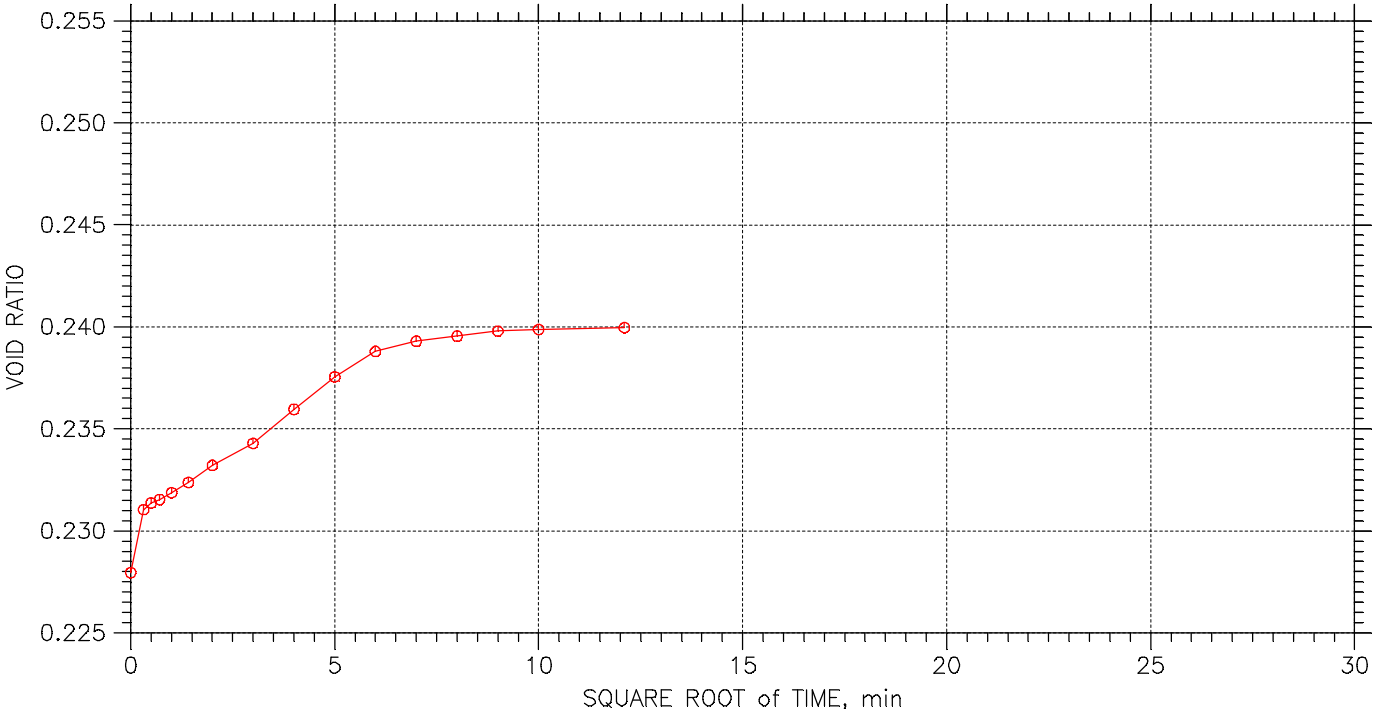
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 23

Stress: 0.125 tsf



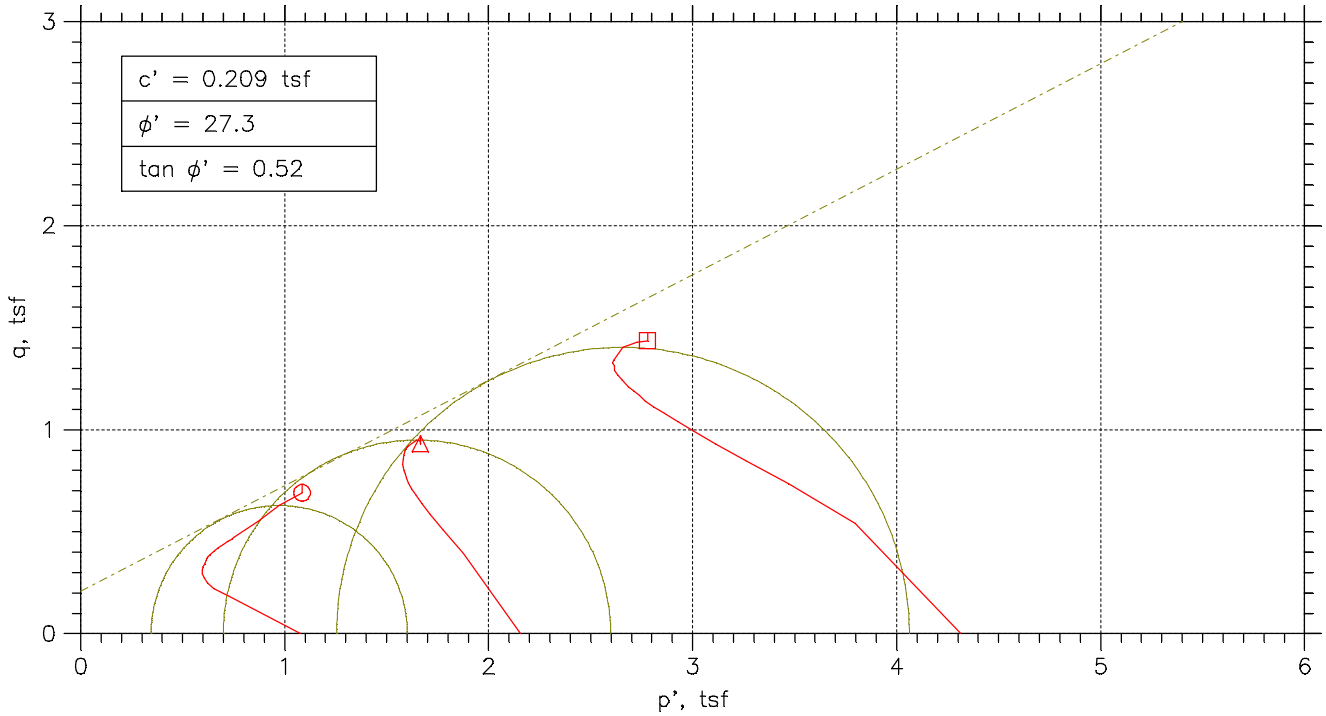


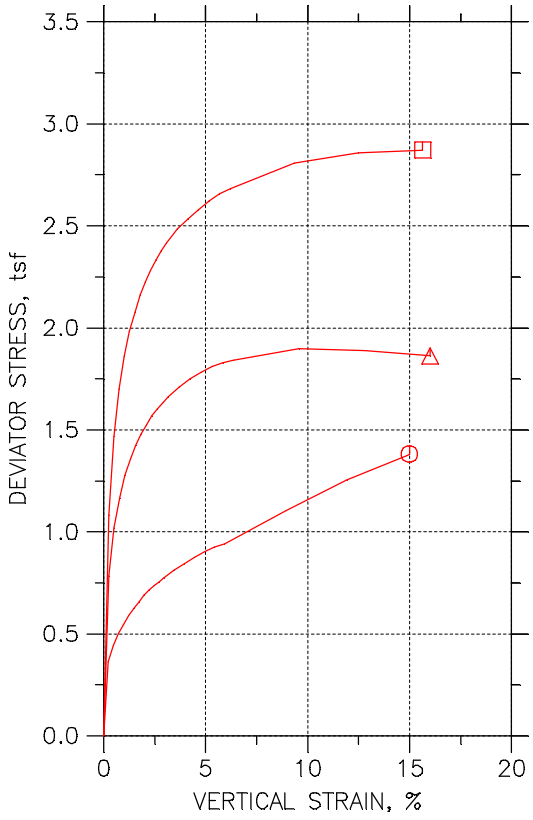
Terracon Consulting Engineers & Scientists	Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		
	296		

Consolidated Undrained Triaxial Compression Tests ASTM D 4767

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

Terracon
Consulting Engineers & Scientists





Symbol		⊙	△	⊡	
Test No.		15.0 PSI	30.0 PSI	60.0 PSI	
Initial	Diameter, in	2.8094	2.7933	2.8169	
	Height, in	5.8933	5.7862	5.9791	
	Water Content, %	18.24	19.46	31.44	
	Dry Density, pcf	113.4	98.63	90.07	
	Saturation, %	99.86	73.35	96.60	
	Void Ratio	0.49693	0.72163	0.88521	
Before Shear	Water Content, %	17.26	23.33	24.34	
	Dry Density, pcf	115.6	103.9	102.2	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.46942	0.63453	0.66201	
	Back Press., tsf	5.0445	5.0434	5.0461	
Minor Prin. Stress, tsf		1.0755	2.1566	4.3139	
Max. Dev. Stress, tsf		1.3812	1.8986	2.8714	
Time to Failure, min		302.24	180	300	
Strain Rate, %/min		0.02	0.02	0.02	
B-Value		0.99	0.97	0.97	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		41	41	41	
Plastic Limit		23	23	23	
Plasticity Index		18	18	18	

Project: DYNERGY HENNEPIN

Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HEN-002 S8

Sample Type: 3.0" ST

Failure Sketch

NOTE: SAMPLE TRANSITIONS INTO FLY ASH

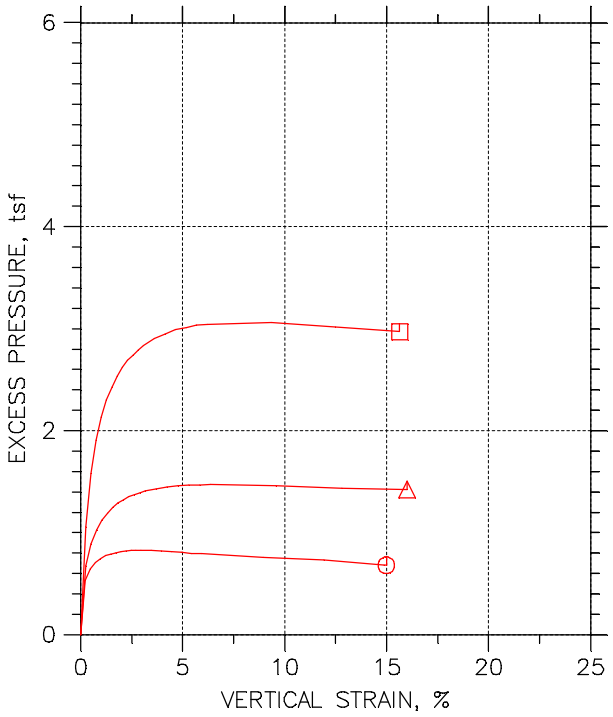
Description: DARK GRAY LEAN CLAY WITH SAND AND GRAVEL CL - FLY ASH NOTED

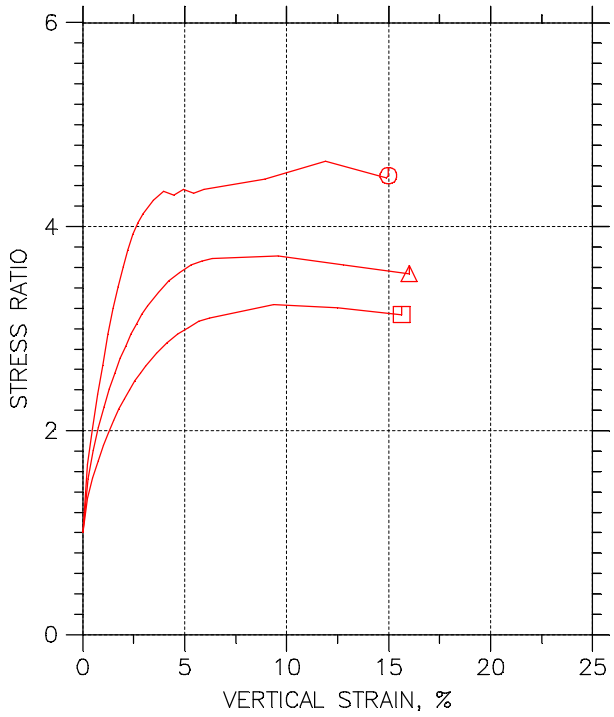
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

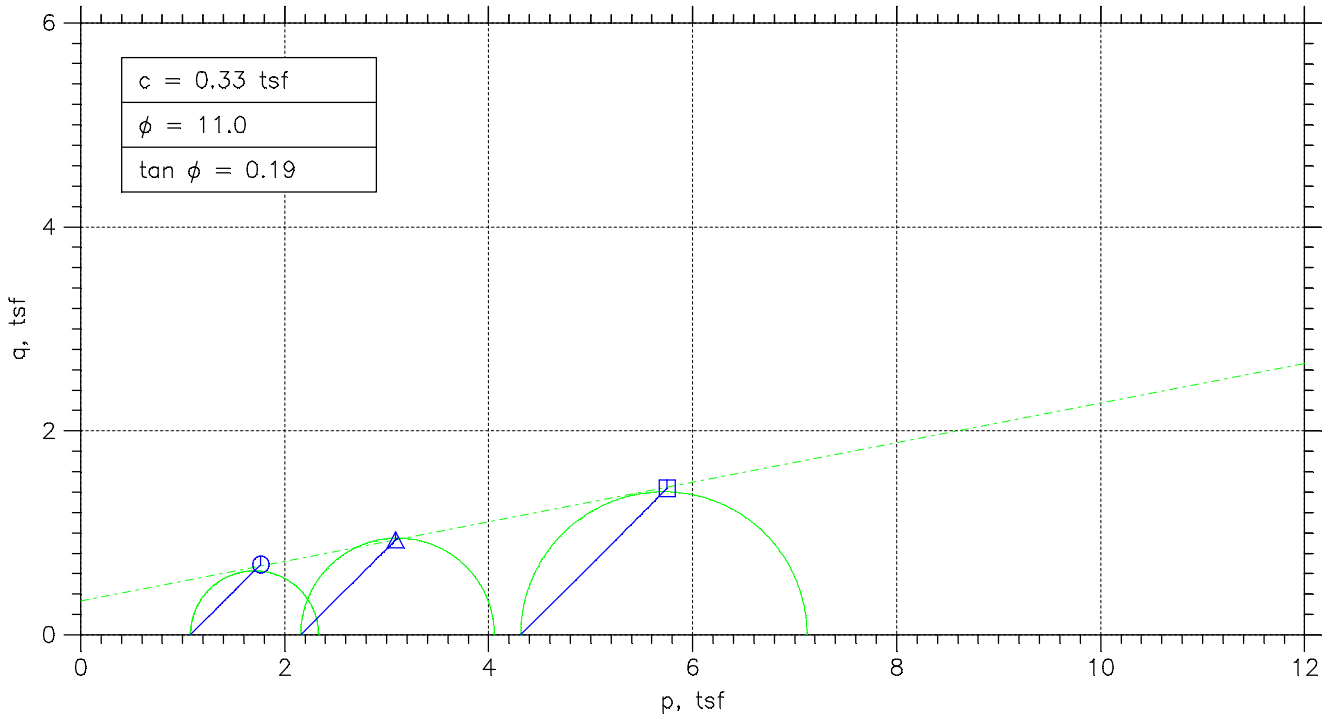
Tue, 22-DEC-2015 09:43:10

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

Terracon
Consulting Engineers & Scientists







Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-002 S8	Tested By: BCM	Checked By: WPQ
Sample No.: S-8	Test Date: 12/16/15	Depth: 25.0'-27.0'
Test No.: HEN-002 S8	Sample Type: 3.0" ST	Elevation: -----
Description: DARK GRAY LEAN CLAY WITH SAND AND GRAVEL CL - FLY ASH NOTED		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767		
299		

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-002 S8
Sample No.: S-8
Test No.: 15.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: -----

Terracon
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Soil Description: DARK GRAY LEAN CLAY WITH SAND AND GRAVEL CL - FLY ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 5.89 in
Specimen Area: 6.20 in^2
Specimen Volume: 36.53 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41
Plastic Limit: 23
Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.1991	0	0	5.0445	6.12	6.12
2	5.0042	0.23264	6.2136	31.483	0.36481	5.574	6.12	6.4848
3	10	0.47992	6.229	38.274	0.4424	5.6893	6.12	6.5624
4	15	0.72426	6.2444	43.434	0.50081	5.7504	6.12	6.6208
5	20	0.973	6.2601	47.488	0.54618	5.787	6.12	6.6662
6	25	1.2247	6.276	51.331	0.58888	5.8179	6.12	6.7089
7	30	1.4763	6.292	54.49	0.62353	5.8365	6.12	6.7435
8	35	1.7265	6.3081	57.333	0.65439	5.8487	6.12	6.7744
9	40	1.9782	6.3243	60.544	0.68928	5.8557	6.12	6.8093
10	45	2.224	6.3402	62.966	0.71505	5.8621	6.12	6.8351
11	50	2.4683	6.356	65.019	0.73652	5.8685	6.12	6.8565
12	55	2.7112	6.3719	66.651	0.75313	5.872	6.12	6.8731
13	60	2.9556	6.388	68.704	0.77438	5.8726	6.12	6.8944
14	70	3.4516	6.4208	72.39	0.81175	5.8708	6.12	6.9317
15	80	3.9564	6.4545	75.759	0.84509	5.8673	6.12	6.9651
16	90	4.4568	6.4883	78.76	0.87399	5.8557	6.12	6.994
17	100	4.9455	6.5217	81.866	0.90381	5.8516	6.12	7.0238
18	110	5.4371	6.5556	84.183	0.92458	5.8423	6.12	7.0446
19	120	5.9375	6.5905	86.288	0.94269	5.84	6.12	7.0627
20	180	8.9296	6.807	104.29	1.1032	5.8016	6.12	7.2232
21	240	11.909	7.0372	122.77	1.2561	5.7748	6.12	7.3761
22	300	14.874	7.2824	138.94	1.3736	5.7248	6.12	7.4936
23	302.24	14.986	7.2919	139.88	1.3812	5.7253	6.12	7.5012

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-002 S8
Sample No.: S-8
Test No.: 15.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: -----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK GRAY LEAN CLAY WITH SAND AND GRAVEL CL - FLY ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 5.89 in
Specimen Area: 6.20 in^2
Specimen Volume: 36.53 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	6.12	6.12	0	0.000	1.0755	1.0755	1.000	1.0755	0
2	0.23	6.4848	6.12	0.52953	1.452	0.91076	0.54595	1.668	0.72836	0.1824
3	0.48	6.5624	6.12	0.64475	1.457	0.87314	0.43074	2.027	0.65194	0.2212
4	0.72	6.6208	6.12	0.70585	1.409	0.87045	0.36964	2.355	0.62004	0.2504
5	0.97	6.6662	6.12	0.74251	1.359	0.87916	0.33298	2.640	0.60607	0.27309
6	1.22	6.7089	6.12	0.77335	1.313	0.89102	0.30214	2.949	0.59658	0.29444
7	1.48	6.7435	6.12	0.79197	1.270	0.90704	0.28352	3.199	0.59528	0.31176
8	1.73	6.7744	6.12	0.80419	1.229	0.92569	0.2713	3.412	0.59849	0.3272
9	1.98	6.8093	6.12	0.81117	1.177	0.95359	0.26431	3.608	0.60895	0.34464
10	2.22	6.8351	6.12	0.81757	1.143	0.97296	0.25791	3.772	0.61544	0.35753
11	2.47	6.8565	6.12	0.82397	1.119	0.98803	0.25151	3.928	0.61977	0.36826
12	2.71	6.8731	6.12	0.82747	1.099	1.0012	0.24802	4.037	0.62459	0.37657
13	2.96	6.8944	6.12	0.82805	1.069	1.0218	0.24744	4.130	0.63463	0.38719
14	3.45	6.9317	6.12	0.8263	1.018	1.0609	0.24918	4.258	0.65506	0.40587
15	3.96	6.9651	6.12	0.82281	0.974	1.0978	0.25268	4.345	0.67522	0.42255
16	4.46	6.994	6.12	0.81117	0.928	1.1383	0.26431	4.307	0.70131	0.43699
17	4.95	7.0238	6.12	0.8071	0.893	1.1722	0.26839	4.368	0.72029	0.45191
18	5.44	7.0446	6.12	0.79779	0.863	1.2023	0.2777	4.329	0.73999	0.46229
19	5.94	7.0627	6.12	0.79546	0.844	1.2227	0.28002	4.366	0.75137	0.47135
20	8.93	7.2232	6.12	0.75706	0.686	1.4216	0.31843	4.464	0.87001	0.55158
21	11.91	7.3761	6.12	0.73029	0.581	1.6013	0.3452	4.639	0.97326	0.62807
22	14.87	7.4936	6.12	0.68024	0.495	1.7689	0.39524	4.475	1.0821	0.68682
23	14.99	7.5012	6.12	0.68083	0.493	1.7759	0.39466	4.500	1.0853	0.6906

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-002 S8
Sample No.: S8
Test No.: 30.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK GRAY LEAN CLAY WITH SAND AND GRAVEL CL - FLY ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.79 in
Specimen Area: 6.13 in^2
Specimen Volume: 35.46 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.1281	0	0	5.0434	7.2	7.2
2	5.0038	0.25301	6.1437	66.941	0.7845	5.7164	7.2	7.9845
3	10.004	0.51759	6.16	87.336	1.0208	5.9351	7.2	8.2208
4	15.004	0.77886	6.1762	100.19	1.1679	6.0704	7.2	8.3679
5	20.004	1.0451	6.1928	109.71	1.2756	6.1648	7.2	8.4756
6	25.004	1.3064	6.2092	117.13	1.3582	6.236	7.2	8.5582
7	30.004	1.5693	6.2258	123.08	1.4233	6.2908	7.2	8.6233
8	35.004	1.8322	6.2425	128.19	1.4785	6.3334	7.2	8.6785
9	40.004	2.1001	6.2596	132.6	1.5252	6.3666	7.2	8.7252
10	45.004	2.368	6.2768	136.69	1.568	6.394	7.2	8.768
11	50.004	2.6376	6.2941	140.15	1.6032	6.4168	7.2	8.8032
12	55.004	2.9071	6.3116	143.34	1.6352	6.436	7.2	8.8352
13	60.004	3.1766	6.3292	146.09	1.6619	6.4518	7.2	8.8619
14	70.004	3.7025	6.3637	151.14	1.7101	6.4739	7.2	8.9101
15	80.004	4.2283	6.3987	155.56	1.7504	6.4908	7.2	8.9504
16	90	4.7641	6.4347	159.14	1.7806	6.5013	7.2	8.9806
17	100	5.3032	6.4713	162.59	1.809	6.5101	7.2	9.009
18	110	5.839	6.5081	165.27	1.8284	6.513	7.2	9.0284
19	120	6.3665	6.5448	167.45	1.8421	6.5147	7.2	9.0421
20	180	9.5729	6.7769	178.7	1.8986	6.5007	7.2	9.0986
21	240	12.794	7.0272	184.33	1.8886	6.4803	7.2	9.0886
22	300	15.999	7.2953	188.74	1.8627	6.4663	7.2	9.0627

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-002 S8
Sample No.: S8
Test No.: 30.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK GRAY LEAN CLAY WITH SAND AND GRAVEL CL - FLY ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.79 in
Specimen Area: 6.13 in^2
Specimen Volume: 35.46 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	7.2	7.2	0	0.000	2.1566	2.1566	1.000	2.1566	0
2	0.25	7.9845	7.2	0.67299	0.858	2.2681	1.4836	1.529	1.8759	0.39225
3	0.52	8.2208	7.2	0.89169	0.874	2.2857	1.2649	1.807	1.7753	0.51041
4	0.78	8.3679	7.2	1.027	0.879	2.2976	1.1296	2.034	1.7136	0.58397
5	1.05	8.4756	7.2	1.1215	0.879	2.3107	1.0352	2.232	1.6729	0.63778
6	1.31	8.5582	7.2	1.1926	0.878	2.3222	0.96402	2.409	1.6431	0.6791
7	1.57	8.6233	7.2	1.2474	0.876	2.3325	0.9092	2.565	1.6209	0.71167
8	1.83	8.6785	7.2	1.29	0.872	2.3452	0.86662	2.706	1.6059	0.73927
9	2.10	8.7252	7.2	1.3232	0.868	2.3586	0.83338	2.830	1.596	0.76262
10	2.37	8.768	7.2	1.3507	0.861	2.374	0.80597	2.945	1.59	0.784
11	2.64	8.8032	7.2	1.3734	0.857	2.3864	0.78323	3.047	1.5848	0.80159
12	2.91	8.8352	7.2	1.3926	0.852	2.3992	0.76398	3.140	1.5816	0.8176
13	3.18	8.8619	7.2	1.4084	0.847	2.4102	0.74824	3.221	1.5792	0.83097
14	3.70	8.9101	7.2	1.4305	0.837	2.4361	0.72608	3.355	1.5811	0.85503
15	4.23	8.9504	7.2	1.4475	0.827	2.4595	0.70916	3.468	1.5843	0.87518
16	4.76	8.9806	7.2	1.458	0.819	2.4793	0.69867	3.549	1.589	0.89031
17	5.30	9.009	7.2	1.4667	0.811	2.4989	0.68992	3.622	1.5944	0.90448
18	5.84	9.0284	7.2	1.4696	0.804	2.5154	0.687	3.661	1.6012	0.91422
19	6.37	9.0421	7.2	1.4714	0.799	2.5274	0.68525	3.688	1.6063	0.92105
20	9.57	9.0986	7.2	1.4574	0.768	2.5978	0.69925	3.715	1.6485	0.94929
21	12.79	9.0886	7.2	1.437	0.761	2.6083	0.71966	3.624	1.664	0.9443
22	16.00	9.0627	7.2	1.423	0.764	2.5964	0.73366	3.539	1.665	0.93136

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-002 S8
Sample No.: S-8
Test No.: 60.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK GRAY LEAN CLAY WITH SAND AND GRAVEL CL - FLY ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.98 in
Specimen Area: 6.23 in^2
Specimen Volume: 37.26 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.2322	0	0	5.0461	9.36	9.36
2	5.004	0.24293	6.2474	93.936	1.0826	6.1049	9.36	10.443
3	10.004	0.49961	6.2635	127.82	1.4693	6.625	9.36	10.829
4	15.004	0.75323	6.2795	148.22	1.6995	6.9512	9.36	11.059
5	20.004	1.0084	6.2957	162.75	1.8613	7.1795	9.36	11.221
6	25.004	1.2666	6.3122	173.87	1.9832	7.3449	9.36	11.343
7	30.004	1.5248	6.3287	182.68	2.0783	7.4724	9.36	11.438
8	35.004	1.7845	6.3454	190.5	2.1615	7.5784	9.36	11.521
9	40.004	2.0427	6.3622	196.63	2.2253	7.6646	9.36	11.585
10	45.004	2.304	6.3792	202.14	2.2815	7.7345	9.36	11.641
11	50.004	2.5668	6.3964	207.49	2.3356	7.7887	9.36	11.696
12	55.004	2.8281	6.4136	211.79	2.3776	7.8388	9.36	11.738
13	60.004	3.0909	6.431	215.83	2.4164	7.8825	9.36	11.776
14	70.004	3.6118	6.4657	223.22	2.4857	7.9477	9.36	11.846
15	80.004	4.1328	6.5009	228.94	2.5356	7.9954	9.36	11.896
16	90.004	4.6508	6.5362	234.24	2.5803	8.0345	9.36	11.94
17	100	5.1748	6.5723	239.48	2.6235	8.0554	9.36	11.984
18	110	5.6958	6.6086	243.78	2.656	8.0793	9.36	12.016
19	120	6.2184	6.6454	247.51	2.6816	8.0863	9.36	12.042
20	180	9.352	6.8752	268.01	2.8068	8.1049	9.36	12.167
21	240	12.498	7.1223	282.81	2.8589	8.0642	9.36	12.219
22	300	15.636	7.3873	294.61	2.8714	8.017	9.36	12.231

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-002 S8
Sample No.: S-8
Test No.: 60.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK GRAY LEAN CLAY WITH SAND AND GRAVEL CL - FLY ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.98 in
Specimen Area: 6.23 in^2
Specimen Volume: 37.26 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

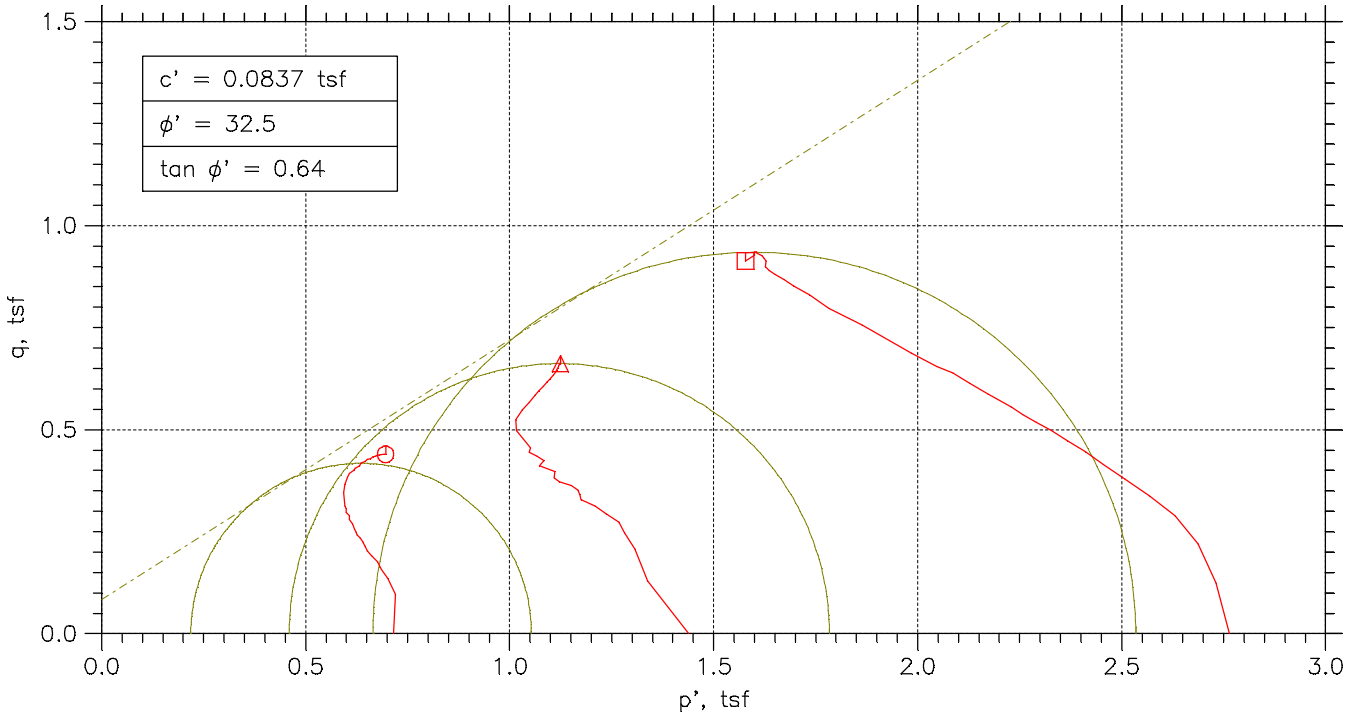
Plastic Limit: 23

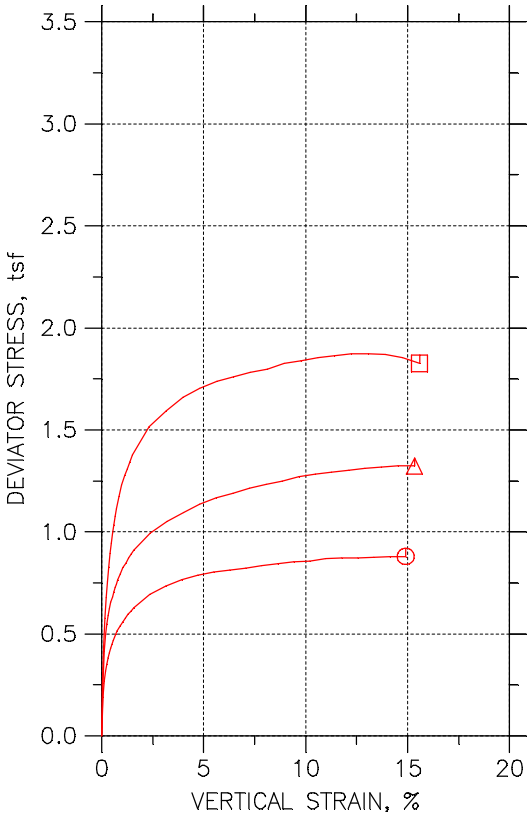
Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	9.36	9.36	0	0.000	4.3139	4.3139	1.000	4.3139	0
2	0.24	10.443	9.36	1.0588	0.978	4.3377	3.2551	1.333	3.7964	0.5413
3	0.50	10.829	9.36	1.5789	1.075	4.2043	2.735	1.537	3.4696	0.73465
4	0.75	11.059	9.36	1.9051	1.121	4.1083	2.4088	1.706	3.2586	0.84974
5	1.01	11.221	9.36	2.1334	1.146	4.0418	2.1805	1.854	3.1112	0.93063
6	1.27	11.343	9.36	2.2988	1.159	3.9984	2.0151	1.984	3.0067	0.99162
7	1.52	11.438	9.36	2.4264	1.167	3.9659	1.8876	2.101	2.9267	1.0392
8	1.78	11.521	9.36	2.5324	1.172	3.9431	1.7816	2.213	2.8623	1.0807
9	2.04	11.585	9.36	2.6186	1.177	3.9206	1.6954	2.313	2.808	1.1126
10	2.30	11.641	9.36	2.6884	1.178	3.907	1.6255	2.404	2.7662	1.1407
11	2.57	11.696	9.36	2.7426	1.174	3.9069	1.5713	2.486	2.7391	1.1678
12	2.83	11.738	9.36	2.7927	1.175	3.8988	1.5212	2.563	2.71	1.1888
13	3.09	11.776	9.36	2.8364	1.174	3.8939	1.4775	2.635	2.6857	1.2082
14	3.61	11.846	9.36	2.9016	1.167	3.898	1.4123	2.760	2.6552	1.2429
15	4.13	11.896	9.36	2.9494	1.163	3.9002	1.3646	2.858	2.6324	1.2678
16	4.65	11.94	9.36	2.9884	1.158	3.9058	1.3255	2.947	2.6157	1.2901
17	5.17	11.984	9.36	3.0094	1.147	3.9281	1.3046	3.011	2.6163	1.3118
18	5.70	12.016	9.36	3.0332	1.142	3.9367	1.2807	3.074	2.6087	1.328
19	6.22	12.042	9.36	3.0402	1.134	3.9553	1.2737	3.105	2.6145	1.3408
20	9.35	12.167	9.36	3.0589	1.090	4.0618	1.2551	3.236	2.6584	1.4034
21	12.50	12.219	9.36	3.0181	1.056	4.1547	1.2958	3.206	2.7253	1.4294
22	15.64	12.231	9.36	2.9709	1.035	4.2144	1.343	3.138	2.7787	1.4357

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

Terracon
Consulting Engineers & Scientists





Symbol		⏲	△	⏍	
Test No.		10.0 PSI	20.0 PSI	40.0 PSI	
Initial	Diameter, in	2.8071	2.7992	2.802	
	Height, in	5.9681	6.1213	6.0421	
	Water Content, %	34.07	34.53	33.55	
	Dry Density, pcf	86.29	87.22	79.75	
	Saturation, %	95.76	99.18	80.83	
	Void Ratio	0.96775	0.94695	1.1292	
Before Shear	Water Content, %	32.71	29.92	32.67	
	Dry Density, pcf	89.86	93.61	89.91	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.88973	0.81387	0.8885	
	Back Press., tsf	5.0445	5.0422	5.1556	
Minor Prin. Stress, tsf		0.71549	1.4378	2.7644	
Max. Dev. Stress, tsf		0.87949	1.3239	1.8718	
Time to Failure, min		1080	1080	900	
Strain Rate, %/min		0.02	0.02	0.02	
B-Value		0.97	0.95	0.99	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		38	38	38	
Plastic Limit		21	21	21	
Plasticity Index		17	17	17	

Project: DYNERGY HENNEPIN

Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HEN-016 S7

Sample Type: 3.0" ST

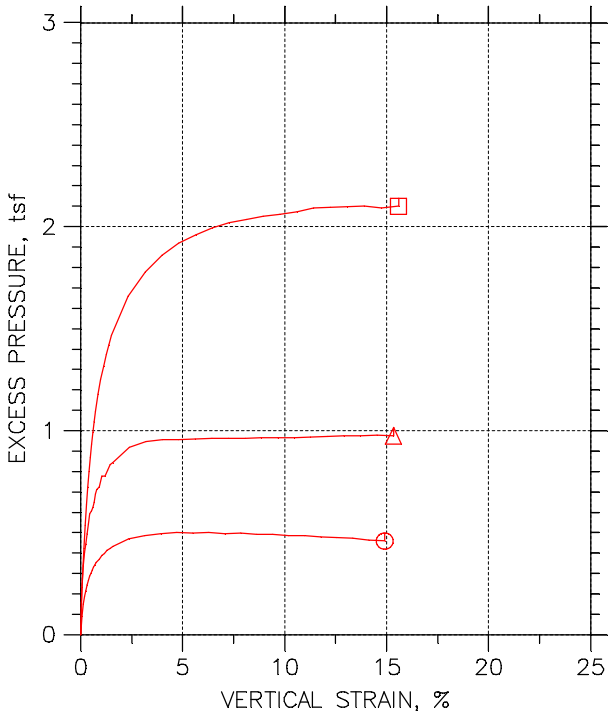
Failure Sketch

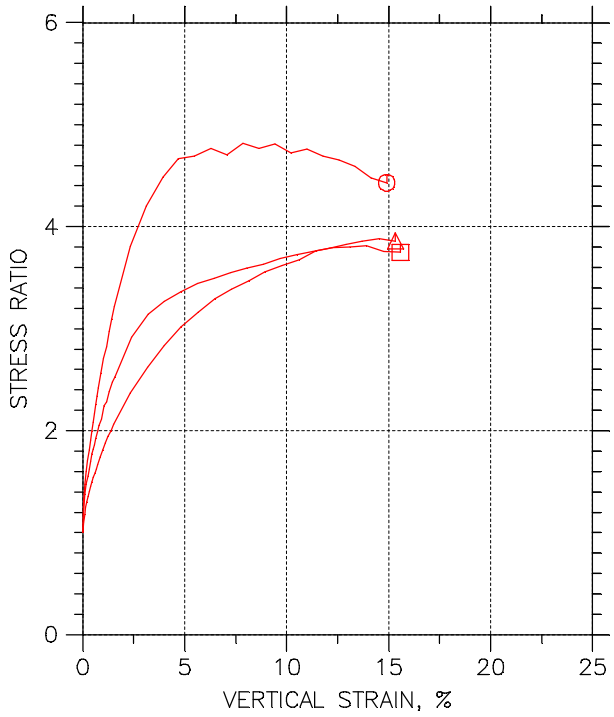
Description: VERY DARK GRAY CLAY WITH SAND AND GRAVEL - ORGANICS AND ASH NOTED

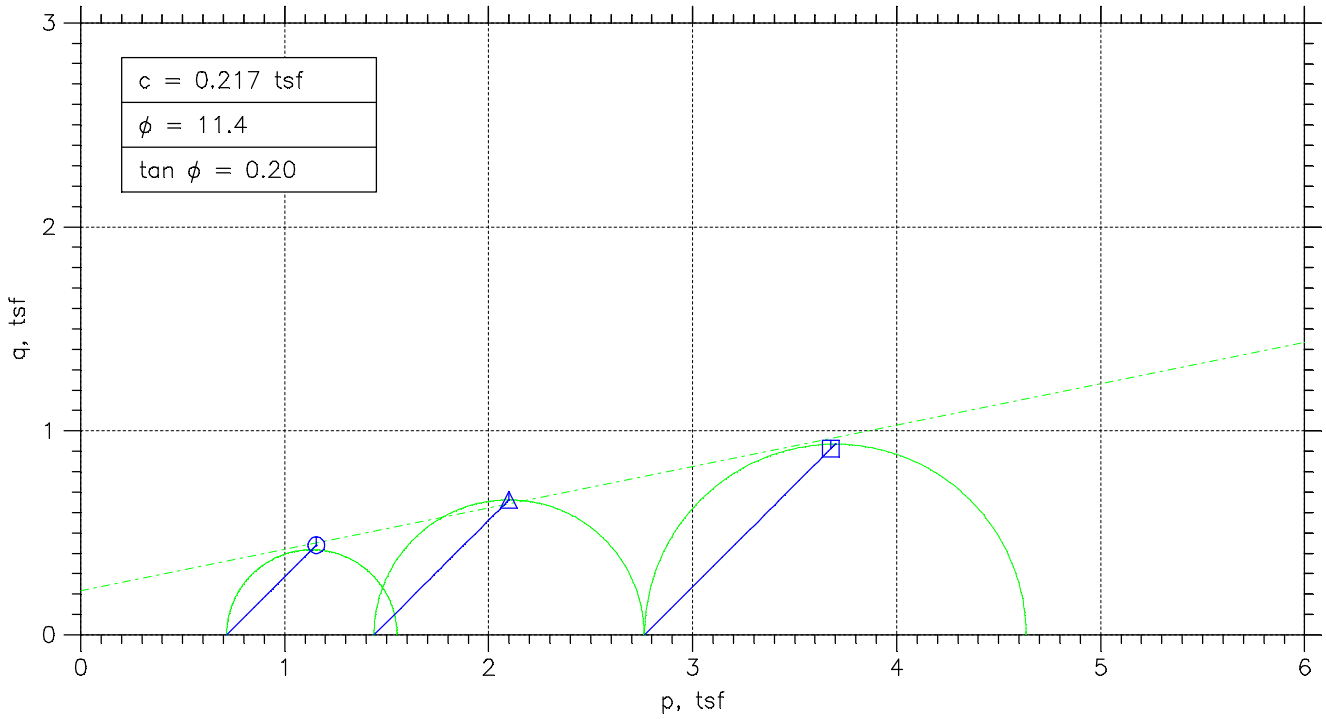
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Tue, 22-DEC-2015 10:05:37

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767







Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-016 S7	Tested By: BCM	Checked By: WPQ
Sample No.: S-7	Test Date: 12/16/15	Depth: 20.0'-22.0'
Test No.: HEN-016 S7	Sample Type: 3.0" ST	Elevation: -----
Description: VERY DARK GRAY CLAY WITH SAND AND GRAVEL - ORGANICS AND ASH NOTED		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767		
307		

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S7
Sample No.: S-7
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 20.0'-22.0'
Elevation: -----

Terracon
Consulting Engineers & Scientists

Soil Description: VERY DARK GRAY CLAY WITH SAND AND GRAVEL - ORGANICS AND ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 5.97 in
Specimen Area: 6.19 in^2
Specimen Volume: 36.94 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 38

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.1887	0	0	5.0445	5.76	5.76
2	5	0.057793	6.1923	16.531	0.19221	5.1359	5.76	5.9522
3	10	0.12136	6.1962	23.217	0.26978	5.1929	5.76	6.0298
4	15	0.18494	6.2002	27.218	0.31608	5.2319	5.76	6.0761
5	20	0.24851	6.2041	30.325	0.35192	5.2604	5.76	6.1119
6	25	0.31208	6.2081	32.904	0.38162	5.2895	5.76	6.1416
7	30	0.3771	6.2122	35.063	0.40639	5.3116	5.76	6.1664
8	35	0.44211	6.2162	37.116	0.4299	5.3308	5.76	6.1899
9	40	0.50713	6.2203	38.853	0.44973	5.3454	5.76	6.2097
10	45	0.57215	6.2243	40.433	0.46771	5.3593	5.76	6.2277
11	50	0.63716	6.2284	41.907	0.48444	5.3756	5.76	6.2444
12	55	0.70363	6.2326	43.223	0.49932	5.3873	5.76	6.2593
13	60	0.76864	6.2367	44.487	0.51358	5.3977	5.76	6.2736
14	70	0.90012	6.2449	46.751	0.539	5.4152	5.76	6.299
15	80	1.033	6.2533	48.593	0.5595	5.4326	5.76	6.3195
16	90	1.1645	6.2616	50.331	0.57873	5.442	5.76	6.3387
17	100	1.2974	6.2701	51.805	0.59488	5.4588	5.76	6.3549
18	110	1.4318	6.2786	53.437	0.61278	5.4676	5.76	6.3728
19	120	1.5647	6.2871	54.753	0.62703	5.4775	5.76	6.387
20	180	2.3464	6.3374	60.965	0.69263	5.5135	5.76	6.4526
21	240	3.128	6.3886	65.019	0.73277	5.531	5.76	6.4928
22	300	3.9256	6.4416	68.546	0.76617	5.5403	5.76	6.5262
23	360	4.7029	6.4941	70.968	0.78682	5.5455	5.76	6.5468
24	420	5.4845	6.5478	72.969	0.80236	5.5426	5.76	6.5624
25	480	6.2806	6.6035	74.443	0.81168	5.5444	5.76	6.5717
26	540	7.0637	6.6591	76.022	0.82197	5.538	5.76	6.582
27	600	7.8468	6.7157	77.865	0.8348	5.5415	5.76	6.5948
28	660	8.6386	6.7739	79.497	0.84498	5.5356	5.76	6.605
29	720	9.4144	6.8319	80.971	0.85334	5.5362	5.76	6.6133
30	780	10.195	6.8913	82.077	0.85754	5.5298	5.76	6.6175
31	840	10.991	6.9529	83.814	0.86793	5.5292	5.76	6.6279
32	900	11.769	7.0143	84.867	0.87114	5.524	5.76	6.6311
33	960	12.555	7.0773	85.762	0.87249	5.5211	5.76	6.6325
34	1020	13.35	7.1422	86.815	0.87517	5.5164	5.76	6.6352
35	1080	14.12	7.2063	88.026	0.87949	5.5071	5.76	6.6395
36	1140	14.906	7.2728	88.815	0.87926	5.5036	5.76	6.6393

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S7
Sample No.: S-7
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 20.0'-22.0'
Elevation: -----

Terracon
Consulting Engineers & Scientists

Soil Description: VERY DARK GRAY CLAY WITH SAND AND GRAVEL - ORGANICS AND ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 5.97 in
Specimen Area: 6.19 in^2
Specimen Volume: 36.94 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 38

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	5.76	5.76	0	0.000	0.71549	0.71549	1.000	0.71549	0
2	0.06	5.9522	5.76	0.091359	0.475	0.81634	0.62413	1.308	0.72023	0.096107
3	0.12	6.0298	5.76	0.14839	0.550	0.83688	0.5671	1.476	0.70199	0.13489
4	0.18	6.0761	5.76	0.18737	0.593	0.84419	0.52811	1.599	0.68615	0.15804
5	0.25	6.1119	5.76	0.21589	0.613	0.85152	0.4996	1.704	0.67556	0.17596
6	0.31	6.1416	5.76	0.24498	0.642	0.85212	0.4705	1.811	0.66131	0.19081
7	0.38	6.1664	5.76	0.26709	0.657	0.85478	0.44839	1.906	0.65158	0.20319
8	0.44	6.1899	5.76	0.2863	0.666	0.85909	0.42919	2.002	0.64414	0.21495
9	0.51	6.2097	5.76	0.30084	0.669	0.86437	0.41464	2.085	0.63951	0.22487
10	0.57	6.2277	5.76	0.31481	0.673	0.86838	0.40068	2.167	0.63453	0.23385
11	0.64	6.2444	5.76	0.3311	0.683	0.86882	0.38438	2.260	0.6266	0.24222
12	0.70	6.2593	5.76	0.34274	0.686	0.87207	0.37274	2.340	0.62241	0.24966
13	0.77	6.2736	5.76	0.35321	0.688	0.87585	0.36227	2.418	0.61906	0.25679
14	0.90	6.299	5.76	0.37067	0.688	0.88382	0.34481	2.563	0.61431	0.2695
15	1.03	6.3195	5.76	0.38813	0.694	0.88685	0.32736	2.709	0.6071	0.27975
16	1.16	6.3387	5.76	0.39744	0.687	0.89678	0.31805	2.820	0.60741	0.28936
17	1.30	6.3549	5.76	0.41431	0.696	0.89605	0.30117	2.975	0.59861	0.29744
18	1.43	6.3728	5.76	0.42304	0.690	0.90523	0.29244	3.095	0.59883	0.30639
19	1.56	6.387	5.76	0.43294	0.690	0.90958	0.28255	3.219	0.59607	0.31352
20	2.35	6.4526	5.76	0.46901	0.677	0.9391	0.24647	3.810	0.59279	0.34632
21	3.13	6.4928	5.76	0.48647	0.664	0.96179	0.22901	4.200	0.5954	0.36639
22	3.93	6.5262	5.76	0.49578	0.647	0.98587	0.2197	4.487	0.60279	0.38308
23	4.70	6.5468	5.76	0.50102	0.637	1.0013	0.21447	4.669	0.60788	0.39341
24	5.48	6.5624	5.76	0.49811	0.621	1.0197	0.21738	4.691	0.61856	0.40118
25	6.28	6.5717	5.76	0.49985	0.616	1.0273	0.21563	4.764	0.62147	0.40584
26	7.06	6.582	5.76	0.49345	0.600	1.044	0.22203	4.702	0.63302	0.41099
27	7.85	6.5948	5.76	0.49694	0.595	1.0533	0.21854	4.820	0.63594	0.4174
28	8.64	6.605	5.76	0.49113	0.581	1.0693	0.22436	4.766	0.64685	0.42249
29	9.41	6.6133	5.76	0.49171	0.576	1.0771	0.22378	4.813	0.65045	0.42667
30	10.19	6.6175	5.76	0.48531	0.566	1.0877	0.23018	4.726	0.65895	0.42877
31	10.99	6.6279	5.76	0.48472	0.558	1.0987	0.23076	4.761	0.66472	0.43396
32	11.77	6.6311	5.76	0.47949	0.550	1.1071	0.236	4.691	0.67157	0.43557
33	12.56	6.6325	5.76	0.47658	0.546	1.1114	0.23891	4.652	0.67515	0.43624
34	13.35	6.6352	5.76	0.47192	0.539	1.1187	0.24356	4.593	0.68115	0.43759
35	14.12	6.6395	5.76	0.46261	0.526	1.1324	0.25287	4.478	0.69262	0.43975
36	14.91	6.6393	5.76	0.45912	0.522	1.1356	0.25636	4.430	0.69599	0.43963

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S7
Sample No.: S-7
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 20.0'-22.0'
Elevation: ----

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Consulting Engineers & Scientists

Soil Description: VERY DARK GRAY CLAY WITH SAND AND GRAVEL - ORGANICS AND ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.12 in
Specimen Area: 6.15 in^2
Specimen Volume: 37.67 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 38

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.1541	0	0	5.0422	6.48	6.48
2	5.0039	0.051583	6.1572	22.233	0.25998	5.2726	6.48	6.74
3	10.004	0.11723	6.1613	35.573	0.4157	5.3816	6.48	6.8957
4	15.004	0.18289	6.1653	42.348	0.49455	5.4452	6.48	6.9746
5	20.004	0.2501	6.1695	47.007	0.54859	5.486	6.48	7.0286
6	25.004	0.31731	6.1736	50.448	0.58834	5.5379	6.48	7.0683
7	30.004	0.38453	6.1778	53.571	0.62435	5.5828	6.48	7.1043
8	35.004	0.45174	6.182	56.271	0.65537	5.633	6.48	7.1354
9	40.004	0.52052	6.1863	58.547	0.68141	5.6487	6.48	7.1614
10	45.004	0.58617	6.1903	60.558	0.70435	5.6645	6.48	7.1844
11	50.004	0.65495	6.1946	62.517	0.72663	5.6919	6.48	7.2066
12	55.004	0.72216	6.1988	64.105	0.74459	5.7309	6.48	7.2246
13	60.004	0.78782	6.2029	65.852	0.76437	5.7537	6.48	7.2444
14	70	0.91756	6.211	68.605	0.79528	5.7665	6.48	7.2753
15	80	1.0504	6.2194	71.145	0.82363	5.819	6.48	7.3036
16	90	1.1817	6.2277	73.316	0.84763	5.8202	6.48	7.3276
17	100	1.313	6.2359	75.433	0.87095	5.8488	6.48	7.351
18	110	1.4459	6.2443	77.18	0.88992	5.8767	6.48	7.3699
19	120	1.5803	6.2529	78.98	0.90943	5.8843	6.48	7.3894
20	180	2.3947	6.305	87.079	0.99439	5.9607	6.48	7.4744
21	240	3.2075	6.358	92.69	1.0497	5.9899	6.48	7.5297
22	300	4.0032	6.4107	97.613	1.0963	5.9969	6.48	7.5763
23	360	4.816	6.4654	101.85	1.1342	5.9992	6.48	7.6142
24	420	5.6319	6.5213	105.82	1.1683	6.0015	6.48	7.6483
25	480	6.4323	6.5771	108.68	1.1897	6.0033	6.48	7.6697
26	540	7.2467	6.6349	111.8	1.2132	6.0039	6.48	7.6932
27	600	8.0579	6.6934	114.61	1.2328	6.005	6.48	7.7128
28	660	8.8551	6.752	116.99	1.2475	6.0062	6.48	7.7275
29	720	9.6695	6.8128	120.16	1.2699	6.0074	6.48	7.7499
30	780	10.479	6.8744	122.44	1.2824	6.0091	6.48	7.7624
31	840	11.28	6.9365	124.56	1.2929	6.0115	6.48	7.7729
32	900	12.1	7.0012	126.67	1.3027	6.0132	6.48	7.7827
33	960	12.91	7.0663	128.85	1.3128	6.0155	6.48	7.7928
34	1020	13.702	7.1312	130.65	1.3191	6.0185	6.48	7.7991
35	1080	14.526	7.1999	132.39	1.3239	6.0202	6.48	7.8039
36	1140	15.334	7.2687	133.56	1.323	6.0173	6.48	7.803

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S7
Sample No.: S-7
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 20.0'-22.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: VERY DARK GRAY CLAY WITH SAND AND GRAVEL - ORGANICS AND ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.12 in
Specimen Area: 6.15 in^2
Specimen Volume: 37.67 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 38

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	6.48	6.48	0	0.000	1.4378	1.4378	1.000	1.4378	0
2	0.05	6.74	6.48	0.23036	0.886	1.4674	1.2074	1.215	1.3374	0.12999
3	0.12	6.8957	6.48	0.33941	0.816	1.5141	1.0984	1.378	1.3062	0.20785
4	0.18	6.9746	6.48	0.40298	0.815	1.5294	1.0348	1.478	1.2821	0.24728
5	0.25	7.0286	6.48	0.4438	0.809	1.5426	0.99399	1.552	1.2683	0.27429
6	0.32	7.0683	6.48	0.49571	0.843	1.5304	0.94209	1.625	1.2363	0.29417
7	0.38	7.1043	6.48	0.54061	0.866	1.5215	0.89718	1.696	1.2094	0.31217
8	0.45	7.1354	6.48	0.59077	0.901	1.5024	0.84703	1.774	1.1747	0.32768
9	0.52	7.1614	6.48	0.60651	0.890	1.5127	0.83128	1.820	1.172	0.3407
10	0.59	7.1844	6.48	0.62226	0.883	1.5199	0.81554	1.864	1.1677	0.35218
11	0.65	7.2066	6.48	0.64967	0.894	1.5148	0.78813	1.922	1.1514	0.36332
12	0.72	7.2246	6.48	0.68874	0.925	1.4936	0.74905	1.994	1.1213	0.37229
13	0.79	7.2444	6.48	0.71148	0.931	1.4907	0.72631	2.052	1.1085	0.38219
14	0.92	7.2753	6.48	0.72431	0.911	1.5088	0.71348	2.115	1.1111	0.39764
15	1.05	7.3036	6.48	0.7768	0.943	1.4846	0.66099	2.246	1.0728	0.41181
16	1.18	7.3276	6.48	0.77797	0.918	1.5075	0.65983	2.285	1.0836	0.42381
17	1.31	7.351	6.48	0.80654	0.926	1.5022	0.63125	2.380	1.0667	0.43548
18	1.45	7.3699	6.48	0.83454	0.938	1.4932	0.60326	2.475	1.0482	0.44496
19	1.58	7.3894	6.48	0.84212	0.926	1.5051	0.59568	2.527	1.0504	0.45472
20	2.39	7.4744	6.48	0.91851	0.924	1.5137	0.51928	2.915	1.0165	0.4972
21	3.21	7.5297	6.48	0.94767	0.903	1.5398	0.49012	3.142	1.0149	0.52483
22	4.00	7.5763	6.48	0.95467	0.871	1.5794	0.48312	3.269	1.0313	0.54816
23	4.82	7.6142	6.48	0.957	0.844	1.615	0.48079	3.359	1.0479	0.5671
24	5.63	7.6483	6.48	0.95934	0.821	1.6468	0.47846	3.442	1.0626	0.58415
25	6.43	7.6697	6.48	0.96109	0.808	1.6664	0.47671	3.496	1.0716	0.59484
26	7.25	7.6932	6.48	0.96167	0.793	1.6894	0.47612	3.548	1.0827	0.60661
27	8.06	7.7128	6.48	0.96284	0.781	1.7078	0.47496	3.596	1.0914	0.6164
28	8.86	7.7275	6.48	0.964	0.773	1.7213	0.47379	3.633	1.0975	0.62375
29	9.67	7.7499	6.48	0.96517	0.760	1.7426	0.47262	3.687	1.1076	0.63496
30	10.48	7.7624	6.48	0.96692	0.754	1.7533	0.47087	3.723	1.1121	0.64119
31	11.28	7.7729	6.48	0.96925	0.750	1.7614	0.46854	3.759	1.115	0.64645
32	12.10	7.7827	6.48	0.971	0.745	1.7695	0.46679	3.791	1.1181	0.65136
33	12.91	7.7928	6.48	0.97333	0.741	1.7773	0.46446	3.827	1.1209	0.65641
34	13.70	7.7991	6.48	0.97625	0.740	1.7806	0.46154	3.858	1.1211	0.65953
35	14.53	7.8039	6.48	0.978	0.739	1.7837	0.45979	3.879	1.1218	0.66197
36	15.33	7.803	6.48	0.97508	0.737	1.7857	0.46271	3.859	1.1242	0.66148

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S7
Sample No.: S-7
Test No.: 40.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 20.0'-22.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: VERY DARK GRAY CLAY WITH SAND AND GRAVEL - ORGANICS AND ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.04 in
Specimen Area: 6.17 in^2
Specimen Volume: 37.26 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 38

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.1662	0	0	5.1556	7.92	7.92
2	5.0003	0.042334	6.1688	21.452	0.25038	5.314	7.92	8.1704
3	10	0.093739	6.172	37.711	0.43992	5.4532	7.92	8.3599
4	15	0.15119	6.1755	49.512	0.57726	5.5784	7.92	8.4973
5	20	0.21167	6.1793	58.061	0.67652	5.6902	7.92	8.5965
6	25	0.27366	6.1831	65.037	0.75733	5.7904	7.92	8.6773
7	30	0.33716	6.187	71.173	0.82826	5.8784	7.92	8.7483
8	35	0.40066	6.191	76.785	0.893	5.9558	7.92	8.813
9	40	0.46567	6.195	81.296	0.94484	6.0245	7.92	8.8648
10	45.001	0.52917	6.199	85.702	0.99541	6.0898	7.92	8.9154
11	50.001	0.59419	6.203	89.216	1.0355	6.1474	7.92	8.9555
12	55.001	0.6592	6.2071	92.73	1.0756	6.2004	7.92	8.9956
13	60.001	0.72421	6.2112	96.034	1.1132	6.2482	7.92	9.0332
14	70.001	0.85575	6.2194	101.38	1.1737	6.3344	7.92	9.0937
15	80.001	0.98729	6.2277	106.31	1.2291	6.4078	7.92	9.1491
16	90.001	1.1203	6.236	110.56	1.2765	6.4718	7.92	9.1965
17	100	1.2519	6.2444	113.55	1.3093	6.5278	7.92	9.2293
18	110	1.3849	6.2528	116.65	1.3432	6.5767	7.92	9.2632
19	120	1.518	6.2612	119.64	1.3757	6.6233	7.92	9.2957
20	180	2.3344	6.3136	132.8	1.5145	6.8143	7.92	9.4345
21	240	3.169	6.368	141.04	1.5946	6.9349	7.92	9.5146
22	300	3.987	6.4222	148.06	1.66	7.0152	7.92	9.58
23	360	4.8125	6.4779	153.26	1.7034	7.0752	7.92	9.6234
24	420	5.6486	6.5353	157.66	1.737	7.116	7.92	9.657
25	480	6.462	6.5922	161.28	1.7615	7.1509	7.92	9.6815
26	540	7.2875	6.6509	164.48	1.7806	7.1742	7.92	9.7006
27	600	8.1266	6.7116	167.63	1.7983	7.1923	7.92	9.7183
28	660	8.9355	6.7712	171.82	1.827	7.2051	7.92	9.747
29	720	9.7625	6.8333	174.6	1.8397	7.2168	7.92	9.7597
30	780	10.606	6.8978	177.54	1.8532	7.2272	7.92	9.7732
31	840	11.424	6.9615	180.22	1.8639	7.2459	7.92	9.7839
32	900	12.251	7.0271	182.68	1.8718	7.2505	7.92	9.7918
33	960	13.09	7.0949	184.41	1.8714	7.2523	7.92	9.7914
34	1020	13.905	7.1621	185.98	1.8697	7.2552	7.92	9.7897
35	1080	14.744	7.2326	186.35	1.8551	7.2476	7.92	9.7751
36	1140	15.58	7.3042	185.3	1.8266	7.2552	7.92	9.7466

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S7
Sample No.: S-7
Test No.: 40.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 20.0'-22.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: VERY DARK GRAY CLAY WITH SAND AND GRAVEL - ORGANICS AND ASH NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.04 in
Specimen Area: 6.17 in^2
Specimen Volume: 37.26 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 38

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	7.92	7.92	0	0.000	2.7644	2.7644	1.000	2.7644	0
2	0.04	8.1704	7.92	0.15842	0.633	2.8564	2.606	1.096	2.7312	0.12519
3	0.09	8.3599	7.92	0.29762	0.677	2.9067	2.4668	1.178	2.6868	0.21996
4	0.15	8.4973	7.92	0.42284	0.732	2.9188	2.3416	1.247	2.6302	0.28863
5	0.21	8.5965	7.92	0.53466	0.790	2.9063	2.2298	1.303	2.568	0.33826
6	0.27	8.6773	7.92	0.63484	0.838	2.8869	2.1296	1.356	2.5083	0.37867
7	0.34	8.7483	7.92	0.72278	0.873	2.8699	2.0416	1.406	2.4558	0.41413
8	0.40	8.813	7.92	0.80024	0.896	2.8572	1.9642	1.455	2.4107	0.4465
9	0.47	8.8648	7.92	0.86897	0.920	2.8403	1.8955	1.498	2.3679	0.47242
10	0.53	8.9154	7.92	0.9342	0.939	2.8256	1.8302	1.544	2.3279	0.4977
11	0.59	8.9555	7.92	0.99186	0.958	2.8081	1.7726	1.584	2.2903	0.51777
12	0.66	8.9956	7.92	1.0449	0.971	2.7952	1.7196	1.626	2.2574	0.53782
13	0.72	9.0332	7.92	1.0926	0.981	2.785	1.6718	1.666	2.2284	0.55662
14	0.86	9.0937	7.92	1.1788	1.004	2.7593	1.5856	1.740	2.1725	0.58685
15	0.99	9.1491	7.92	1.2522	1.019	2.7414	1.5122	1.813	2.1268	0.61457
16	1.12	9.1965	7.92	1.3163	1.031	2.7247	1.4482	1.881	2.0864	0.63827
17	1.25	9.2293	7.92	1.3722	1.048	2.7016	1.3922	1.940	2.0469	0.65465
18	1.38	9.2632	7.92	1.4211	1.058	2.6865	1.3433	2.000	2.0149	0.67159
19	1.52	9.2957	7.92	1.4677	1.067	2.6725	1.2967	2.061	1.9846	0.68787
20	2.33	9.4345	7.92	1.6587	1.095	2.6202	1.1057	2.370	1.8629	0.75723
21	3.17	9.5146	7.92	1.7793	1.116	2.5798	0.98514	2.619	1.7824	0.79731
22	3.99	9.58	7.92	1.8597	1.120	2.5647	0.90476	2.835	1.7347	0.82998
23	4.81	9.6234	7.92	1.9197	1.127	2.5482	0.84477	3.016	1.6965	0.8517
24	5.65	9.657	7.92	1.9604	1.129	2.541	0.804	3.160	1.6725	0.86848
25	6.46	9.6815	7.92	1.9954	1.133	2.5306	0.76906	3.290	1.6498	0.88076
26	7.29	9.7006	7.92	2.0187	1.134	2.5264	0.74576	3.388	1.6361	0.8903
27	8.13	9.7183	7.92	2.0367	1.133	2.526	0.72771	3.471	1.6268	0.89913
28	8.94	9.747	7.92	2.0495	1.122	2.5419	0.71489	3.556	1.6284	0.91352
29	9.76	9.7597	7.92	2.0612	1.120	2.543	0.70324	3.616	1.6231	0.91987
30	10.61	9.7732	7.92	2.0717	1.118	2.546	0.69276	3.675	1.6194	0.9266
31	11.42	9.7839	7.92	2.0903	1.121	2.538	0.67412	3.765	1.6061	0.93195
32	12.25	9.7918	7.92	2.095	1.119	2.5412	0.66946	3.796	1.6053	0.93588
33	13.09	9.7914	7.92	2.0967	1.120	2.5391	0.66772	3.803	1.6034	0.93571
34	13.91	9.7897	7.92	2.0996	1.123	2.5345	0.66481	3.812	1.5997	0.93485
35	14.74	9.7751	7.92	2.092	1.128	2.5275	0.67238	3.759	1.5999	0.92756
36	15.58	9.7466	7.92	2.0996	1.149	2.4914	0.66481	3.748	1.5781	0.91329

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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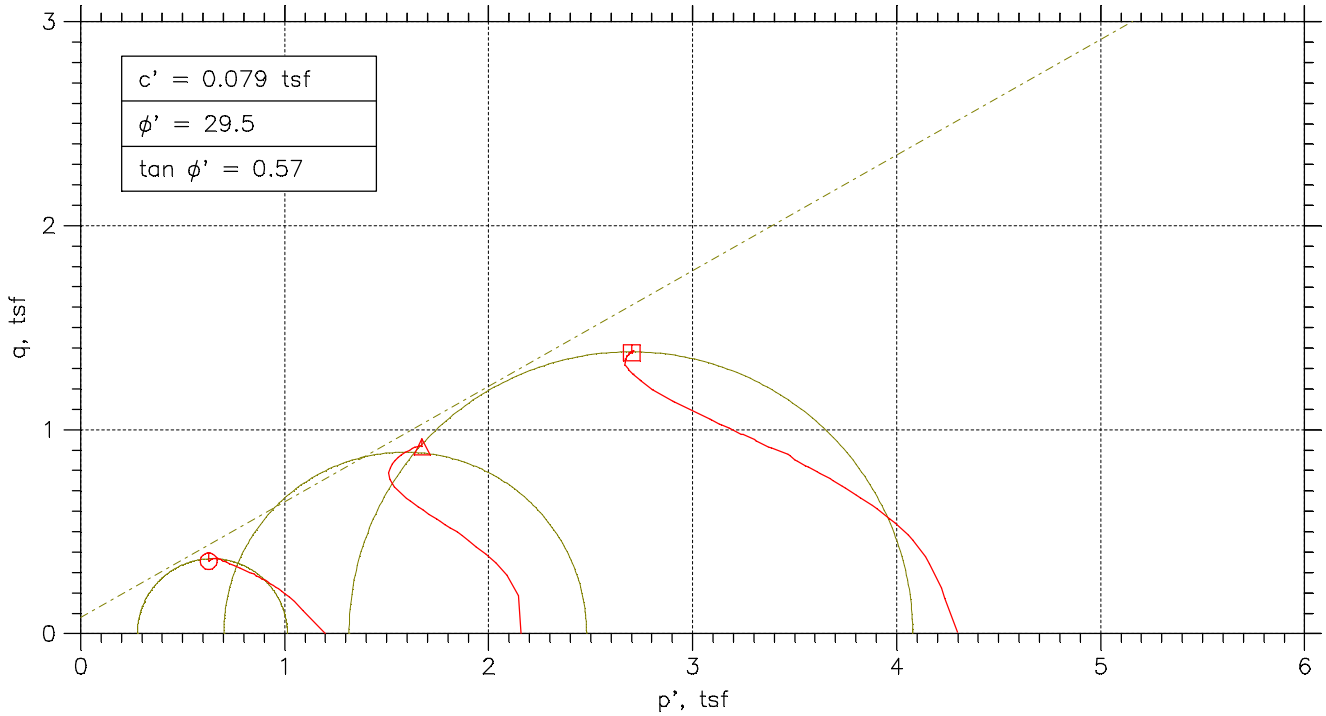

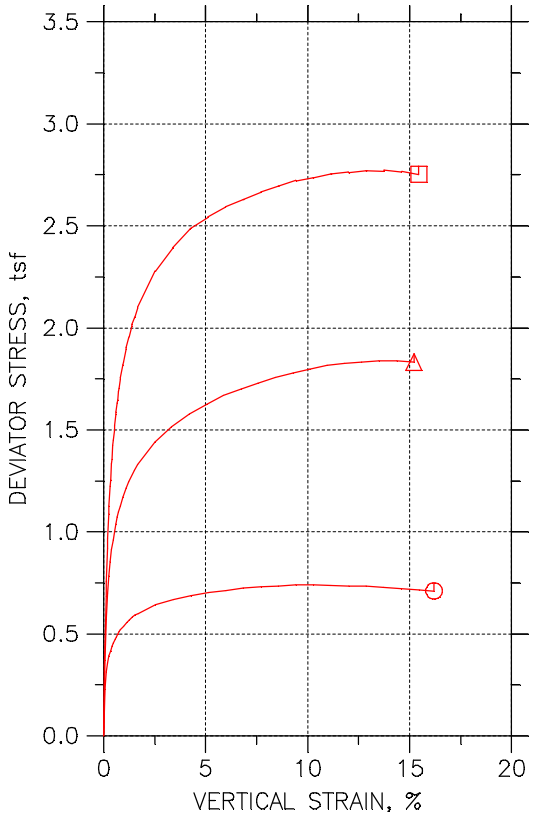

Symbol		⏲	△	⊡	
Test No.		15.0 PSI	30.0 PSI	60.0 PSI	
Initial	Diameter, in	2.828	2.8043	2.7835	
	Height, in	5.7787	5.8472	5.7602	
	Water Content, %	23.57	23.55	25.59	
	Dry Density, pcf	92.14	96.79	92.12	
	Saturation, %	76.04	84.91	82.54	
	Void Ratio	0.84297	0.75427	0.84321	
Before Shear	Water Content, %	26.53	21.69	21.75	
	Dry Density, pcf	98.64	106.8	106.7	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.72151	0.59007	0.59162	
	Back Press., tsf	5.0451	5.0416	5.0706	
Minor Prin. Stress, tsf		1.1973	2.1584	4.2894	
Max. Dev. Stress, tsf		0.73973	1.8396	2.773	
Time to Failure, min		660	1020	960	
Strain Rate, %/min		0.02	0.02	0.02	
B-Value		0.99	0.97	0.98	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		41	41	41	
Plastic Limit		23	23	23	
Plasticity Index		18	18	18	

Project: DYNERGY HENNEPIN

Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HEN-016 S10

Sample Type: 3 "ST

Failure Sketch

Description: VERY DARK GRAY LEAN CLAY WITH SAND CL FLY ASH AND SHELL NOTED

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D 4767

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CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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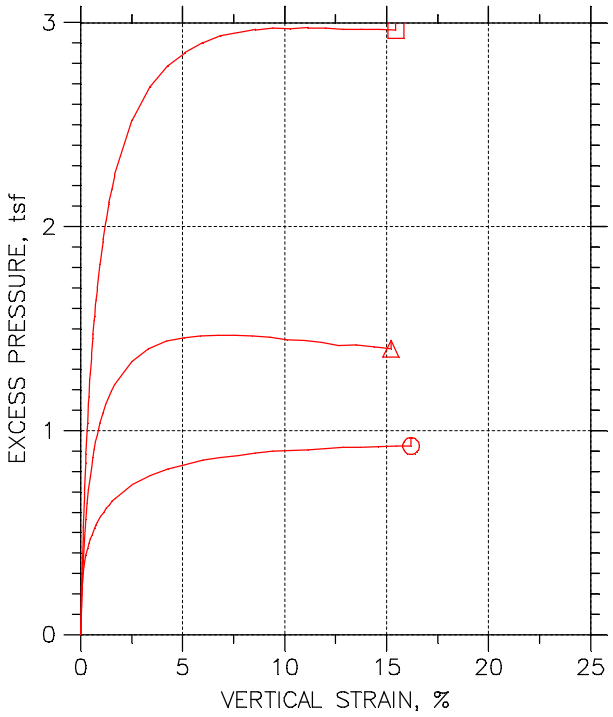

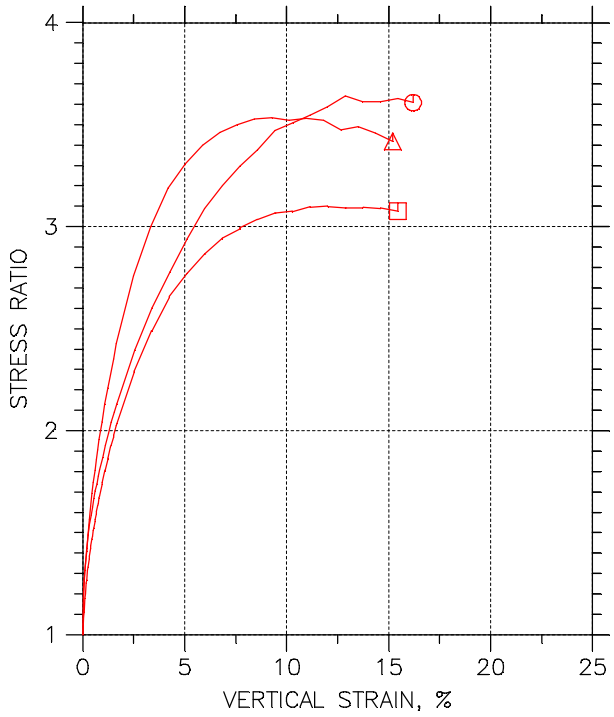

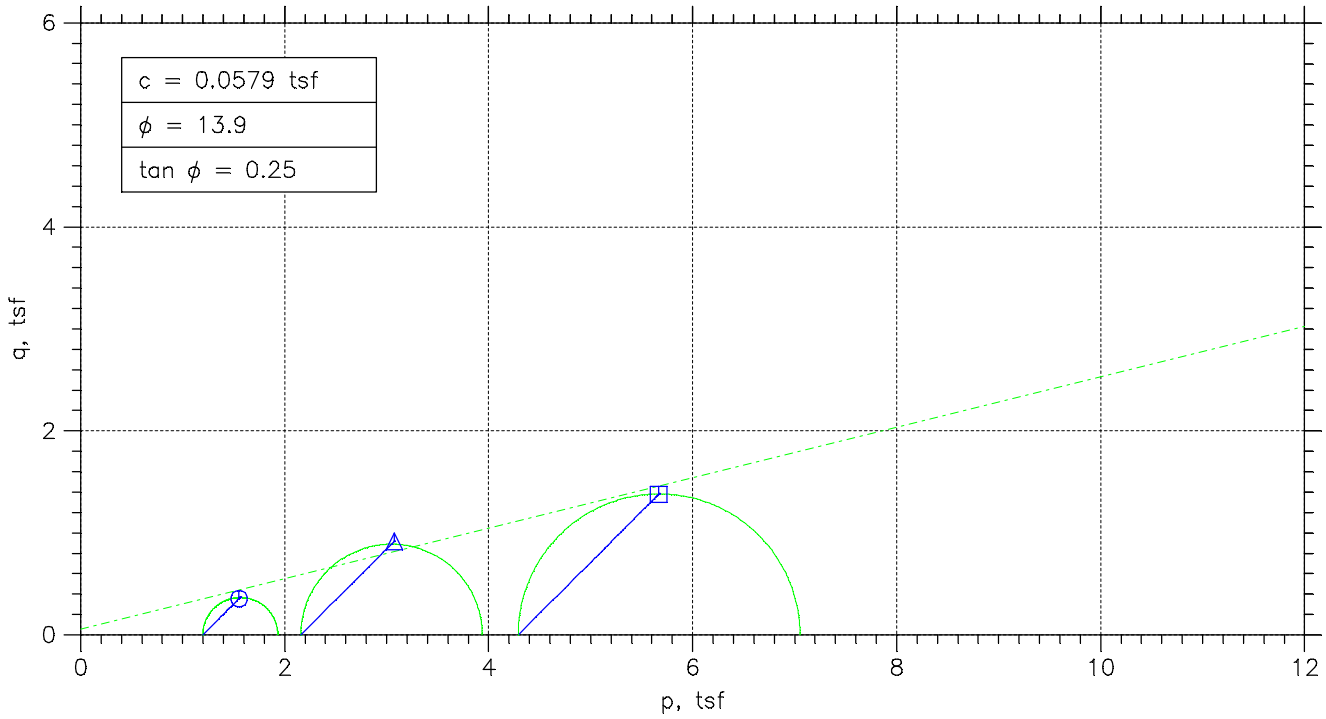

Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-016 S10	Tested By: BCM	Checked By: WPQ
Sample No.: S-10	Test Date: 12/16/15	Depth: 35.0'-37.0'
Test No.: HEN-016 S10	Sample Type: 3 "ST	Elevation: ----
Description: VERY DARK GRAY LEAN CLAY WITH SAND CL FLY ASH AND SHELL NOTED		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D 4767		
315		

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S10
Sample No.: S-10
Test No.: 15.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3 "ST

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: VERY DARK GRAY LEAN CLAY WITH SAND CL FLY ASH AND SHELL NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D 4767

Specimen Height: 5.78 in
Specimen Area: 6.28 in^2
Specimen Volume: 36.30 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.2811	0	0	5.0451	6.2424	6.2424
2	5.0001	0.054641	6.2845	19.902	0.22801	5.2685	6.2424	6.4704
3	10	0.12584	6.289	27.345	0.31307	5.3507	6.2424	6.5555
4	15	0.19373	6.2933	31.283	0.3579	5.3997	6.2424	6.6003
5	20	0.26658	6.2979	34.249	0.39155	5.4364	6.2424	6.634
6	25	0.33778	6.3024	36.622	0.41838	5.4673	6.2424	6.6608
7	30	0.40732	6.3068	38.456	0.43903	5.4918	6.2424	6.6814
8	35	0.48018	6.3114	39.912	0.45532	5.514	6.2424	6.6977
9	40.001	0.55137	6.3159	41.476	0.47282	5.5332	6.2424	6.7152
10	45.001	0.62257	6.3204	42.609	0.48539	5.5525	6.2424	6.7278
11	50.001	0.69377	6.325	43.742	0.49793	5.5694	6.2424	6.7403
12	55.001	0.76166	6.3293	45.036	0.51232	5.5834	6.2424	6.7547
13	60.001	0.83286	6.3338	45.899	0.52176	5.5968	6.2424	6.7642
14	70.001	0.97525	6.3429	47.355	0.53754	5.6242	6.2424	6.7799
15	80.001	1.1176	6.3521	48.92	0.5545	5.6446	6.2424	6.7969
16	90.001	1.26	6.3612	50.214	0.56835	5.6662	6.2424	6.8108
17	100	1.4008	6.3703	51.616	0.58339	5.6825	6.2424	6.8258
18	110	1.5448	6.3796	52.479	0.59228	5.6995	6.2424	6.8347
19	120	1.6889	6.389	53.234	0.59992	5.7129	6.2424	6.8423
20	180	2.5532	6.4456	57.495	0.64224	5.7817	6.2424	6.8846
21	240	3.4126	6.503	60.462	0.66942	5.8248	6.2424	6.9118
22	300	4.2653	6.5609	62.511	0.686	5.8563	6.2424	6.9284
23	360	5.1329	6.6209	64.615	0.70266	5.8802	6.2424	6.9451
24	420	5.9889	6.6812	66.125	0.7126	5.9012	6.2424	6.955
25	480	6.8466	6.7427	67.851	0.72452	5.9135	6.2424	6.9669
26	540	7.7093	6.8058	69.092	0.73094	5.924	6.2424	6.9733
27	600	8.5637	6.8693	70.008	0.73378	5.9339	6.2424	6.9762
28	660	9.428	6.9349	71.249	0.73973	5.9432	6.2424	6.9821
29	720	10.292	7.0017	71.896	0.73932	5.9479	6.2424	6.9817
30	780	11.145	7.0689	72.436	0.73779	5.9526	6.2424	6.9802
31	840	12.008	7.1382	72.813	0.73443	5.9584	6.2424	6.9768
32	900	12.874	7.2092	73.568	0.73475	5.9642	6.2424	6.9771
33	960	13.726	7.2804	73.676	0.72862	5.9636	6.2424	6.971
34	1020	14.596	7.3545	73.73	0.72181	5.966	6.2424	6.9642
35	1080	15.46	7.4297	73.892	0.71607	5.9701	6.2424	6.9585
36	1131.9	16.195	7.4949	73.946	0.71036	5.9701	6.2424	6.9528

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S10
Sample No.: S-10
Test No.: 15.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3 "ST

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: VERY DARK GRAY LEAN CLAY WITH SAND CL FLY ASH AND SHELL NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D 4767

Specimen Height: 5.78 in
Specimen Area: 6.28 in^2
Specimen Volume: 36.30 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	6.2424	6.2424	0	0.000	1.1973	1.1973	1.000	1.1973	0
2	0.05	6.4704	6.2424	0.22336	0.980	1.2019	0.97392	1.234	1.0879	0.11401
3	0.13	6.5555	6.2424	0.30559	0.976	1.2048	0.89169	1.351	1.0482	0.15653
4	0.19	6.6003	6.2424	0.35458	0.991	1.2006	0.8427	1.425	1.0217	0.17895
5	0.27	6.634	6.2424	0.39132	0.999	1.1975	0.80596	1.486	1.0017	0.19578
6	0.34	6.6608	6.2424	0.42223	1.009	1.1934	0.77505	1.540	0.98424	0.20919
7	0.41	6.6814	6.2424	0.44672	1.018	1.1896	0.75056	1.585	0.97007	0.21951
8	0.48	6.6977	6.2424	0.46888	1.030	1.1837	0.7284	1.625	0.95606	0.22766
9	0.55	6.7152	6.2424	0.48812	1.032	1.182	0.70915	1.667	0.94556	0.23641
10	0.62	6.7278	6.2424	0.50737	1.045	1.1753	0.68991	1.704	0.9326	0.24269
11	0.69	6.7403	6.2424	0.52428	1.053	1.1709	0.67299	1.740	0.92196	0.24897
12	0.76	6.7547	6.2424	0.53828	1.051	1.1713	0.659	1.777	0.91516	0.25616
13	0.83	6.7642	6.2424	0.55169	1.057	1.1673	0.64559	1.808	0.90647	0.26088
14	0.98	6.7799	6.2424	0.5791	1.077	1.1557	0.61818	1.870	0.88695	0.26877
15	1.12	6.7969	6.2424	0.59951	1.081	1.1523	0.59776	1.928	0.87501	0.27725
16	1.26	6.8108	6.2424	0.62109	1.093	1.1445	0.57619	1.986	0.86036	0.28418
17	1.40	6.8258	6.2424	0.63742	1.093	1.1432	0.55986	2.042	0.85155	0.2917
18	1.54	6.8347	6.2424	0.65433	1.105	1.1352	0.54294	2.091	0.83908	0.29614
19	1.69	6.8423	6.2424	0.66775	1.113	1.1295	0.52953	2.133	0.82949	0.29996
20	2.55	6.8846	6.2424	0.73656	1.147	1.103	0.46072	2.394	0.78184	0.32112
21	3.41	6.9118	6.2424	0.77972	1.165	1.087	0.41756	2.603	0.75227	0.33471
22	4.27	6.9284	6.2424	0.81121	1.183	1.0721	0.38607	2.777	0.72907	0.343
23	5.13	6.9451	6.2424	0.83512	1.189	1.0648	0.36216	2.940	0.71349	0.35133
24	5.99	6.955	6.2424	0.85611	1.201	1.0538	0.34116	3.089	0.69746	0.3563
25	6.85	6.9669	6.2424	0.86836	1.199	1.0534	0.32892	3.203	0.69118	0.36226
26	7.71	6.9733	6.2424	0.87886	1.202	1.0494	0.31842	3.296	0.68389	0.36547
27	8.56	6.9762	6.2424	0.88877	1.211	1.0423	0.30851	3.379	0.6754	0.36689
28	9.43	6.9821	6.2424	0.8981	1.214	1.0389	0.29917	3.473	0.66904	0.36986
29	10.29	6.9817	6.2424	0.90277	1.221	1.0338	0.29451	3.510	0.66417	0.36966
30	11.15	6.9802	6.2424	0.90743	1.230	1.0276	0.28984	3.545	0.65874	0.36889
31	12.01	6.9768	6.2424	0.91327	1.243	1.0184	0.28401	3.586	0.65123	0.36722
32	12.87	6.9771	6.2424	0.9191	1.251	1.0129	0.27818	3.641	0.64555	0.36737
33	13.73	6.971	6.2424	0.91851	1.261	1.0074	0.27876	3.614	0.64307	0.36431
34	14.60	6.9642	6.2424	0.92085	1.276	0.99824	0.27643	3.611	0.63733	0.3609
35	15.46	6.9585	6.2424	0.92493	1.292	0.98842	0.27235	3.629	0.63038	0.35804
36	16.20	6.9528	6.2424	0.92493	1.302	0.98271	0.27235	3.608	0.62753	0.35518

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S10
Sample No.: S-10
Test No.: 30.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-37.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: VERY DARK GRAY LEAN CLAY WITH SAND CL FLY ASH AND SHELL NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.85 in
Specimen Area: 6.18 in^2
Specimen Volume: 36.12 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.1766	0	0	5.0416	7.2	7.2
2	5.0037	0.054	6.1799	31.761	0.37004	5.2399	7.2	7.57
3	10.004	0.11946	6.184	49.071	0.57134	5.3956	7.2	7.7713
4	15.004	0.18655	6.1881	59.764	0.69537	5.5105	7.2	7.8954
5	20.004	0.25528	6.1924	67.387	0.78352	5.605	7.2	7.9835
6	25.004	0.32237	6.1966	73.369	0.8525	5.686	7.2	8.0525
7	30.004	0.39109	6.2008	78.503	0.91153	5.7543	7.2	8.1115
8	35.004	0.45982	6.2051	82.844	0.96127	5.812	7.2	8.1613
9	40.004	0.52855	6.2094	86.444	1.0023	5.8575	7.2	8.2023
10	45.004	0.60055	6.2139	89.726	1.0396	5.9088	7.2	8.2396
11	50.004	0.66764	6.2181	92.584	1.072	5.9508	7.2	8.272
12	55.004	0.73473	6.2223	95.019	1.0995	5.9875	7.2	8.2995
13	60.004	0.80837	6.2269	97.507	1.1274	6.019	7.2	8.3274
14	70.004	0.94583	6.2356	101.48	1.1717	6.0791	7.2	8.3717
15	80.004	1.0882	6.2445	105.18	1.2128	6.1287	7.2	8.4128
16	90.004	1.2306	6.2535	108.25	1.2464	6.1695	7.2	8.4464
17	110	1.5153	6.2716	113.44	1.3023	6.2366	7.2	8.5023
18	120	1.6577	6.2807	115.93	1.329	6.2681	7.2	8.529
19	180	2.5037	6.3352	126.62	1.4391	6.3818	7.2	8.6391
20	240	3.3431	6.3902	134.46	1.515	6.443	7.2	8.715
21	300	4.2006	6.4474	141.18	1.5766	6.4798	7.2	8.7766
22	360	5.04	6.5044	146.84	1.6255	6.4955	7.2	8.8255
23	420	5.8779	6.5623	152.03	1.668	6.5048	7.2	8.868
24	480	6.7321	6.6224	156.32	1.6995	6.5095	7.2	8.8995
25	540	7.5781	6.683	160.45	1.7286	6.5083	7.2	8.9286
26	600	8.4224	6.7446	164.47	1.7557	6.5054	7.2	8.9557
27	660	9.2734	6.8079	168.18	1.7786	6.4984	7.2	8.9786
28	720	10.116	6.8717	171.56	1.7976	6.4868	7.2	8.9976
29	780	10.964	6.9372	174.9	1.8153	6.4827	7.2	9.0153
30	840	11.811	7.0038	177.7	1.8268	6.4757	7.2	9.0268
31	900	12.661	7.0719	179.98	1.8324	6.4599	7.2	9.0324
32	960	13.502	7.1407	182.42	1.8393	6.4611	7.2	9.0393
33	1020	14.359	7.2122	184.27	1.8396	6.4518	7.2	9.0396
34	1080	15.204	7.284	185.33	1.8319	6.4424	7.2	9.0319

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S10
Sample No.: S-10
Test No.: 30.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-37.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: VERY DARK GRAY LEAN CLAY WITH SAND CL FLY ASH AND SHELL NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.85 in
Specimen Area: 6.18 in^2
Specimen Volume: 36.12 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	7.2	7.2	0	0.000	2.1584	2.1584	1.000	2.1584	0
2	0.05	7.57	7.2	0.19828	0.536	2.3301	1.9601	1.189	2.1451	0.18502
3	0.12	7.7713	7.2	0.35399	0.620	2.3757	1.8044	1.317	2.0901	0.28567
4	0.19	7.8954	7.2	0.46888	0.674	2.3849	1.6895	1.412	2.0372	0.34768
5	0.26	7.9835	7.2	0.56336	0.719	2.3785	1.595	1.491	1.9868	0.39176
6	0.32	8.0525	7.2	0.64442	0.756	2.3665	1.514	1.563	1.9402	0.42625
7	0.39	8.1115	7.2	0.71265	0.782	2.3573	1.4457	1.631	1.9015	0.45577
8	0.46	8.1613	7.2	0.77039	0.801	2.3493	1.388	1.693	1.8686	0.48063
9	0.53	8.2023	7.2	0.81587	0.814	2.3448	1.3425	1.747	1.8437	0.50117
10	0.60	8.2396	7.2	0.86719	0.834	2.3308	1.2912	1.805	1.811	0.51982
11	0.67	8.272	7.2	0.90918	0.848	2.3212	1.2492	1.858	1.7852	0.53602
12	0.73	8.2995	7.2	0.94592	0.860	2.3119	1.2125	1.907	1.7622	0.54975
13	0.81	8.3274	7.2	0.97742	0.867	2.3084	1.181	1.955	1.7447	0.56372
14	0.95	8.3717	7.2	1.0375	0.885	2.2926	1.1209	2.045	1.7068	0.58586
15	1.09	8.4128	7.2	1.0871	0.896	2.2841	1.0713	2.132	1.6777	0.60638
16	1.23	8.4464	7.2	1.1279	0.905	2.2769	1.0305	2.209	1.6537	0.62319
17	1.52	8.5023	7.2	1.1949	0.918	2.2658	0.96343	2.352	1.6146	0.65117
18	1.66	8.529	7.2	1.2264	0.923	2.2609	0.93194	2.426	1.5964	0.66449
19	2.50	8.6391	7.2	1.3402	0.931	2.2573	0.81822	2.759	1.5378	0.71953
20	3.34	8.715	7.2	1.4014	0.925	2.2719	0.75699	3.001	1.5145	0.75748
21	4.20	8.7766	7.2	1.4381	0.912	2.2968	0.72025	3.189	1.5085	0.78829
22	5.04	8.8255	7.2	1.4539	0.894	2.33	0.7045	3.307	1.5172	0.81273
23	5.88	8.868	7.2	1.4632	0.877	2.3632	0.69517	3.399	1.5292	0.83402
24	6.73	8.8995	7.2	1.4679	0.864	2.39	0.6905	3.461	1.5403	0.84976
25	7.58	8.9286	7.2	1.4667	0.848	2.4203	0.69167	3.499	1.556	0.8643
26	8.42	8.9557	7.2	1.4638	0.834	2.4503	0.69458	3.528	1.5725	0.87787
27	9.27	8.9786	7.2	1.4568	0.819	2.4802	0.70158	3.535	1.5909	0.88931
28	10.12	8.9976	7.2	1.4451	0.804	2.5108	0.71325	3.520	1.612	0.8988
29	10.96	9.0153	7.2	1.441	0.794	2.5326	0.71733	3.531	1.625	0.90763
30	11.81	9.0268	7.2	1.434	0.785	2.5511	0.72433	3.522	1.6377	0.91341
31	12.66	9.0324	7.2	1.4183	0.774	2.5725	0.74007	3.476	1.6563	0.9162
32	13.50	9.0393	7.2	1.4195	0.772	2.5782	0.73891	3.489	1.6586	0.91965
33	14.36	9.0396	7.2	1.4101	0.767	2.5878	0.74824	3.459	1.668	0.91979
34	15.20	9.0319	7.2	1.4008	0.765	2.5895	0.75757	3.418	1.6735	0.91595

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S10
Sample No.: S-10
Test No.: 60.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: VERY DARK GRAY LEAN CLAY WITH SAND CL FLY ASH AND SHELL NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.76 in
Specimen Area: 6.09 in^2
Specimen Volume: 35.05 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.085	1.2705	0.015032	5.0706	9.36	9.375
2	5.0035	0.047279	6.0879	29.485	0.34871	5.2986	9.36	9.7087
3	5.0001	0.063039	6.0888	37.849	0.44756	5.3655	9.36	9.8076
4	10.004	0.11189	6.0918	57.964	0.68509	5.5412	9.36	10.045
5	10	0.12923	6.0929	64.052	0.75691	5.5964	9.36	10.117
6	15.004	0.17966	6.096	77.815	0.91908	5.7401	9.36	10.279
7	15	0.197	6.097	81.838	0.96643	5.7855	9.36	10.326
8	20.004	0.24585	6.1	92.214	1.0884	5.9146	9.36	10.448
9	20	0.26476	6.1012	95.39	1.1257	5.9576	9.36	10.486
10	25.004	0.31519	6.1042	103.81	1.2244	6.0699	9.36	10.584
11	25	0.3341	6.1054	106.51	1.256	6.1071	9.36	10.616
12	30.004	0.38611	6.1086	113.02	1.3321	6.2054	9.36	10.692
13	30	0.40345	6.1097	115.03	1.3556	6.2368	9.36	10.716
14	35.004	0.45545	6.1129	120.9	1.4241	6.3229	9.36	10.784
15	35	0.47279	6.1139	122.97	1.4481	6.3496	9.36	10.808
16	40.004	0.52322	6.117	127.42	1.4997	6.4229	9.36	10.86
17	40	0.54213	6.1182	129.32	1.5219	6.4485	9.36	10.882
18	45.004	0.59572	6.1215	133.82	1.574	6.5218	9.36	10.934
19	45	0.61305	6.1225	134.93	1.5868	6.5451	9.36	10.947
20	50.004	0.66506	6.1257	138.9	1.6326	6.6096	9.36	10.993
21	50	0.68397	6.1269	140.17	1.6472	6.6317	9.36	11.007
22	55.004	0.73598	6.1301	143.67	1.6874	6.6899	9.36	11.047
23	55	0.75331	6.1312	145.15	1.7045	6.7097	9.36	11.065
24	60.004	0.80374	6.1343	148.85	1.7471	6.7574	9.36	11.107
25	60	0.82108	6.1354	149.81	1.758	6.7731	9.36	11.118
26	70.004	0.94558	6.1431	155.37	1.821	6.8865	9.36	11.181
27	70	0.96449	6.1443	156.27	1.8312	6.9033	9.36	11.191
28	80.004	1.0874	6.1519	161.82	1.8939	6.997	9.36	11.254
29	80	1.1063	6.1531	162.78	1.9047	7.0086	9.36	11.265
30	90.004	1.2277	6.1606	167.06	1.9525	7.0889	9.36	11.313
31	90	1.2466	6.1618	167.44	1.9565	7.1017	9.36	11.316
32	100	1.3727	6.1697	172.09	2.0083	7.1802	9.36	11.368
33	100	1.39	6.1708	172.78	2.016	7.1907	9.36	11.376
34	110	1.5145	6.1786	175.85	2.0492	7.243	9.36	11.409
35	110	1.5334	6.1798	176.43	2.0556	7.2552	9.36	11.416
36	120	1.6563	6.1875	180.19	2.0968	7.3175	9.36	11.457
37	120	1.6753	6.1887	180.72	2.1025	7.3274	9.36	11.463
38	180	2.5168	6.2421	197.34	2.2763	7.5908	9.36	11.636
39	180	2.5357	6.2433	197.56	2.2783	7.5961	9.36	11.638
40	240	3.3789	6.2978	209.2	2.3917	7.7543	9.36	11.752
41	240	3.3978	6.299	209.36	2.3931	7.7549	9.36	11.753
42	300	4.2409	6.3545	219.21	2.4837	7.8566	9.36	11.844
43	300	4.2598	6.3558	219.52	2.4868	7.8601	9.36	11.847
44	360	5.103	6.4122	226.41	2.5422	7.9229	9.36	11.902
45	360	5.1235	6.4136	226.62	2.544	7.9253	9.36	11.904
46	420	5.9698	6.4713	232.81	2.5903	7.9706	9.36	11.95
47	420	5.9871	6.4725	233.13	2.5933	7.9712	9.36	11.953
48	480	6.8271	6.5309	238.42	2.6285	8.0055	9.36	11.988
49	480	6.8444	6.5321	238.63	2.6303	8.0073	9.36	11.99
50	540	7.686	6.5916	243.77	2.6627	8.0207	9.36	12.023
51	540	7.7049	6.593	244.14	2.6662	8.023	9.36	12.026
52	600	8.5543	6.6542	249.06	2.6949	8.0364	9.36	12.055
53	600	8.5733	6.6556	249.11	2.6949	8.0352	9.36	12.055
54	660	9.4117	6.7172	253.99	2.7224	8.0433	9.36	12.082
55	660	9.4306	6.7186	253.77	2.7196	8.0433	9.36	12.08
56	720	10.267	6.7813	257.8	2.7371	8.041	9.36	12.097
57	720	10.286	6.7827	257.64	2.7349	8.0416	9.36	12.095
58	780	11.136	6.8475	262.03	2.7552	8.0474	9.36	12.115
59	780	11.153	6.8489	261.93	2.7535	8.0451	9.36	12.114
60	840	11.998	6.9146	265.37	2.7632	8.0445	9.36	12.123
61	840	12.017	6.9161	265.26	2.7615	8.0439	9.36	12.121
62	900	12.861	6.9831	268.54	2.7688	8.0364	9.36	12.129
63	900	12.88	6.9847	268.6	2.7688	8.0364	9.36	12.129
64	960	13.731	7.0536	270.98	2.766	8.0375	9.36	12.126
65	960	13.75	7.0551	271.72	2.773	8.0369	9.36	12.133
66	1020	14.592	7.1246	273.41	2.763	8.0369	9.36	12.123
67	1020	14.611	7.1262	273.73	2.7656	8.0381	9.36	12.126
68	1080	15.451	7.197	275.11	2.7522	8.0346	9.36	12.112

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-016 S10
Sample No.: S-10
Test No.: 60.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

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Soil Description: VERY DARK GRAY LEAN CLAY WITH SAND CL FLY ASH AND SHELL NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.76 in
Specimen Area: 6.09 in^2
Specimen Volume: 35.05 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	9.375	9.36	0	0.000	4.3044	4.2894	1.004	4.2969	0.0075162
2	0.05	9.7087	9.36	0.228	0.683	4.4101	4.0614	1.086	4.2357	0.17436
3	0.06	9.8076	9.36	0.29489	0.682	4.442	3.9945	1.112	4.2183	0.22378
4	0.11	10.045	9.36	0.47054	0.702	4.5039	3.8188	1.179	4.1614	0.34254
5	0.13	10.117	9.36	0.52579	0.709	4.5205	3.7636	1.201	4.142	0.37845
6	0.18	10.279	9.36	0.66945	0.741	4.539	3.6199	1.254	4.0795	0.45954
7	0.20	10.326	9.36	0.71482	0.751	4.541	3.5745	1.270	4.0578	0.48322
8	0.25	10.448	9.36	0.84394	0.786	4.5338	3.4454	1.316	3.9896	0.54421
9	0.26	10.486	9.36	0.88698	0.799	4.5281	3.4024	1.331	3.9652	0.56285
10	0.32	10.584	9.36	0.99924	0.826	4.5145	3.2901	1.372	3.9023	0.6122
11	0.33	10.616	9.36	1.0365	0.835	4.5089	3.2529	1.386	3.8809	0.62801
12	0.39	10.692	9.36	1.1348	0.862	4.4867	3.1546	1.422	3.8207	0.66605
13	0.40	10.716	9.36	1.1662	0.870	4.4788	3.1232	1.434	3.801	0.67779
14	0.46	10.784	9.36	1.2522	0.889	4.4612	3.0371	1.469	3.7492	0.71204
15	0.47	10.808	9.36	1.279	0.892	4.4585	3.0104	1.481	3.7344	0.72407
16	0.52	10.86	9.36	1.3523	0.911	4.4368	2.9371	1.511	3.6869	0.74987
17	0.54	10.882	9.36	1.3779	0.914	4.4334	2.9115	1.523	3.6724	0.76094
18	0.60	10.934	9.36	1.4512	0.931	4.4122	2.8382	1.555	3.6252	0.78699
19	0.61	10.947	9.36	1.4744	0.938	4.4017	2.8149	1.564	3.6083	0.79339
20	0.67	10.993	9.36	1.539	0.951	4.383	2.7504	1.594	3.5667	0.81631
21	0.68	11.007	9.36	1.5611	0.956	4.3755	2.7283	1.604	3.5519	0.82362
22	0.74	11.047	9.36	1.6193	0.968	4.3575	2.6701	1.632	3.5138	0.84371
23	0.75	11.065	9.36	1.639	0.970	4.3549	2.6503	1.643	3.5026	0.85226
24	0.80	11.107	9.36	1.6867	0.974	4.3498	2.6026	1.671	3.4762	0.87357
25	0.82	11.118	9.36	1.7024	0.977	4.345	2.5869	1.680	3.4659	0.87901
26	0.95	11.181	9.36	1.8158	1.005	4.2945	2.4735	1.736	3.384	0.91048
27	0.96	11.191	9.36	1.8327	1.009	4.2878	2.4567	1.745	3.3722	0.91558
28	1.09	11.254	9.36	1.9264	1.025	4.2569	2.363	1.801	3.31	0.94697
29	1.11	11.265	9.36	1.938	1.026	4.2561	2.3514	1.810	3.3037	0.95236
30	1.23	11.313	9.36	2.0183	1.042	4.2236	2.2711	1.860	3.2474	0.97625
31	1.25	11.316	9.36	2.031	1.046	4.2148	2.2583	1.866	3.2365	0.97823
32	1.37	11.368	9.36	2.1096	1.058	4.1881	2.1798	1.921	3.184	1.0042
33	1.39	11.376	9.36	2.12	1.060	4.1853	2.1693	1.929	3.1773	1.008
34	1.51	11.409	9.36	2.1724	1.068	4.1662	2.117	1.968	3.1416	1.0246
35	1.53	11.416	9.36	2.1846	1.071	4.1604	2.1048	1.977	3.1326	1.0278
36	1.66	11.457	9.36	2.2468	1.079	4.1393	2.0425	2.027	3.0909	1.0484
37	1.68	11.463	9.36	2.2567	1.081	4.1352	2.0326	2.034	3.0839	1.0513
38	2.52	11.636	9.36	2.5202	1.115	4.0454	1.7692	2.287	2.9073	1.1381
39	2.54	11.638	9.36	2.5254	1.116	4.0422	1.7639	2.292	2.9031	1.1391
40	3.38	11.752	9.36	2.6836	1.129	3.9974	1.6057	2.489	2.8016	1.1959
41	3.40	11.753	9.36	2.6842	1.129	3.9982	1.6051	2.491	2.8017	1.1965
42	4.24	11.844	9.36	2.786	1.129	3.9871	1.5034	2.652	2.7452	1.2419
43	4.26	11.847	9.36	2.7895	1.129	3.9867	1.4999	2.658	2.7433	1.2434
44	5.10	11.902	9.36	2.8523	1.129	3.9793	1.4371	2.769	2.7082	1.2711
45	5.12	11.904	9.36	2.8546	1.129	3.9788	1.4347	2.773	2.7067	1.272
46	5.97	11.95	9.36	2.9	1.126	3.9796	1.3894	2.864	2.6845	1.2951
47	5.99	11.953	9.36	2.9006	1.125	3.9821	1.3888	2.867	2.6854	1.2967
48	6.83	11.988	9.36	2.9349	1.123	3.983	1.3545	2.941	2.6687	1.3142
49	6.84	11.99	9.36	2.9366	1.123	3.9831	1.3527	2.944	2.6679	1.3152
50	7.69	12.023	9.36	2.95	1.114	4.002	1.3393	2.988	2.6707	1.3313
51	7.70	12.026	9.36	2.9523	1.114	4.0032	1.337	2.994	2.6701	1.3331
52	8.55	12.055	9.36	2.9657	1.107	4.0185	1.3236	3.036	2.6711	1.3474
53	8.57	12.055	9.36	2.9646	1.106	4.0197	1.3248	3.034	2.6723	1.3475
54	9.41	12.082	9.36	2.9727	1.098	4.0391	1.3167	3.068	2.6779	1.3612
55	9.43	12.08	9.36	2.9727	1.099	4.0362	1.3167	3.065	2.6764	1.3598
56	10.27	12.097	9.36	2.9704	1.091	4.0561	1.319	3.075	2.6876	1.3686
57	10.29	12.095	9.36	2.971	1.092	4.0533	1.3184	3.074	2.6858	1.3674
58	11.14	12.115	9.36	2.9768	1.086	4.0678	1.3126	3.099	2.6902	1.3776
59	11.15	12.114	9.36	2.9744	1.086	4.0685	1.3149	3.094	2.6917	1.3768
60	12.00	12.123	9.36	2.9739	1.082	4.0787	1.3155	3.100	2.6971	1.3816
61	12.02	12.121	9.36	2.9733	1.083	4.0776	1.3161	3.098	2.6968	1.3807
62	12.86	12.129	9.36	2.9657	1.077	4.0925	1.3236	3.092	2.708	1.3844
63	12.88	12.129	9.36	2.9657	1.077	4.0924	1.3236	3.092	2.708	1.3844
64	13.73	12.126	9.36	2.9669	1.078	4.0885	1.3225	3.092	2.7055	1.383
65	13.75	12.133	9.36	2.9663	1.076	4.096	1.3231	3.096	2.7096	1.3865
66	14.59	12.123	9.36	2.9663	1.079	4.0861	1.3231	3.088	2.7046	1.3815
67	14.61	12.126	9.36	2.9675	1.079	4.0875	1.3219	3.092	2.7047	1.3828
68	15.45	12.112	9.36	2.964	1.083	4.0776	1.3254	3.077	2.7015	1.3761

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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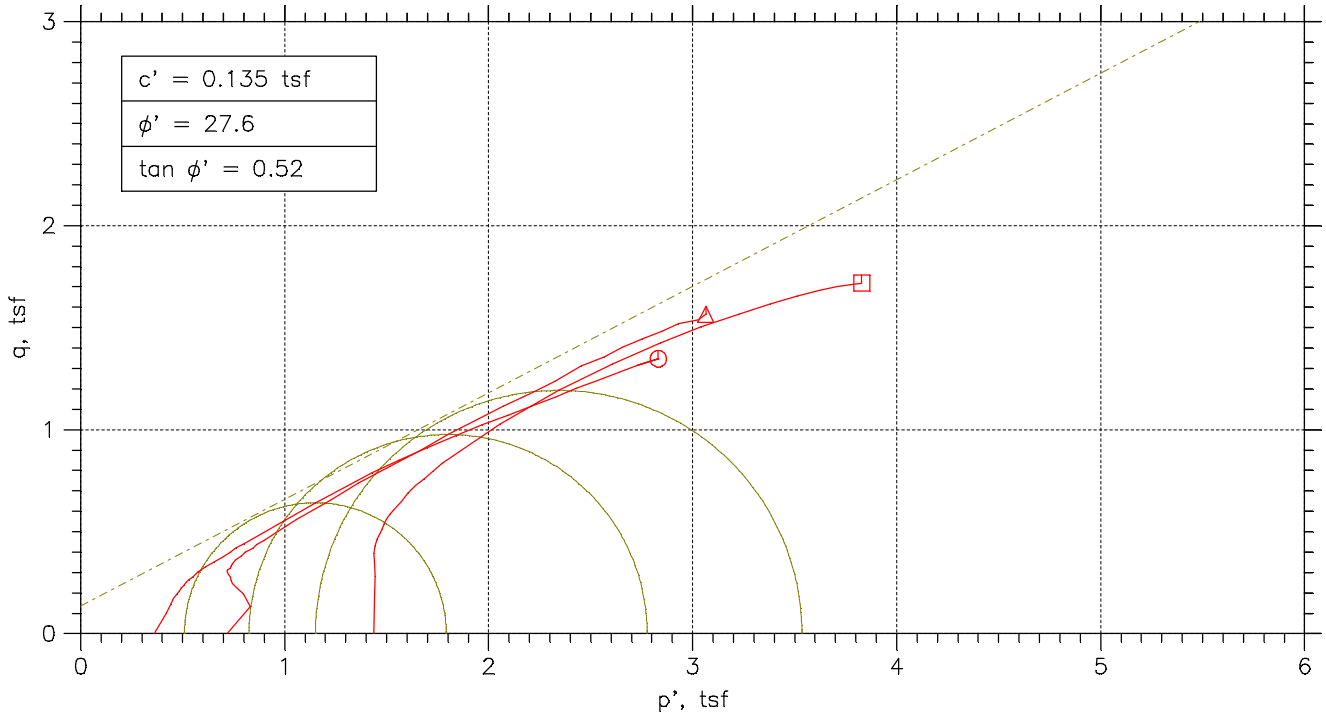
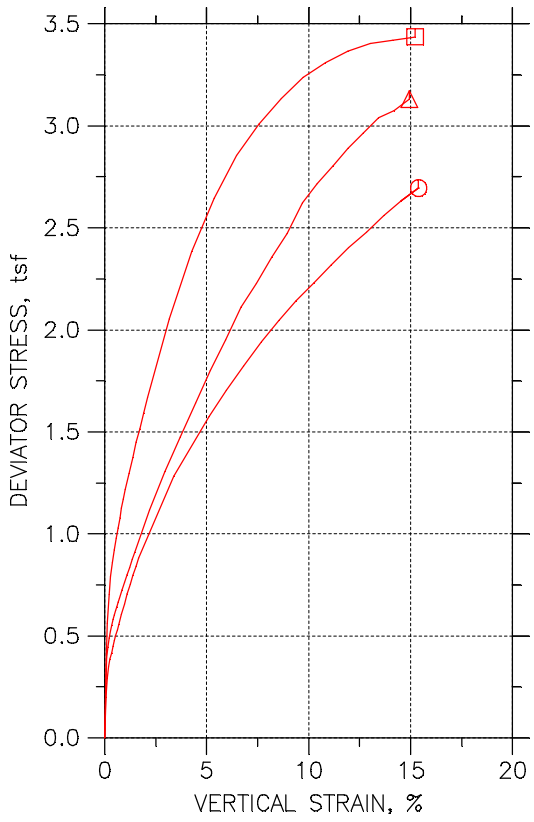




Symbol		⏲	△	⊡	
Test No.		5.0 PSI	10.0 PSI	20.0 PSI	
Initial	Diameter, in	2.8799	2.8646	2.8394	
	Height, in	5.9846	5.9776	5.9764	
	Water Content, %	45.39	45.24	43.38	
	Dry Density, pcf	69.73	70.52	76.64	
	Saturation, %	98.57	100.41	114.22	
	Void Ratio	1.0592	1.0362	0.87359	
Before Shear	Water Content, %	45.39	45.24	43.38	
	Dry Density, pcf	70.25	70.37	71.87	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	1.044	1.0404	0.99783	
	Back Press., tsf	5.0405	5.0425	5.0416	
Minor Prin. Stress, tsf		0.35947	0.71748	1.4384	
Max. Dev. Stress, tsf		2.6948	3.1306	3.4366	
Time to Failure, min		1080	1200	840	
Strain Rate, %/min		0.02	0.02	0.02	
B-Value		0.98	0.99	0.96	
Estimated Specific Gravity		2.30	2.30	2.30	
Liquid Limit		NP	NP	NP	
Plastic Limit		NP	NP	NP	
Plasticity Index		NP	NP	NP	

Project: DYNERGY HENNEPIN

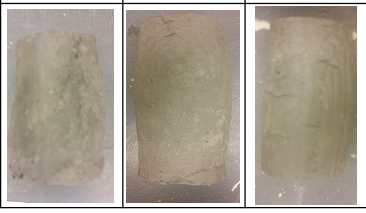
Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HEN-018 S-5

Sample Type: 3.0" ST

Failure Sketch



Description: DARK GRAY TO GRAY FLY ASH WITH SAND AND GRAVEL

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Tue, 22-DEC-2015 13:15:37

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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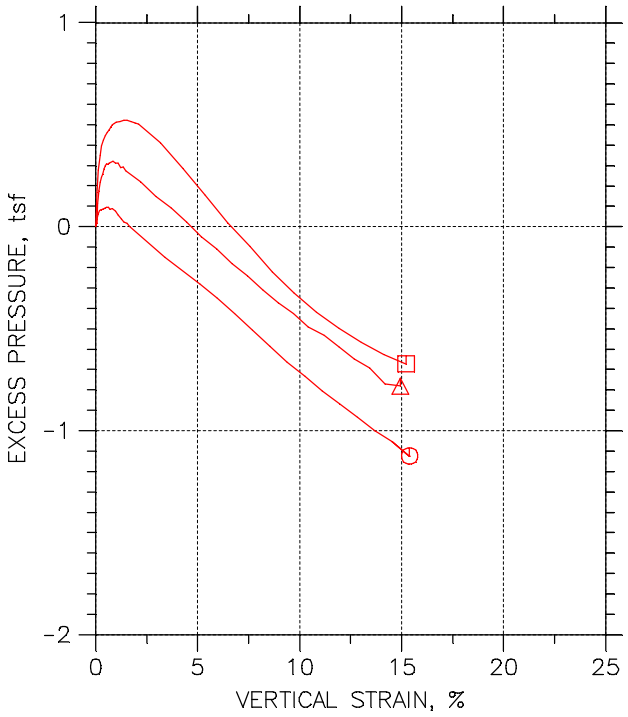

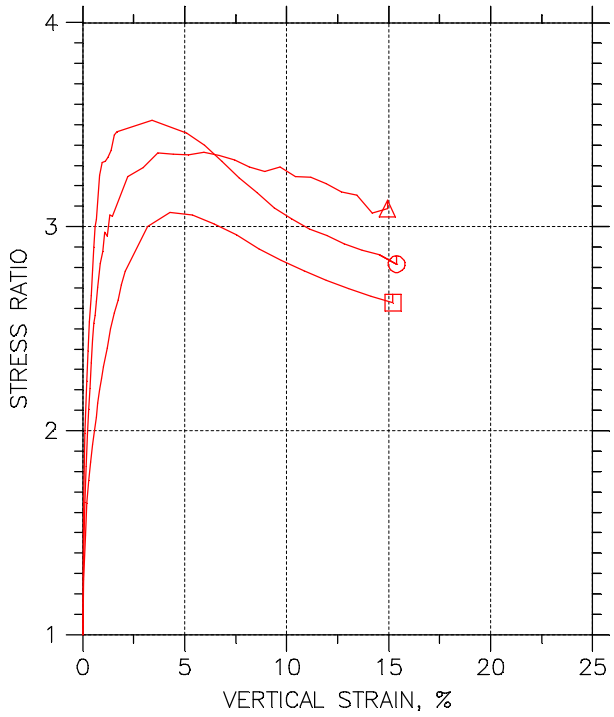

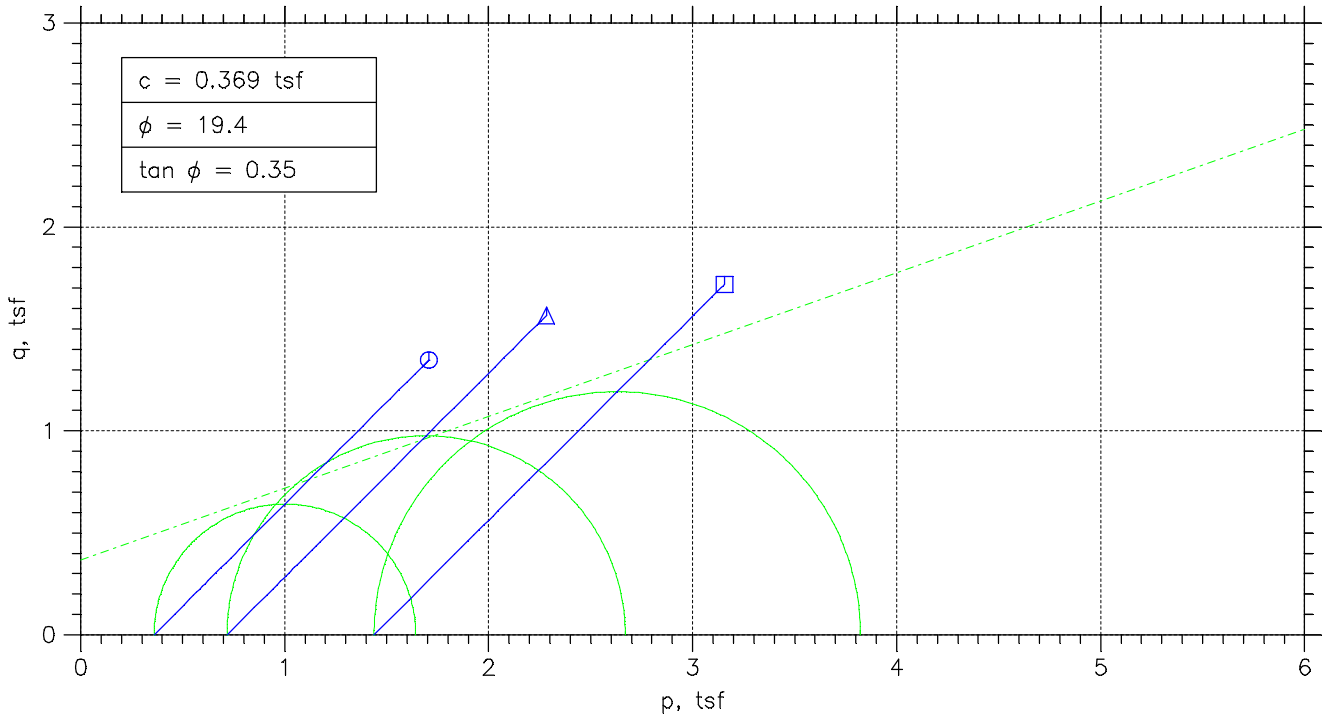

Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-018 S-5	Tested By: BCM	Checked By: WPQ
Sample No.: S-5	Test Date: 12/16/15	Depth: 10.0'-12.0'
Test No.: HEN-018 S-5	Sample Type: 3.0" ST	Elevation: ----
Description: DARK GRAY TO GRAY FLY ASH WITH SAND AND GRAVEL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		

Tue, 22-DEC-2015 13:16:23

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-018 S-5
Sample No.: S-5
Test No.: 5.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

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Soil Description: DARK GRAY TO GRAY FLY ASH WITH SAND AND GRAVEL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.98 in
Specimen Area: 6.51 in^2
Specimen Volume: 38.98 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: NP

Plastic Limit: NP

Estimated Specific Gravity: 2.30

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.5141	0	0	5.0405	5.4	5.4
2	5.001	0.052041	6.5174	18.3	0.20216	5.0794	5.4	5.6022
3	10.001	0.12301	6.5221	26.427	0.29174	5.1044	5.4	5.6917
4	15.001	0.19239	6.5266	31.613	0.34875	5.1201	5.4	5.7487
5	20.001	0.26336	6.5313	35.053	0.38643	5.1224	5.4	5.7864
6	25.001	0.33432	6.5359	37.995	0.41856	5.1271	5.4	5.8186
7	30.001	0.40687	6.5407	40.738	0.44844	5.13	5.4	5.8484
8	35.001	0.47625	6.5452	43.231	0.47556	5.1334	5.4	5.8756
9	40.001	0.54722	6.5499	45.774	0.50317	5.1352	5.4	5.9032
10	45.001	0.61818	6.5546	48.267	0.5302	5.1352	5.4	5.9302
11	50.001	0.68757	6.5591	50.611	0.55555	5.1271	5.4	5.9556
12	60.002	0.82793	6.5684	55.348	0.60669	5.1305	5.4	6.0067
13	70.002	0.96828	6.5777	59.935	0.65605	5.1166	5.4	6.056
14	80.002	1.1086	6.5871	64.522	0.70526	5.0963	5.4	6.1053
15	90.002	1.2506	6.5965	69.06	0.75377	5.0777	5.4	6.1538
16	100	1.3925	6.606	73.149	0.79726	5.0643	5.4	6.1973
17	110	1.536	6.6157	77.237	0.84059	5.0568	5.4	6.2406
18	120	1.6779	6.6252	81.226	0.88273	5.0417	5.4	6.2827
19	240	3.4	6.7433	120.17	1.2831	4.8913	5.4	6.6831
20	360	5.1095	6.8648	150.09	1.5742	4.76	5.4	6.9742
21	420	5.9674	6.9274	163.85	1.703	4.6898	5.4	7.103
22	480	6.8205	6.9909	177.11	1.8241	4.6143	5.4	7.2241
23	540	7.6753	7.0556	190.18	1.9407	4.533	5.4	7.3407
24	600	8.5395	7.1223	202.49	2.047	4.4552	5.4	7.447
25	660	9.391	7.1892	213.96	2.1428	4.3762	5.4	7.5428
26	720	10.252	7.2582	224.88	2.2308	4.3059	5.4	7.6308
27	780	11.108	7.3281	235.9	2.3178	4.2345	5.4	7.7178
28	840	11.958	7.3988	246.92	2.4028	4.1718	5.4	7.8028
29	900	12.826	7.4724	257.29	2.4791	4.1062	5.4	7.8791
30	960	13.68	7.5464	268.41	2.5609	4.0417	5.4	7.9609
31	1020	14.53	7.6215	278.53	2.6313	3.9871	5.4	8.0313
32	1080	15.39	7.6989	288.16	2.6948	3.9163	5.4	8.0948
33	1020	14.53	7.6215	278.53	2.6313	3.9871	5.4	8.0313
34	1080	15.39	7.6989	288.16	2.6948	3.9163	5.4	8.0948
35	1080	15.39	7.6989	288.16	2.6948	3.9163	5.4	8.0948

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-018 S-5
Sample No.: S-5
Test No.: 5.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

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Soil Description: DARK GRAY TO GRAY FLY ASH WITH SAND AND GRAVEL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.98 in
Specimen Area: 6.51 in^2
Specimen Volume: 38.98 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: NP

Plastic Limit: NP

Estimated Specific Gravity: 2.30

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	5.4	5.4	0	0.000	0.35947	0.35947	1.000	0.35947	0
2	0.05	5.6022	5.4	0.038907	0.192	0.52273	0.32057	1.631	0.42165	0.10108
3	0.12	5.6917	5.4	0.063878	0.219	0.58734	0.2956	1.987	0.44147	0.14587
4	0.19	5.7487	5.4	0.079557	0.228	0.62866	0.27992	2.246	0.45429	0.17437
5	0.26	5.7864	5.4	0.08188	0.212	0.66402	0.27759	2.392	0.47081	0.19321
6	0.33	5.8186	5.4	0.086525	0.207	0.69151	0.27295	2.533	0.48223	0.20928
7	0.41	5.8484	5.4	0.089429	0.199	0.71849	0.27004	2.661	0.49427	0.22422
8	0.48	5.8756	5.4	0.092913	0.195	0.74212	0.26656	2.784	0.50434	0.23778
9	0.55	5.9032	5.4	0.094655	0.188	0.76799	0.26482	2.900	0.5164	0.25159
10	0.62	5.9302	5.4	0.094655	0.179	0.79502	0.26482	3.002	0.52992	0.2651
11	0.69	5.9556	5.4	0.086525	0.156	0.8285	0.27295	3.035	0.55072	0.27778
12	0.83	6.0067	5.4	0.090009	0.148	0.87616	0.26946	3.251	0.57281	0.30335
13	0.97	6.056	5.4	0.076072	0.116	0.93945	0.2834	3.315	0.61142	0.32802
14	1.11	6.1053	5.4	0.055748	0.079	1.009	0.30373	3.322	0.65636	0.35263
15	1.25	6.1538	5.4	0.037165	0.049	1.0761	0.32231	3.339	0.69919	0.37689
16	1.39	6.1973	5.4	0.023809	0.030	1.1329	0.33566	3.375	0.73429	0.39863
17	1.54	6.2406	5.4	0.01626	0.019	1.1838	0.34321	3.449	0.76351	0.4203
18	1.68	6.2827	5.4	0.0011614	0.001	1.241	0.35831	3.464	0.79968	0.44137
19	3.40	6.6831	5.4	-0.14924	-0.116	1.7918	0.50871	3.522	1.1503	0.64154
20	5.11	6.9742	5.4	-0.28048	-0.178	2.2141	0.63995	3.460	1.427	0.78708
21	5.97	7.103	5.4	-0.35075	-0.206	2.4132	0.71022	3.398	1.5617	0.85148
22	6.82	7.2241	5.4	-0.42624	-0.234	2.6098	0.78571	3.322	1.6978	0.91205
23	7.68	7.3407	5.4	-0.50754	-0.262	2.8077	0.86701	3.238	1.8374	0.97034
24	8.54	7.447	5.4	-0.58535	-0.286	2.9919	0.94482	3.167	1.9683	1.0235
25	9.39	7.5428	5.4	-0.66433	-0.310	3.1666	1.0238	3.093	2.0952	1.0714
26	10.25	7.6308	5.4	-0.73459	-0.329	3.3249	1.0941	3.039	2.2095	1.1154
27	11.11	7.7178	5.4	-0.80602	-0.348	3.4833	1.1655	2.989	2.3244	1.1589
28	11.96	7.8028	5.4	-0.86874	-0.362	3.6311	1.2282	2.956	2.4296	1.2014
29	12.83	7.8791	5.4	-0.93436	-0.377	3.7729	1.2938	2.916	2.5334	1.2396
30	13.68	7.9609	5.4	-0.99881	-0.390	3.9192	1.3583	2.885	2.6387	1.2804
31	14.53	8.0313	5.4	-1.0534	-0.400	4.0442	1.4129	2.862	2.7285	1.3156
32	15.39	8.0948	5.4	-1.1242	-0.417	4.1786	1.4837	2.816	2.8311	1.3474
33	14.53	8.0313	5.4	-1.0534	-0.400	4.0442	1.4129	2.862	2.7285	1.3156
34	15.39	8.0948	5.4	-1.1242	-0.417	4.1786	1.4837	2.816	2.8311	1.3474
35	15.39	8.0948	5.4	-1.1242	-0.417	4.1786	1.4837	2.816	2.8311	1.3474

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-018 S-5
Sample No.: S-5
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3" ST

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: -----

Terracon Consulting Engineers & Scientists

Soil Description: DARK GRAY TO GRAY FLY ASH WITH SAND AND GRAVEL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D 4767

Specimen Height: 5.98 in
Specimen Area: 6.44 in^2
Specimen Volume: 38.52 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: NP

Plastic Limit: NP

Estimated Specific Gravity: 2.30

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.4448	0	0	5.0425	5.76	5.76
2	5.0003	0.049768	6.448	23.994	0.26792	5.0618	5.76	6.0279
3	10.001	0.11059	6.4519	35.036	0.39099	5.1571	5.76	6.151
4	15.001	0.17142	6.4558	40.066	0.44685	5.2185	5.76	6.2068
5	20.001	0.23225	6.4598	43.94	0.48975	5.2612	5.76	6.2498
6	25.001	0.29308	6.4637	47.12	0.52487	5.2851	5.76	6.2849
7	30.001	0.35667	6.4678	49.722	0.5535	5.3009	5.76	6.3135
8	35.001	0.42026	6.472	52.15	0.58016	5.3243	5.76	6.3402
9	40.001	0.48109	6.4759	54.289	0.60359	5.3424	5.76	6.3636
10	45.001	0.54191	6.4799	56.139	0.62378	5.3518	5.76	6.3838
11	50.001	0.60274	6.4839	58.047	0.64459	5.3483	5.76	6.4046
12	55.001	0.66633	6.488	59.84	0.66406	5.3535	5.76	6.4241
13	60.001	0.72716	6.492	61.69	0.68418	5.3582	5.76	6.4442
14	70.001	0.84881	6.4999	65.332	0.72368	5.3623	5.76	6.4837
15	80.002	0.97323	6.5081	68.859	0.76179	5.3541	5.76	6.5218
16	90.002	1.0949	6.5161	72.386	0.79983	5.3547	5.76	6.5598
17	100	1.2193	6.5243	75.739	0.83583	5.3325	5.76	6.5958
18	110	1.341	6.5324	79.324	0.87431	5.3348	5.76	6.6343
19	120	1.4626	6.5404	82.677	0.91014	5.3161	5.76	6.6701
20	180	2.2091	6.5904	102.22	1.1167	5.2623	5.76	6.8767
21	240	2.9529	6.6409	120.37	1.3051	5.1898	5.76	7.0651
22	300	3.6939	6.692	137.14	1.4755	5.1355	5.76	7.2355
23	360	4.4487	6.7448	153.62	1.6398	5.0642	5.76	7.3998
24	420	5.1869	6.7973	169.86	1.7993	4.9946	5.76	7.5593
25	480	5.9306	6.8511	185.76	1.9522	4.9349	5.76	7.7122
26	540	6.6882	6.9067	202.59	2.1119	4.8613	5.76	7.8719
27	600	7.4403	6.9628	215.48	2.2282	4.8022	5.76	7.9882
28	660	8.1785	7.0188	229.65	2.3557	4.7327	5.76	8.1157
29	720	8.9361	7.0772	243.12	2.4733	4.6707	5.76	8.2333
30	780	9.6881	7.1361	259.94	2.6227	4.6163	5.76	8.3827
31	840	10.432	7.1954	271.39	2.7156	4.5508	5.76	8.4756
32	900	11.189	7.2568	282.66	2.8045	4.5093	5.76	8.5645
33	960	11.933	7.3181	293.71	2.8897	4.4532	5.76	8.6497
34	1020	12.677	7.3804	303.94	2.9651	4.3942	5.76	8.7251
35	1080	13.443	7.4457	314.29	3.0392	4.3497	5.76	8.7992
36	1140	14.189	7.5105	320.82	3.0756	4.2708	5.76	8.8356
37	1200	14.939	7.5766	329.44	3.1306	4.2609	5.76	8.8906

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-018 S-5
Sample No.: S-5
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3" ST

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: -----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK GRAY TO GRAY FLY ASH WITH SAND AND GRAVEL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D 4767

Specimen Height: 5.98 in
Specimen Area: 6.44 in^2
Specimen Volume: 38.52 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: NP

Plastic Limit: NP

Estimated Specific Gravity: 2.30

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	5.76	5.76	0	0.000	0.71748	0.71748	1.000	0.71748	0
2	0.05	6.0279	5.76	0.019293	0.072	0.96611	0.69819	1.384	0.83215	0.13396
3	0.11	6.151	5.76	0.11459	0.293	0.99388	0.60289	1.649	0.79839	0.19549
4	0.17	6.2068	5.76	0.17598	0.394	0.98835	0.5415	1.825	0.76493	0.22342
5	0.23	6.2498	5.76	0.21866	0.446	0.98858	0.49882	1.982	0.7437	0.24488
6	0.29	6.2849	5.76	0.24263	0.462	0.99973	0.47485	2.105	0.73729	0.26244
7	0.36	6.3135	5.76	0.25841	0.467	1.0126	0.45907	2.206	0.73582	0.27675
8	0.42	6.3402	5.76	0.2818	0.486	1.0158	0.43568	2.332	0.72577	0.29008
9	0.48	6.3636	5.76	0.29992	0.497	1.0212	0.41756	2.446	0.71936	0.3018
10	0.54	6.3838	5.76	0.30927	0.496	1.032	0.40821	2.528	0.7201	0.31189
11	0.60	6.4046	5.76	0.30577	0.474	1.0563	0.41171	2.566	0.73401	0.32229
12	0.67	6.4241	5.76	0.31103	0.468	1.0705	0.40645	2.634	0.73848	0.33203
13	0.73	6.4442	5.76	0.31571	0.461	1.0859	0.40177	2.703	0.74386	0.34209
14	0.85	6.4837	5.76	0.3198	0.442	1.1214	0.39768	2.820	0.75952	0.36184
15	0.97	6.5218	5.76	0.31161	0.409	1.1677	0.40587	2.877	0.78676	0.3809
16	1.09	6.5598	5.76	0.3122	0.390	1.2051	0.40528	2.974	0.8052	0.39991
17	1.22	6.5958	5.76	0.28998	0.347	1.2633	0.4275	2.955	0.84541	0.41791
18	1.34	6.6343	5.76	0.29232	0.334	1.2995	0.42516	3.056	0.86231	0.43715
19	1.46	6.6701	5.76	0.27361	0.301	1.354	0.44387	3.050	0.89894	0.45507
20	2.21	6.8767	5.76	0.21982	0.197	1.6144	0.49766	3.244	1.056	0.55837
21	2.95	7.0651	5.76	0.14733	0.113	1.8752	0.57015	3.289	1.2227	0.65254
22	3.69	7.2355	5.76	0.092958	0.063	2.1	0.62452	3.363	1.3623	0.73775
23	4.45	7.3998	5.76	0.021632	0.013	2.3357	0.69585	3.357	1.5158	0.81992
24	5.19	7.5593	5.76	-0.04794	-0.027	2.5647	0.76542	3.351	1.665	0.89963
25	5.93	7.7122	5.76	-0.10757	-0.055	2.7773	0.82505	3.366	1.8012	0.97612
26	6.69	7.8719	5.76	-0.18124	-0.086	3.0106	0.89872	3.350	1.9547	1.0559
27	7.44	7.9882	5.76	-0.24029	-0.108	3.186	0.95777	3.326	2.0719	1.1141
28	8.18	8.1157	5.76	-0.30986	-0.132	3.3831	1.0273	3.293	2.2052	1.1779
29	8.94	8.2333	5.76	-0.37183	-0.150	3.5627	1.0893	3.271	2.326	1.2367
30	9.69	8.3827	5.76	-0.4262	-0.163	3.7664	1.1437	3.293	2.455	1.3113
31	10.43	8.4756	5.76	-0.49168	-0.181	3.9248	1.2092	3.246	2.567	1.3578
32	11.19	8.5645	5.76	-0.53319	-0.190	4.0552	1.2507	3.242	2.6529	1.4023
33	11.93	8.6497	5.76	-0.58932	-0.204	4.1965	1.3068	3.211	2.7516	1.4448
34	12.68	8.7251	5.76	-0.64837	-0.219	4.3309	1.3658	3.171	2.8484	1.4826
35	13.44	8.7992	5.76	-0.6928	-0.228	4.4495	1.4103	3.155	2.9299	1.5196
36	14.19	8.8356	5.76	-0.77172	-0.251	4.5648	1.4892	3.065	3.027	1.5378
37	14.94	8.8906	5.76	-0.78166	-0.250	4.6297	1.4991	3.088	3.0644	1.5653

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-018 S-5
Sample No.: S-5
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK GRAY TO GRAY FLY ASH WITH SAND AND GRAVEL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 5.98 in
Specimen Area: 6.33 in^2
Specimen Volume: 37.84 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: NP

Plastic Limit: NP

Estimated Specific Gravity: 2.30

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.3319	0	0	5.0416	6.48	6.48
2	5.0042	0.056979	6.3355	29.948	0.34034	5.2096	6.48	6.8203
3	10	0.13295	6.3403	49.51	0.56223	5.3192	6.48	7.0422
4	15	0.21525	6.3456	61.928	0.70267	5.3921	6.48	7.1827
5	20	0.29756	6.3508	69.621	0.78931	5.4364	6.48	7.2693
6	25.001	0.38619	6.3564	75.886	0.85956	5.4656	6.48	7.3396
7	30.001	0.47483	6.3621	81.545	0.92285	5.4878	6.48	7.4028
8	35.001	0.56557	6.3679	86.436	0.9773	5.5041	6.48	7.4573
9	40.001	0.65843	6.3739	90.997	1.0279	5.5169	6.48	7.5079
10	45.001	0.74495	6.3794	95.503	1.0779	5.5315	6.48	7.5579
11	50.001	0.83147	6.385	99.844	1.1259	5.542	6.48	7.6059
12	55.001	0.92011	6.3907	103.8	1.1694	5.5484	6.48	7.6494
13	60.001	1.0109	6.3966	108.03	1.216	5.5542	6.48	7.696
14	70.001	1.1902	6.4082	115.39	1.2965	5.5577	6.48	7.7765
15	80.001	1.3675	6.4197	122.54	1.3743	5.5636	6.48	7.8543
16	90.001	1.549	6.4315	129.41	1.4487	5.5618	6.48	7.9287
17	100	1.7305	6.4434	135.73	1.5166	5.5554	6.48	7.9966
18	110	1.9077	6.455	142.76	1.5923	5.5513	6.48	8.0723
19	120	2.0892	6.467	149.96	1.6695	5.5432	6.48	8.1495
20	180	3.1824	6.54	186.55	2.0538	5.4534	6.48	8.5338
21	240	4.2755	6.6147	219.03	2.3841	5.3286	6.48	8.8641
22	300	5.3666	6.691	245.68	2.6437	5.1956	6.48	9.1237
23	360	6.4598	6.7692	268.26	2.8534	5.0626	6.48	9.3334
24	420	7.5571	6.8495	286.18	3.0082	4.9442	6.48	9.4882
25	480	8.6482	6.9313	301.84	3.1354	4.8206	6.48	9.6154
26	540	9.7392	7.0151	315.3	3.2361	4.7168	6.48	9.7161
27	600	10.837	7.1015	326.51	3.3104	4.6235	6.48	9.7904
28	660	11.93	7.1896	336.18	3.3667	4.5436	6.48	9.8467
29	720	13.031	7.2807	344.26	3.4045	4.4736	6.48	9.8845
30	780	14.125	7.3733	350.25	3.4202	4.4165	6.48	9.9002
31	840	15.213	7.468	356.46	3.4366	4.3692	6.48	9.9166

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-018 S-5
Sample No.: S-5
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK GRAY TO GRAY FLY ASH WITH SAND AND GRAVEL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 5.98 in
Specimen Area: 6.33 in^2
Specimen Volume: 37.84 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: NP

Plastic Limit: NP

Estimated Specific Gravity: 2.30

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	6.48	6.48	0	0.000	1.4384	1.4384	1.000	1.4384	0
2	0.06	6.8203	6.48	0.16796	0.493	1.6108	1.2704	1.268	1.4406	0.17017
3	0.13	7.0422	6.48	0.2776	0.494	1.723	1.1608	1.484	1.4419	0.28111
4	0.22	7.1827	6.48	0.35049	0.499	1.7906	1.0879	1.646	1.4392	0.35134
5	0.30	7.2693	6.48	0.39482	0.500	1.8329	1.0436	1.756	1.4382	0.39465
6	0.39	7.3396	6.48	0.42397	0.493	1.874	1.0144	1.847	1.4442	0.42978
7	0.47	7.4028	6.48	0.44614	0.483	1.9151	0.99224	1.930	1.4537	0.46142
8	0.57	7.4573	6.48	0.46246	0.473	1.9532	0.97591	2.001	1.4646	0.48865
9	0.66	7.5079	6.48	0.47529	0.462	1.991	0.96308	2.067	1.477	0.51396
10	0.74	7.5579	6.48	0.48987	0.454	2.0264	0.9485	2.136	1.4874	0.53893
11	0.83	7.6059	6.48	0.50037	0.444	2.0639	0.938	2.200	1.5009	0.56294
12	0.92	7.6494	6.48	0.50679	0.433	2.101	0.93159	2.255	1.5163	0.58472
13	1.01	7.696	6.48	0.51262	0.422	2.1418	0.92576	2.314	1.5338	0.608
14	1.19	7.7765	6.48	0.51612	0.398	2.2188	0.92226	2.406	1.5705	0.64827
15	1.37	7.8543	6.48	0.52195	0.380	2.2907	0.91643	2.500	1.6036	0.68716
16	1.55	7.9287	6.48	0.5202	0.359	2.3669	0.91818	2.578	1.6425	0.72434
17	1.73	7.9966	6.48	0.51378	0.339	2.4412	0.92459	2.640	1.6829	0.75832
18	1.91	8.0723	6.48	0.5097	0.320	2.521	0.92867	2.715	1.7248	0.79617
19	2.09	8.1495	6.48	0.50154	0.300	2.6064	0.93684	2.782	1.7716	0.83477
20	3.18	8.5338	6.48	0.41173	0.200	3.0804	1.0266	3.000	2.0535	1.0269
21	4.28	8.8641	6.48	0.28693	0.120	3.5355	1.1514	3.071	2.3435	1.192
22	5.37	9.1237	6.48	0.15396	0.058	3.9281	1.2844	3.058	2.6063	1.3219
23	6.46	9.3334	6.48	0.020995	0.007	4.2708	1.4174	3.013	2.8441	1.4267
24	7.56	9.4882	6.48	-0.097392	-0.032	4.544	1.5358	2.959	3.0399	1.5041
25	8.65	9.6154	6.48	-0.22103	-0.070	4.7948	1.6594	2.889	3.2271	1.5677
26	9.74	9.7161	6.48	-0.32483	-0.100	4.9993	1.7632	2.835	3.3813	1.6181
27	10.84	9.7904	6.48	-0.41814	-0.126	5.1669	1.8565	2.783	3.5117	1.6552
28	11.93	9.8467	6.48	-0.49804	-0.148	5.3031	1.9364	2.739	3.6198	1.6833
29	13.03	9.8845	6.48	-0.56802	-0.167	5.4109	2.0064	2.697	3.7086	1.7022
30	14.12	9.9002	6.48	-0.62517	-0.183	5.4837	2.0635	2.657	3.7736	1.7101
31	15.21	9.9166	6.48	-0.67241	-0.196	5.5474	2.1108	2.628	3.8291	1.7183

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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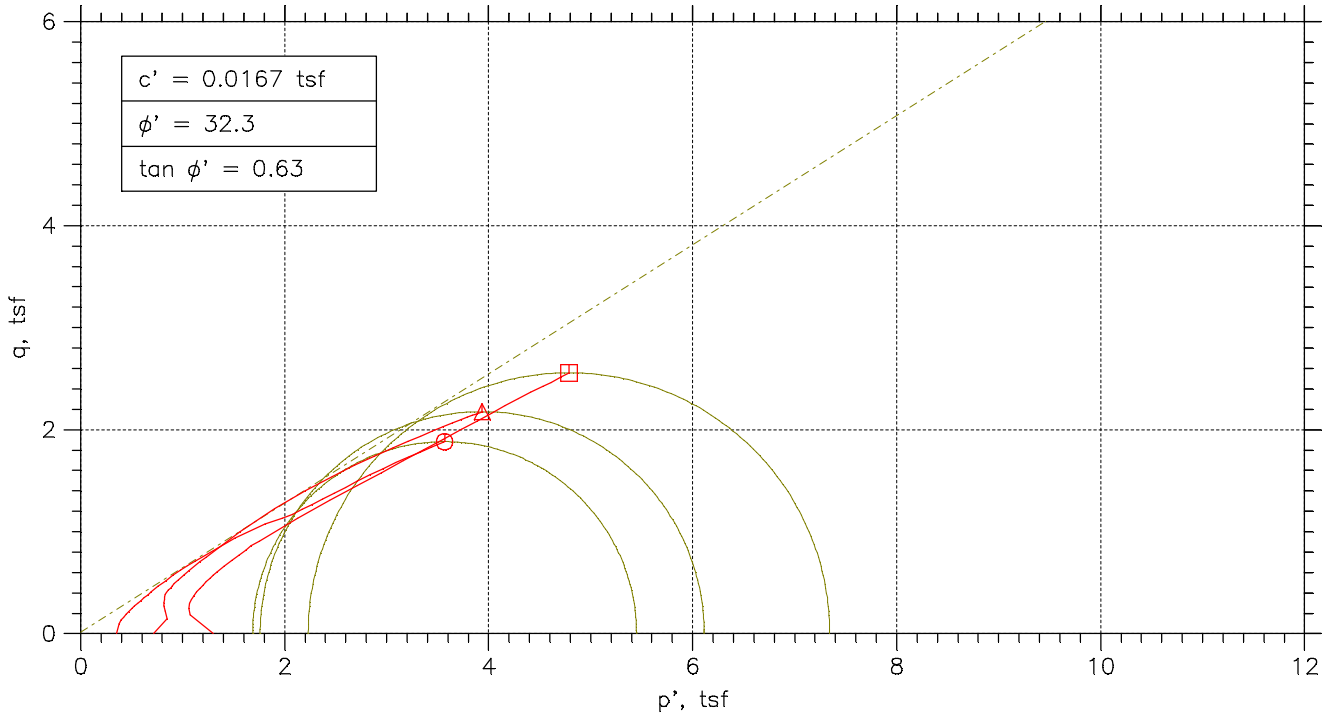

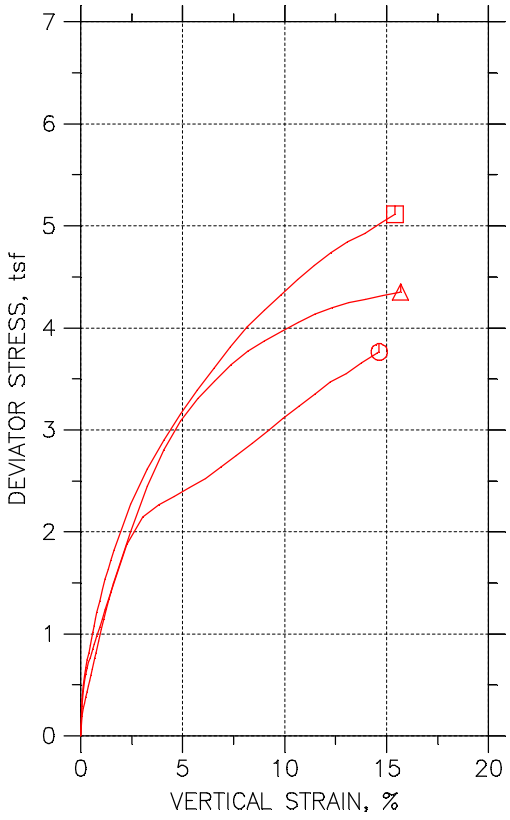

Symbol		⏲	△	⊡	
Test No.		5.0 PSI	10.0 PSI	20.0 PSI	
Initial	Diameter, in	2.813	2.7921	2.8256	
	Height, in	6.0902	5.9878	6.0303	
	Water Content, %	8.98	11.83	8.88	
	Dry Density, pcf	128.2	127.1	126.	
	Saturation, %	75.28	95.64	69.49	
	Void Ratio	0.32442	0.33638	0.34747	
Before Shear	Water Content, %	13.14	12.04	11.49	
	Dry Density, pcf	125.1	127.9	129.4	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.35748	0.32749	0.31248	
	Back Press., tsf	5.0458	5.0445	5.1811	
Minor Prin. Stress, tsf		0.35425	0.71546	1.2989	
Max. Dev. Stress, tsf		3.764	4.3529	5.114	
Time to Failure, min		1147.2	1143.8	1128.7	
Strain Rate, %/min		0.02	0.02	0.02	
B-Value		0.95	0.97	0.95	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		22	22	22	
Plastic Limit		15	15	15	
Plasticity Index		7	7	7	

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN-029 S-3
Sample Type: 3.0" ST

Failure Sketch

Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

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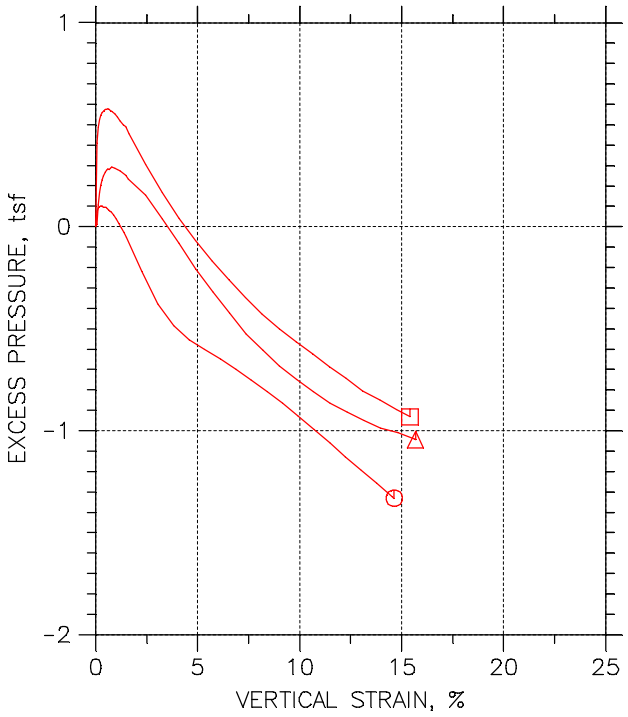
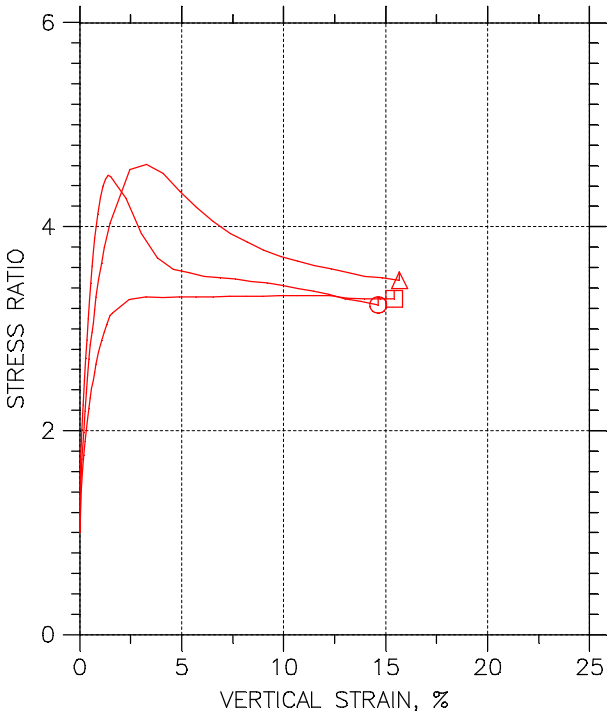
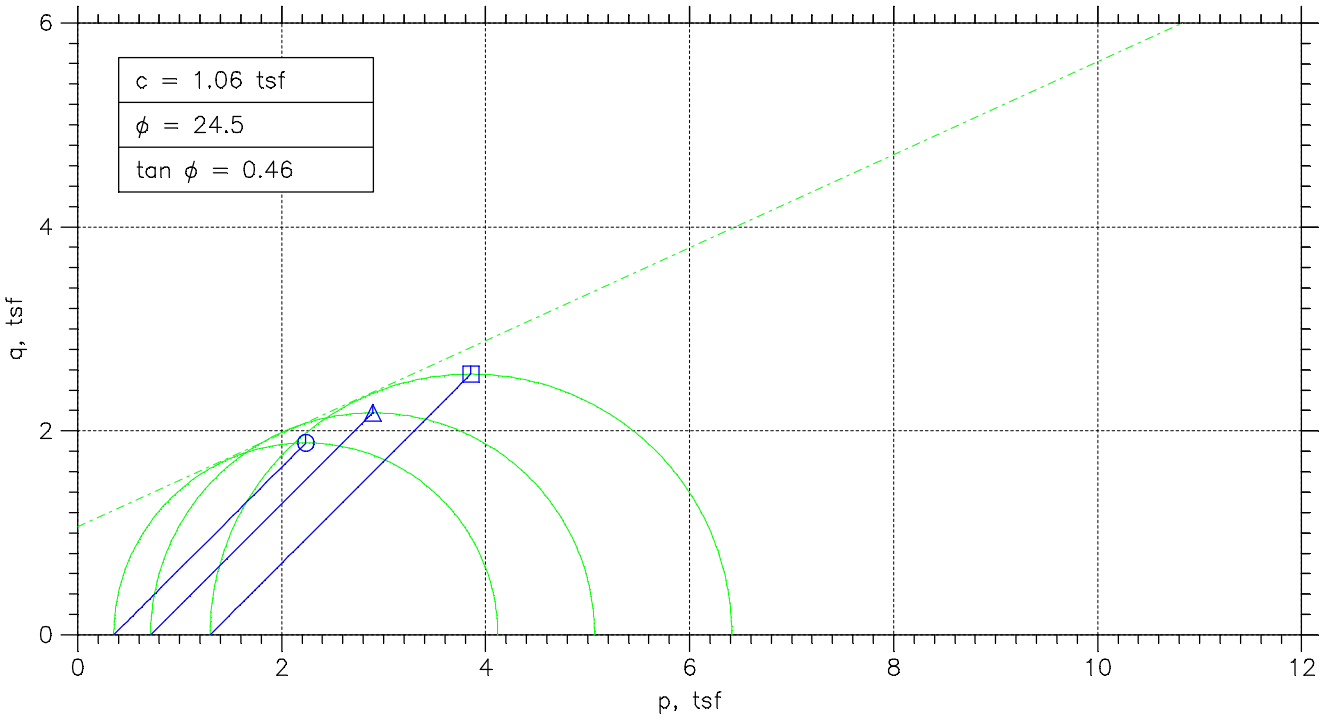
CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767







Project: DYNERGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-029 S-3	Tested By: BCM	Checked By: WPQ
Sample No.: S-3	Test Date: 12/17/15	Depth: 5.0'-7.0'
Test No.: HEN-029 S-3	Sample Type: 3.0" ST	Elevation: ----
Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		
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TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 5.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.09 in
Specimen Area: 6.21 in^2
Specimen Volume: 37.85 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.2148	0	0	5.0458	5.4	5.4
2	5.0035	0.055219	6.2182	17.005	0.1969	5.1201	5.4	5.5969
3	10.003	0.11893	6.2222	23.059	0.26683	5.1363	5.4	5.6668
4	15.003	0.17981	6.226	27.85	0.32207	5.1427	5.4	5.7221
5	20.003	0.24353	6.23	32.852	0.37967	5.1462	5.4	5.7797
6	25.003	0.30866	6.234	37.643	0.43475	5.1462	5.4	5.8348
7	30.003	0.37237	6.238	42.276	0.48795	5.1422	5.4	5.8879
8	35.003	0.43609	6.242	46.961	0.54168	5.1422	5.4	5.9417
9	40.003	0.49838	6.2459	51.752	0.59657	5.1392	5.4	5.9966
10	45.003	0.5621	6.2499	56.385	0.64956	5.1346	5.4	6.0496
11	50.003	0.6244	6.2538	61.386	0.70674	5.1294	5.4	6.1067
12	55.003	0.68811	6.2579	66.335	0.76322	5.123	5.4	6.1632
13	60.003	0.75041	6.2618	71.126	0.81783	5.1172	5.4	6.2178
14	70.003	0.87784	6.2698	80.918	0.92923	5.1027	5.4	6.3292
15	80.003	1.0067	6.278	90.553	1.0385	5.0835	5.4	6.4385
16	90.003	1.1341	6.2861	99.661	1.1415	5.0638	5.4	6.5415
17	100	1.2601	6.2941	108.72	1.2436	5.0411	5.4	6.6436
18	110	1.3904	6.3024	117.14	1.3382	5.0179	5.4	6.7382
19	120	1.5164	6.3105	124.88	1.4248	4.9917	5.4	6.8248
20	180	2.271	6.3592	165.63	1.8753	4.828	5.4	7.2753
21	240	3.037	6.4095	191.27	2.1486	4.6677	5.4	7.5486
22	300	3.8158	6.4613	203.48	2.2674	4.5591	5.4	7.6674
23	360	4.5789	6.513	212.11	2.3449	4.4923	5.4	7.7449
24	420	5.3421	6.5655	222.17	2.4364	4.4447	5.4	7.8364
25	480	6.1095	6.6192	231.96	2.5232	4.3959	5.4	7.9232
26	540	6.874	6.6735	244.18	2.6344	4.346	5.4	8.0344
27	600	7.6386	6.7288	257.13	2.7513	4.2926	5.4	8.1513
28	660	8.4116	6.7856	270.03	2.8652	4.2357	5.4	8.2652
29	720	9.1663	6.842	283.82	2.9867	4.1793	5.4	8.3867
30	780	9.9295	6.8999	298.25	3.1122	4.1172	5.4	8.5122
31	840	10.708	6.9601	312.3	3.2307	4.051	5.4	8.6307
32	900	11.471	7.0201	326.83	3.3521	3.986	5.4	8.7521
33	960	12.232	7.0809	340.94	3.4668	3.9169	5.4	8.8668
34	1020	13.009	7.1442	352.31	3.5507	3.8512	5.4	8.9507
35	1080	13.774	7.2075	366.11	3.6572	3.7891	5.4	9.0572
36	1140	14.538	7.272	379.11	3.7536	3.7217	5.4	9.1536
37	1147.2	14.632	7.28	380.59	3.764	3.7142	5.4	9.164

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 5.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.09 in
Specimen Area: 6.21 in^2
Specimen Volume: 37.85 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	5.4	5.4	0	0.000	0.35425	0.35425	1.000	0.35425	0
2	0.06	5.5969	5.4	0.07433	0.378	0.47681	0.27992	1.703	0.37837	0.098449
3	0.12	5.6668	5.4	0.09059	0.340	0.53049	0.26366	2.012	0.39707	0.13342
4	0.18	5.7221	5.4	0.096978	0.301	0.57934	0.25727	2.252	0.4183	0.16104
5	0.24	5.7797	5.4	0.10046	0.265	0.63345	0.25378	2.496	0.44362	0.18983
6	0.31	5.8348	5.4	0.10046	0.231	0.68854	0.25378	2.713	0.47116	0.21738
7	0.37	5.8879	5.4	0.096397	0.198	0.7458	0.25785	2.892	0.50182	0.24397
8	0.44	5.9417	5.4	0.096397	0.178	0.79953	0.25785	3.101	0.52869	0.27084
9	0.50	5.9966	5.4	0.093494	0.157	0.85732	0.26075	3.288	0.55904	0.29829
10	0.56	6.0496	5.4	0.088848	0.137	0.91496	0.2654	3.447	0.59018	0.32478
11	0.62	6.1067	5.4	0.083622	0.118	0.97736	0.27062	3.611	0.62399	0.35337
12	0.69	6.1632	5.4	0.077234	0.101	1.0402	0.27701	3.755	0.65862	0.38161
13	0.75	6.2178	5.4	0.071427	0.087	1.1007	0.28282	3.892	0.69173	0.40892
14	0.88	6.3292	5.4	0.056909	0.061	1.2266	0.29734	4.125	0.76195	0.46462
15	1.01	6.4385	5.4	0.037746	0.036	1.355	0.3165	4.281	0.83576	0.51926
16	1.13	6.5415	5.4	0.018002	0.016	1.4777	0.33624	4.395	0.907	0.57075
17	1.26	6.6436	5.4	-0.0046456	-0.004	1.6025	0.35889	4.465	0.98071	0.62182
18	1.39	6.7382	5.4	-0.027874	-0.021	1.7203	0.38212	4.502	1.0512	0.66911
19	1.52	6.8248	5.4	-0.054006	-0.038	1.8331	0.40825	4.490	1.1207	0.71241
20	2.27	7.2753	5.4	-0.21776	-0.116	2.4473	0.57201	4.278	1.5096	0.93763
21	3.04	7.5486	5.4	-0.37804	-0.176	2.8809	0.73229	3.934	1.8066	1.0743
22	3.82	7.6674	5.4	-0.48663	-0.215	3.1083	0.84088	3.696	1.9746	1.1337
23	4.58	7.7449	5.4	-0.55341	-0.236	3.2525	0.90766	3.583	2.0801	1.1724
24	5.34	7.8364	5.4	-0.60103	-0.247	3.3917	0.95528	3.550	2.1735	1.2182
25	6.11	7.9232	5.4	-0.64981	-0.258	3.5272	1.0041	3.513	2.2656	1.2616
26	6.87	8.0344	5.4	-0.69975	-0.266	3.6884	1.054	3.499	2.3712	1.3172
27	7.64	8.1513	5.4	-0.75318	-0.274	3.8588	1.1074	3.484	2.4831	1.3757
28	8.41	8.2652	5.4	-0.81008	-0.283	4.0295	1.1643	3.461	2.5969	1.4326
29	9.17	8.3867	5.4	-0.86641	-0.290	4.2074	1.2207	3.447	2.714	1.4934
30	9.93	8.5122	5.4	-0.92855	-0.298	4.395	1.2828	3.426	2.8389	1.5561
31	10.71	8.6307	5.4	-0.99475	-0.308	4.5797	1.349	3.395	2.9643	1.6153
32	11.47	8.7521	5.4	-1.0598	-0.316	4.7661	1.414	3.371	3.0901	1.676
33	12.23	8.8668	5.4	-1.1289	-0.326	4.9499	1.4831	3.337	3.2165	1.7334
34	13.01	8.9507	5.4	-1.1945	-0.336	5.0994	1.5488	3.293	3.3241	1.7753
35	13.77	9.0572	5.4	-1.2566	-0.344	5.2681	1.6109	3.270	3.4395	1.8286
36	14.54	9.1536	5.4	-1.324	-0.353	5.4318	1.6783	3.237	3.555	1.8768
37	14.63	9.164	5.4	-1.3316	-0.354	5.4499	1.6858	3.233	3.5678	1.882

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

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Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.99 in
Specimen Area: 6.12 in^2
Specimen Volume: 36.66 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.1229	0	0	5.0445	5.76	5.76
2	5.0033	0.057527	6.1265	25.039	0.29426	5.058	5.76	6.0543
3	10.003	0.12145	6.1304	37.584	0.44142	5.1518	5.76	6.2014
4	15.003	0.19176	6.1347	45.895	0.53865	5.2102	5.76	6.2986
5	20.003	0.25727	6.1387	52.089	0.61094	5.2487	5.76	6.3709
6	25.003	0.32599	6.143	57.012	0.66822	5.2731	5.76	6.4282
7	30.003	0.3931	6.1471	61.458	0.71985	5.2947	5.76	6.4799
8	35.003	0.46021	6.1512	65.375	0.76522	5.3111	5.76	6.5252
9	40.003	0.52573	6.1553	69.134	0.80868	5.321	5.76	6.5687
10	45.003	0.59444	6.1596	72.945	0.85267	5.3262	5.76	6.6127
11	50.003	0.66316	6.1638	76.651	0.89536	5.3239	5.76	6.6554
12	55.003	0.72867	6.1679	80.356	0.93803	5.3315	5.76	6.698
13	60.003	0.79898	6.1723	84.009	0.97997	5.3355	5.76	6.74
14	70.003	0.93481	6.1807	91.314	1.0637	5.3309	5.76	6.8237
15	80.003	1.0674	6.189	98.884	1.1504	5.3251	5.76	6.9104
16	90.003	1.2049	6.1976	106.24	1.2343	5.3186	5.76	6.9943
17	110	1.4781	6.2148	121.28	1.405	5.2971	5.76	7.165
18	120	1.6155	6.2235	129.06	1.4931	5.2784	5.76	7.2531
19	180	2.4465	6.2765	174.42	2.0009	5.1979	5.76	7.7609
20	240	3.2615	6.3294	215.08	2.4466	5.0819	5.76	8.2066
21	300	4.0812	6.3835	248.9	2.8074	4.9623	5.76	8.5674
22	360	4.909	6.439	275.85	3.0845	4.8381	5.76	8.8445
23	420	5.7319	6.4952	298.08	3.3042	4.7238	5.76	9.0642
24	480	6.5549	6.5524	316.61	3.479	4.6206	5.76	9.239
25	540	7.3826	6.611	334.34	3.6413	4.5173	5.76	9.4013
26	600	8.1976	6.6697	349.06	3.7681	4.4392	5.76	9.5281
27	660	9.0189	6.7299	362.08	3.8737	4.3628	5.76	9.6337
28	720	9.8547	6.7923	374.04	3.9649	4.2946	5.76	9.7249
29	780	10.668	6.8541	386.11	4.056	4.2374	5.76	9.816
30	840	11.485	6.9174	397.49	4.1373	4.1808	5.76	9.8973
31	900	12.324	6.9836	407.45	4.2007	4.1354	5.76	9.9607
32	960	13.15	7.05	415.97	4.2482	4.0945	5.76	10.008
33	1020	13.976	7.1177	423.01	4.279	4.0578	5.76	10.039
34	1080	14.808	7.1873	430.74	4.315	4.0345	5.76	10.075
35	1140	15.625	7.2568	438.47	4.3503	4.003	5.76	10.11
36	1143.8	15.678	7.2613	438.99	4.3529	4.0001	5.76	10.113

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.99 in
Specimen Area: 6.12 in^2
Specimen Volume: 36.66 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	5.76	5.76	0	0.000	0.71546	0.71546	1.000	0.71546	0
2	0.06	6.0543	5.76	0.013413	0.046	0.99631	0.70205	1.419	0.84918	0.14713
3	0.12	6.2014	5.76	0.10731	0.243	1.0496	0.60815	1.726	0.82886	0.22071
4	0.19	6.2986	5.76	0.16562	0.307	1.0885	0.54984	1.980	0.81916	0.26932
5	0.26	6.3709	5.76	0.20411	0.334	1.1223	0.51135	2.195	0.81681	0.30547
6	0.33	6.4282	5.76	0.22861	0.342	1.1551	0.48685	2.373	0.82096	0.33411
7	0.39	6.4799	5.76	0.25019	0.348	1.1851	0.46527	2.547	0.8252	0.35993
8	0.46	6.5252	5.76	0.26651	0.348	1.2142	0.44895	2.704	0.83155	0.38261
9	0.53	6.5687	5.76	0.27643	0.342	1.2477	0.43903	2.842	0.84337	0.40434
10	0.59	6.6127	5.76	0.28168	0.330	1.2865	0.43378	2.966	0.86012	0.42633
11	0.66	6.6554	5.76	0.27935	0.312	1.3315	0.43612	3.053	0.8838	0.44768
12	0.73	6.698	5.76	0.28693	0.306	1.3666	0.42853	3.189	0.89755	0.46901
13	0.80	6.74	5.76	0.29101	0.297	1.4044	0.42445	3.309	0.91444	0.48999
14	0.93	6.8237	5.76	0.28634	0.269	1.4928	0.42912	3.479	0.96098	0.53186
15	1.07	6.9104	5.76	0.28051	0.244	1.5853	0.43495	3.645	1.0101	0.57518
16	1.20	6.9943	5.76	0.2741	0.222	1.6756	0.44136	3.796	1.0585	0.61713
17	1.48	7.165	5.76	0.25252	0.180	1.8679	0.46294	4.035	1.1654	0.7025
18	1.62	7.2531	5.76	0.23386	0.157	1.9747	0.4816	4.100	1.2281	0.74654
19	2.45	7.7609	5.76	0.15338	0.077	2.563	0.56208	4.560	1.5625	1.0004
20	3.26	8.2066	5.76	0.037324	0.015	3.1248	0.67814	4.608	1.9014	1.2233
21	4.08	8.5674	5.76	-0.082229	-0.029	3.6051	0.79769	4.519	2.2014	1.4037
22	4.91	8.8445	5.76	-0.20645	-0.067	4.0064	0.92191	4.346	2.4641	1.5422
23	5.73	9.0642	5.76	-0.32075	-0.097	4.3404	1.0362	4.189	2.6883	1.6521
24	6.55	9.239	5.76	-0.42397	-0.122	4.6184	1.1394	4.053	2.8789	1.7395
25	7.38	9.4013	5.76	-0.5272	-0.145	4.8839	1.2427	3.930	3.0633	1.8206
26	8.20	9.5281	5.76	-0.60534	-0.161	5.0889	1.3208	3.853	3.2049	1.8841
27	9.02	9.6337	5.76	-0.68174	-0.176	5.2709	1.3972	3.772	3.3341	1.9369
28	9.85	9.7249	5.76	-0.74997	-0.189	5.4304	1.4654	3.706	3.4479	1.9825
29	10.67	9.816	5.76	-0.80713	-0.199	5.5785	1.5226	3.664	3.5506	2.028
30	11.48	9.8973	5.76	-0.8637	-0.209	5.7165	1.5792	3.620	3.6478	2.0687
31	12.32	9.9607	5.76	-0.90918	-0.216	5.8254	1.6246	3.586	3.725	2.1004
32	13.15	10.008	5.76	-0.95001	-0.224	5.9137	1.6655	3.551	3.7896	2.1241
33	13.98	10.039	5.76	-0.98675	-0.231	5.9812	1.7022	3.514	3.8417	2.1395
34	14.81	10.075	5.76	-1.0101	-0.234	6.0405	1.7255	3.501	3.883	2.1575
35	15.62	10.11	5.76	-1.0416	-0.239	6.1074	1.757	3.476	3.9322	2.1752
36	15.68	10.113	5.76	-1.0445	-0.240	6.1128	1.7599	3.473	3.9364	2.1764

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.03 in
Specimen Area: 6.27 in^2
Specimen Volume: 37.81 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.2706	0	0	5.1811	6.48	6.48
2	5.0002	0.061721	6.2745	31.946	0.36658	5.5924	6.48	6.8466
3	10	0.12796	6.2786	43.274	0.49624	5.6668	6.48	6.9762
4	15	0.19419	6.2828	51.605	0.59138	5.7058	6.48	7.0714
5	20	0.26043	6.287	58.557	0.67061	5.7267	6.48	7.1506
6	25	0.32817	6.2912	65.03	0.74424	5.7413	6.48	7.2242
7	30	0.39441	6.2954	71.383	0.8164	5.7511	6.48	7.2964
8	35	0.45914	6.2995	77.257	0.88301	5.7558	6.48	7.363
9	40	0.52538	6.3037	83.31	0.95156	5.7575	6.48	7.4316
10	45	0.59312	6.308	89.244	1.0186	5.7587	6.48	7.4986
11	50	0.66086	6.3123	94.878	1.0822	5.7558	6.48	7.5622
12	55	0.72861	6.3166	100.57	1.1464	5.7511	6.48	7.6264
13	60	0.79635	6.3209	106.15	1.2091	5.7477	6.48	7.6891
14	70	0.93334	6.3297	116.22	1.3219	5.7337	6.48	7.8019
15	80.001	1.0688	6.3383	126.22	1.4338	5.718	6.48	7.9138
16	90.001	1.2043	6.347	135.51	1.5373	5.6994	6.48	8.0173
17	100	1.3428	6.3559	144.26	1.6342	5.6796	6.48	8.1142
18	110	1.4798	6.3648	152.18	1.7215	5.6726	6.48	8.2015
19	120	1.6183	6.3737	160.81	1.8165	5.6371	6.48	8.2965
20	180	2.4372	6.4272	202.52	2.2687	5.4865	6.48	8.7487
21	240	3.2501	6.4812	235.37	2.6147	5.3475	6.48	9.0947
22	300	4.0781	6.5372	263.42	2.9013	5.2224	6.48	9.3813
23	360	4.8865	6.5927	289.19	3.1583	5.1119	6.48	9.6383
24	420	5.7054	6.65	313.16	3.3906	5.0119	6.48	9.8706
25	480	6.5349	6.709	335.88	3.6046	4.92	6.48	10.085
26	540	7.3478	6.7679	358.41	3.813	4.8328	6.48	10.293
27	600	8.1637	6.828	379.99	4.0069	4.7525	6.48	10.487
28	660	8.9992	6.8907	399.41	4.1734	4.6792	6.48	10.653
29	720	9.8151	6.953	417.75	4.3259	4.6164	6.48	10.806
30	780	10.631	7.0165	435.67	4.4706	4.5565	6.48	10.951
31	840	11.459	7.0821	453.83	4.6139	4.4954	6.48	11.094
32	900	12.269	7.1475	470.55	4.7401	4.4396	6.48	11.22
33	960	13.094	7.2154	485.54	4.8451	4.3744	6.48	11.325
34	1020	13.928	7.2853	498.42	4.9259	4.3314	6.48	11.406
35	1080	14.742	7.3549	513.89	5.0307	4.2854	6.48	11.511
36	1128.7	15.412	7.4131	526.53	5.114	4.2494	6.48	11.594

TRIAXIAL TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.03 in
Specimen Area: 6.27 in^2
Specimen Volume: 37.81 in^3

Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

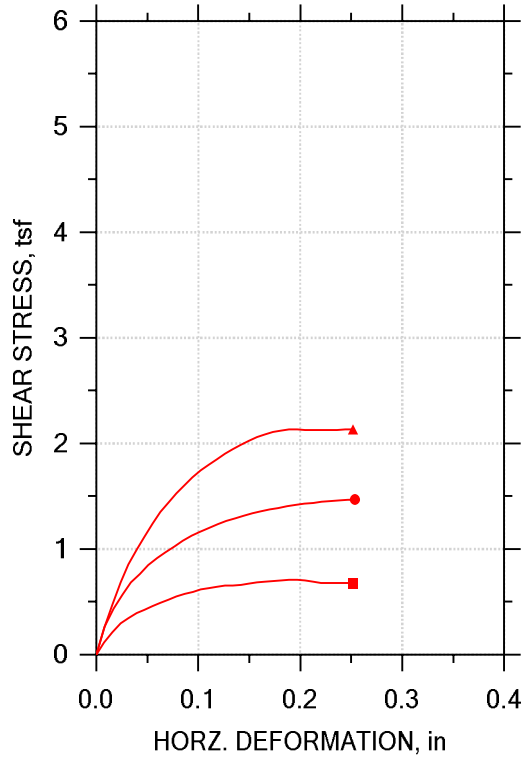
Estimated Specific Gravity: 2.72

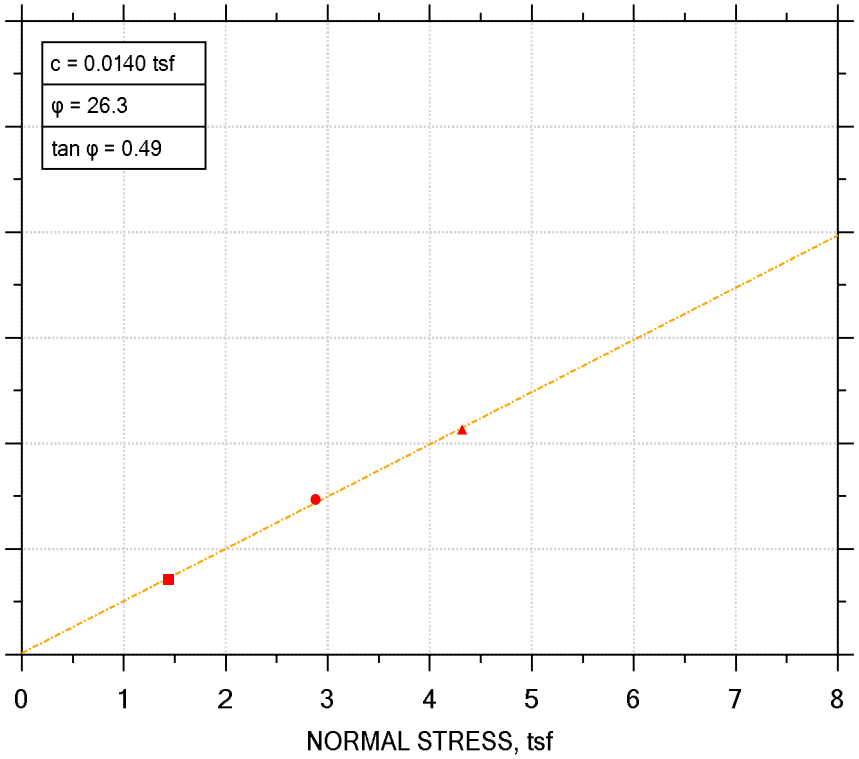
	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	6.48	6.48	0	0.000	1.2989	1.2989	1.000	1.2989	0
2	0.06	6.8466	6.48	0.41121	1.122	1.2542	0.88764	1.413	1.0709	0.18329
3	0.13	6.9762	6.48	0.48566	0.979	1.3094	0.81319	1.610	1.0613	0.24812
4	0.19	7.0714	6.48	0.52463	0.887	1.3656	0.77423	1.764	1.0699	0.29569
5	0.26	7.1506	6.48	0.54557	0.814	1.4239	0.75329	1.890	1.0886	0.33531
6	0.33	7.2242	6.48	0.56011	0.753	1.483	0.73875	2.007	1.1109	0.37212
7	0.39	7.2964	6.48	0.57	0.698	1.5453	0.72886	2.120	1.1371	0.4082
8	0.46	7.363	6.48	0.57465	0.651	1.6072	0.72421	2.219	1.1657	0.4415
9	0.53	7.4316	6.48	0.57639	0.606	1.674	0.72246	2.317	1.1982	0.47578
10	0.59	7.4986	6.48	0.57756	0.567	1.7399	0.7213	2.412	1.2306	0.50932
11	0.66	7.5622	6.48	0.57465	0.531	1.8064	0.72421	2.494	1.2653	0.5411
12	0.73	7.6264	6.48	0.57	0.497	1.8752	0.72886	2.573	1.302	0.57319
13	0.80	7.6891	6.48	0.56651	0.469	1.9414	0.73235	2.651	1.3369	0.60454
14	0.93	7.8019	6.48	0.55255	0.418	2.0683	0.74631	2.771	1.4073	0.66097
15	1.07	7.9138	6.48	0.53684	0.374	2.1959	0.76201	2.882	1.4789	0.71692
16	1.20	8.0173	6.48	0.51823	0.337	2.3179	0.78062	2.969	1.5493	0.76863
17	1.34	8.1142	6.48	0.49846	0.305	2.4346	0.8004	3.042	1.6175	0.81712
18	1.48	8.2015	6.48	0.49148	0.285	2.5288	0.80738	3.132	1.6681	0.86073
19	1.62	8.2965	6.48	0.456	0.251	2.6594	0.84286	3.155	1.7511	0.90827
20	2.44	8.7487	6.48	0.30535	0.135	3.2622	0.9935	3.284	2.1279	1.1344
21	3.25	9.0947	6.48	0.16635	0.064	3.7472	1.1325	3.309	2.4399	1.3073
22	4.08	9.3813	6.48	0.041296	0.014	4.1588	1.2576	3.307	2.7082	1.4506
23	4.89	9.6383	6.48	-0.069214	-0.022	4.5263	1.3681	3.309	2.9472	1.5791
24	5.71	9.8706	6.48	-0.16925	-0.050	4.8588	1.4681	3.310	3.1634	1.6953
25	6.53	10.085	6.48	-0.26115	-0.072	5.1646	1.56	3.311	3.3623	1.8023
26	7.35	10.293	6.48	-0.3484	-0.091	5.4602	1.6472	3.315	3.5537	1.9065
27	8.16	10.487	6.48	-0.42866	-0.107	5.7345	1.7275	3.319	3.731	2.0035
28	9.00	10.653	6.48	-0.50195	-0.120	5.9742	1.8008	3.318	3.8875	2.0867
29	9.82	10.806	6.48	-0.56476	-0.131	6.1895	1.8636	3.321	4.0266	2.1629
30	10.63	10.951	6.48	-0.62467	-0.140	6.3942	1.9235	3.324	4.1588	2.2353
31	11.46	11.094	6.48	-0.68574	-0.149	6.5985	1.9846	3.325	4.2915	2.3069
32	12.27	11.22	6.48	-0.74158	-0.156	6.7805	2.0404	3.323	4.4105	2.3701
33	13.09	11.325	6.48	-0.80672	-0.167	6.9506	2.1056	3.301	4.5281	2.4225
34	13.93	11.406	6.48	-0.84976	-0.173	7.0745	2.1486	3.293	4.6116	2.463
35	14.74	11.511	6.48	-0.89571	-0.178	7.2252	2.1946	3.292	4.7099	2.5153
36	15.41	11.594	6.48	-0.93177	-0.182	7.3446	2.2306	3.293	4.7876	2.557

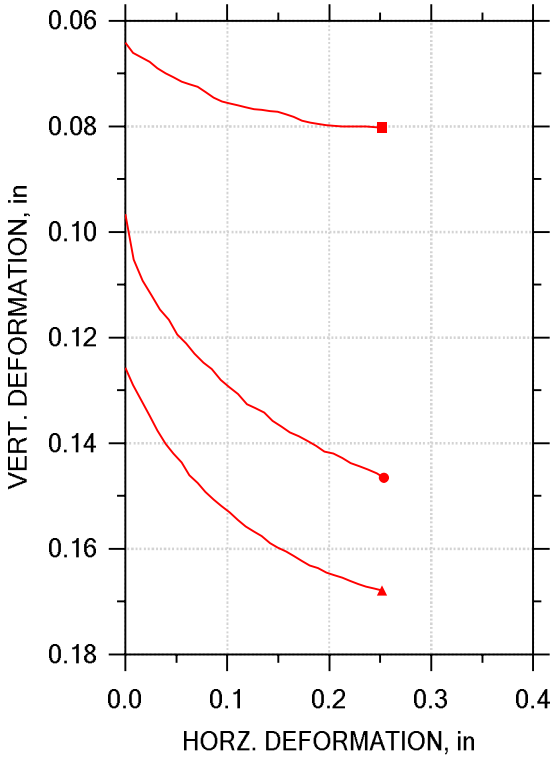
Drained Direct Shear Tests
ASTM D 3080

DIRECT SHEAR TEST by ASTM D3080

Terracon
Consulting Engineers & Scientists







Symbol		■	●	▲	
Test No.		20.0 PSI	40.0 PSI	60.0 PSI	
Sample No.		S-10	S-10	S-10	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.5008	2.4941	2.4941	
	Area, in²	4.9118	4.8856	4.8856	
	Height, in	0.99488	0.99134	0.99134	
	Water Content, %	31.89	31.11	31.27	
	Dry Density, pcf	90.09	91.18	91.04	
	Saturation, %	98.03	98.12	98.32	
	Void Ratio	0.88489	0.8623	0.86515	
Consol. Height, in		0.9307	0.89469	0.86562	
Consol. Void Ratio		0.76329	0.68073	0.62862	
Final	Water Content, %	26.56	21.67	19.99	
	Dry Density, pcf	97.99	107.0	109.6	
	Saturation, %	98.57	100.41	98.99	
	Void Ratio	0.73289	0.58702	0.5493	
Normal Stress, tsf		1.4397	2.8796	4.3197	
Max. Shear Stress, tsf		0.7101	1.4695	2.1341	
Ult. Shear Stress, tsf		0.67742	1.4695	2.1332	
Time to Failure, min		3213.2	1360.9	976.75	
Disp. Rate, in/min		5.9055e-05	0.00020472	0.00020472	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		46	46	46	
Plastic Limit		21	21	21	
Plasticity Index		25	25	25	

Project: DYNEGY HENNEPIN	
Location: HENNEPIN, IL	
Project No.: MR155233	
Boring No.: HEN-002 S-10	
Sample Type: TRIMMED	
Description: GRAY LEAN CLAY CL	339
Remarks:	

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-002 S-10
Sample No.: S-10
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/22/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: GRAY LEAN CLAY CL
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.44	0.06418	0.000	0.0000	0.0000
2	131.60	1.44	0.06602	0.118	0.007867	0.007867
3	254.56	1.44	0.06694	0.209	0.01577	0.01577
4	403.13	1.44	0.06782	0.298	0.02364	0.02364
5	547.67	1.44	0.06897	0.348	0.03150	0.03150
6	674.90	1.44	0.06998	0.392	0.03937	0.03937
7	808.72	1.44	0.07065	0.423	0.04724	0.04724
8	938.15	1.44	0.07157	0.460	0.05514	0.05514
9	1062.33	1.44	0.07200	0.493	0.06300	0.06300
10	1186.07	1.44	0.07247	0.522	0.07087	0.07087
11	1319.95	1.44	0.07342	0.551	0.07874	0.07874
12	1456.77	1.44	0.07454	0.576	0.08660	0.08660
13	1592.98	1.44	0.07522	0.595	0.09451	0.09451
14	1735.33	1.44	0.07565	0.616	0.1024	0.1024
15	1877.85	1.44	0.07603	0.633	0.1102	0.1102
16	2020.47	1.44	0.07634	0.644	0.1181	0.1181
17	2150.55	1.44	0.07672	0.655	0.1260	0.1260
18	2262.37	1.44	0.07684	0.654	0.1339	0.1339
19	2385.54	1.44	0.07709	0.660	0.1417	0.1417
20	2525.44	1.44	0.07726	0.671	0.1496	0.1496
21	2675.94	1.44	0.07772	0.682	0.1575	0.1575
22	2805.55	1.44	0.07819	0.690	0.1653	0.1653
23	2942.54	1.44	0.07888	0.696	0.1732	0.1732
24	3076.86	1.44	0.07922	0.705	0.1811	0.1811
25	3213.20	1.44	0.07954	0.710	0.1890	0.1890
26	3343.01	1.44	0.07974	0.710	0.1968	0.1968
27	3473.34	1.44	0.07985	0.704	0.2047	0.2047
28	3608.85	1.44	0.07996	0.692	0.2126	0.2126
29	3746.25	1.44	0.07996	0.681	0.2205	0.2205
30	3883.52	1.44	0.08005	0.680	0.2283	0.2283
31	4012.40	1.44	0.08003	0.681	0.2362	0.2362
32	4135.33	1.44	0.08007	0.677	0.2441	0.2441
33	4281.23	1.44	0.08023	0.677	0.2520	0.2520

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-002 S-10
Sample No.: S-10
Test No.: 40.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/28/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: GRAY LEAN CLAY CL
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	2.88	0.09665	0.000	0.0000	0.0000
2	63.01	2.88	0.1053	0.266	0.008527	0.008527
3	113.06	2.88	0.1093	0.435	0.01702	0.01702
4	161.97	2.88	0.1120	0.572	0.02551	0.02551
5	207.04	2.88	0.1147	0.682	0.03400	0.03400
6	246.29	2.88	0.1166	0.766	0.04252	0.04252
7	290.78	2.88	0.1194	0.846	0.05101	0.05101
8	336.22	2.88	0.1211	0.914	0.05950	0.05950
9	381.75	2.88	0.1231	0.971	0.06799	0.06799
10	427.55	2.88	0.1247	1.02	0.07648	0.07648
11	476.78	2.88	0.1260	1.08	0.08505	0.08505
12	524.26	2.88	0.1281	1.12	0.09350	0.09350
13	568.33	2.88	0.1294	1.16	0.1020	0.1020
14	609.05	2.88	0.1306	1.20	0.1105	0.1105
15	655.39	2.88	0.1326	1.24	0.1190	0.1190
16	700.01	2.88	0.1334	1.27	0.1275	0.1275
17	744.02	2.88	0.1342	1.29	0.1360	0.1360
18	791.88	2.88	0.1358	1.32	0.1445	0.1445
19	840.22	2.88	0.1369	1.34	0.1530	0.1530
20	881.51	2.88	0.1380	1.36	0.1615	0.1615
21	924.69	2.88	0.1387	1.37	0.1700	0.1700
22	970.07	2.88	0.1395	1.39	0.1785	0.1785
23	1012.97	2.88	0.1404	1.40	0.1870	0.1870
24	1060.61	2.88	0.1416	1.42	0.1954	0.1954
25	1102.24	2.88	0.1419	1.43	0.2039	0.2039
26	1147.68	2.88	0.1428	1.44	0.2125	0.2125
27	1193.57	2.88	0.1438	1.45	0.2210	0.2210
28	1237.05	2.88	0.1444	1.46	0.2294	0.2294
29	1282.41	2.88	0.1449	1.46	0.2380	0.2380
30	1326.10	2.88	0.1457	1.47	0.2464	0.2464
31	1360.88	2.88	0.1465	1.47	0.2535	0.2535

DIRECT SHEAR TEST DATA

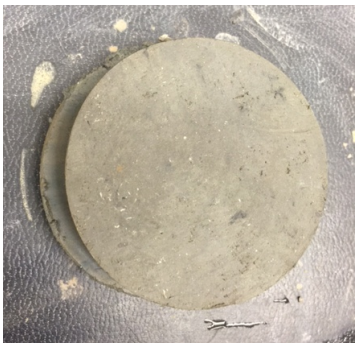
Project: DYNEGY HENNEPIN
Boring No.: HEN-002 S-10
Sample No.: S-10
Test No.: 60.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/29/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

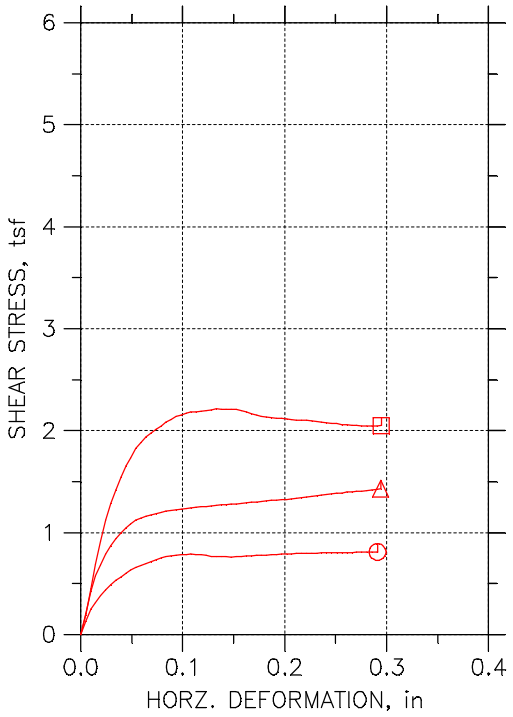
Soil Description: GRAY LEAN CLAY CL
Remarks:

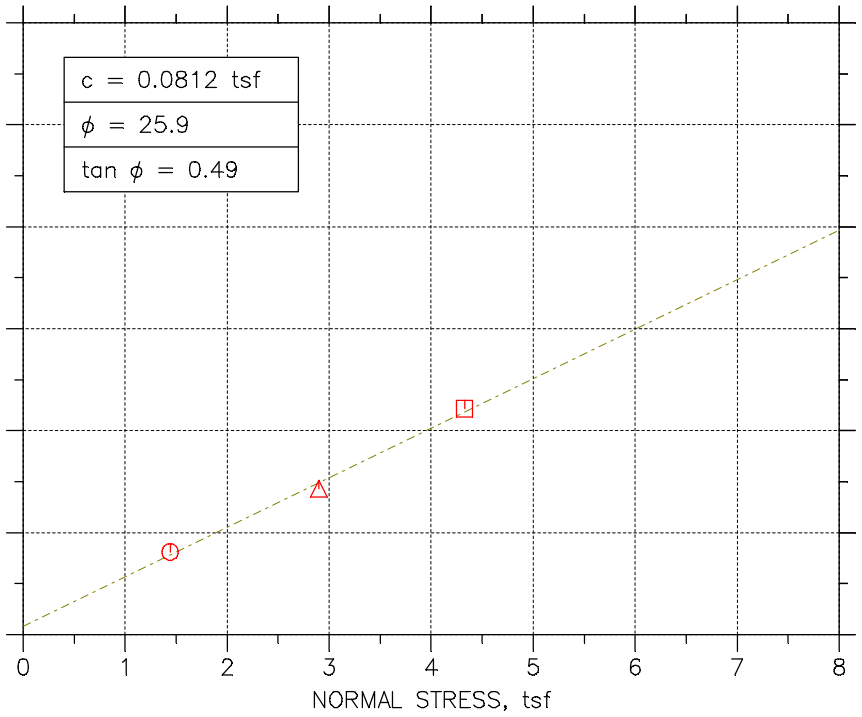
Step: 1 of 1

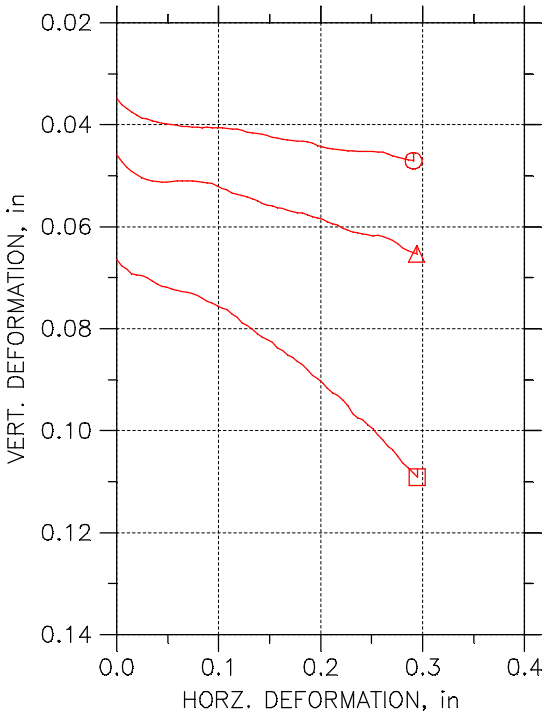


	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	4.32	0.1257	0.000	0.0000	0.0000
2	36.45	4.32	0.1290	0.248	0.007867	0.007867
3	76.38	4.32	0.1319	0.473	0.01573	0.01573
4	117.56	4.32	0.1348	0.683	0.02360	0.02360
5	158.10	4.32	0.1376	0.854	0.03150	0.03150
6	195.04	4.32	0.1402	0.991	0.03937	0.03937
7	234.81	4.32	0.1419	1.12	0.04724	0.04724
8	276.54	4.32	0.1437	1.24	0.05510	0.05510
9	317.01	4.32	0.1460	1.35	0.06297	0.06297
10	354.77	4.32	0.1475	1.44	0.07087	0.07087
11	393.79	4.32	0.1492	1.53	0.07874	0.07874
12	432.98	4.32	0.1507	1.61	0.08660	0.08660
13	471.79	4.32	0.1519	1.68	0.09447	0.09447
14	510.07	4.32	0.1530	1.74	0.1023	0.1023
15	550.12	4.32	0.1546	1.80	0.1102	0.1102
16	586.12	4.32	0.1558	1.85	0.1181	0.1181
17	626.51	4.32	0.1567	1.90	0.1260	0.1260
18	667.00	4.32	0.1576	1.95	0.1338	0.1338
19	705.99	4.32	0.1589	1.99	0.1417	0.1417
20	740.73	4.32	0.1598	2.02	0.1496	0.1496
21	783.69	4.32	0.1604	2.06	0.1575	0.1575
22	822.45	4.32	0.1613	2.09	0.1654	0.1654
23	862.70	4.32	0.1624	2.11	0.1732	0.1732
24	899.50	4.32	0.1631	2.12	0.1811	0.1811
25	938.61	4.32	0.1637	2.13	0.1890	0.1890
26	976.75	4.32	0.1645	2.13	0.1968	0.1968
27	1016.13	4.32	0.1649	2.13	0.2047	0.2047
28	1052.08	4.32	0.1654	2.12	0.2126	0.2126
29	1090.23	4.32	0.1661	2.13	0.2204	0.2204
30	1128.98	4.32	0.1666	2.13	0.2283	0.2283
31	1166.56	4.32	0.1671	2.13	0.2362	0.2362
32	1203.36	4.32	0.1675	2.13	0.2441	0.2441
33	1242.33	4.32	0.1679	2.13	0.2519	0.2519

DIRECT SHEAR TEST REPORT







Symbol		⏲	△	⊡	
Test No.		20.0 PSI	40.0 PSI	60.0 PSI	
Sample No.		S-8	S-8	S-8	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.4961	2.4961	2.4965	
	Area, in^2	4.8933	4.8933	4.8948	
	Height, in	1.0122	1.0122	1.0039	
	Water Content, %	32.17	32.73	32.51	
	Dry Density, pcf	87.418	87.479	87.762	
	Saturation, %	92.85	94.60	94.59	
	Void Ratio	0.94243	0.94108	0.93482	
Consol. Height, in		0.97952	0.97134	0.94117	
Consol. Void Ratio		0.87971	0.86272	0.81385	
Final	Water Content, %	31.22	30.03	26.52	
	Dry Density, pcf	91.684	93.514	98.465	
	Saturation, %	99.66	100.12	99.56	
	Void Ratio	0.85205	0.81582	0.72452	
Normal Stress, tsf		1.4402	2.8996	4.3279	
Max. Shear Stress, tsf		0.8107	1.4297	2.2144	
Ult. Shear Stress, tsf		0.8107	1.4297	2.0494	
Time to Failure, min		1757.8	1807.9	847.22	
Disp. Rate, in/min		0.000173	0.000173	0.000173	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		45	45	45	
Plastic Limit		21	21	21	
Plasticity Index		24	24	24	

Project: DYNEGY HENNEPIN

Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HEN-003 S-8

Sample Type: 3" ST

Description: DARK GRAY LEAN CLAY

Remarks: TEST PERFORMED AS PER ASTM D 3080

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Thu, 31-DEC-2015 10:00:11

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-003 S-8
Sample No.: S-8
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/30/15
Sample Type: 3" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.5'
Elevation: ----

Soil Description: DARK GRAY LEAN CLAY
Remarks: TEST PERFORMED AS PER ASTM D 3080

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	1.439	0.03483	0	0
2	96.13	1.44	0.03603	0.1338	0.004953
3	131.38	1.439	0.03684	0.2532	0.00986
4	155.73	1.44	0.03749	0.3118	0.01477
5	187.84	1.44	0.03813	0.3833	0.01972
6	217.18	1.441	0.03869	0.4396	0.02463
7	243.52	1.44	0.0389	0.4875	0.02953
8	275.52	1.44	0.03916	0.5354	0.03449
9	300.06	1.439	0.0395	0.5673	0.03939
10	328.84	1.44	0.03976	0.6016	0.0443
11	357.41	1.44	0.03985	0.6312	0.04925
12	389.00	1.44	0.03993	0.6594	0.05416
13	412.41	1.44	0.0401	0.6799	0.05907
14	439.26	1.44	0.04036	0.6997	0.06402
15	469.45	1.44	0.0404	0.7187	0.06892
16	492.76	1.44	0.04049	0.7347	0.07383
17	525.42	1.44	0.04053	0.7521	0.07878
18	555.92	1.44	0.04058	0.7651	0.08369
19	584.60	1.44	0.04053	0.7734	0.0886
20	614.13	1.44	0.04062	0.7788	0.0935
21	638.65	1.44	0.04062	0.7826	0.09846
22	668.06	1.44	0.04066	0.7871	0.1034
23	694.56	1.44	0.04075	0.7886	0.1083
24	724.56	1.44	0.04083	0.7818	0.1132
25	753.15	1.44	0.04088	0.7833	0.1181
26	781.97	1.44	0.04105	0.7772	0.123
27	808.98	1.439	0.04143	0.7666	0.128
28	836.74	1.44	0.04161	0.7658	0.1329
29	867.05	1.439	0.04173	0.7628	0.1378
30	895.41	1.44	0.04186	0.7674	0.1428
31	924.95	1.44	0.04212	0.7605	0.1477
32	952.02	1.44	0.04246	0.7628	0.1526
33	982.73	1.44	0.04255	0.7674	0.1575
34	1008.92	1.44	0.04289	0.7704	0.1624
35	1040.42	1.44	0.04294	0.7742	0.1673
36	1068.99	1.439	0.04306	0.7772	0.1723
37	1097.71	1.44	0.04319	0.7795	0.1772
38	1125.56	1.44	0.04319	0.781	0.1821
39	1153.88	1.439	0.04332	0.7848	0.187
40	1182.79	1.44	0.04366	0.7871	0.192
41	1213.01	1.44	0.04409	0.7902	0.1969
42	1239.85	1.44	0.04435	0.7924	0.2018
43	1267.40	1.44	0.04457	0.7932	0.2067
44	1295.23	1.44	0.04478	0.7955	0.2116
45	1327.06	1.44	0.04491	0.7955	0.2165
46	1353.95	1.44	0.04499	0.7978	0.2215
47	1384.41	1.44	0.04517	0.7993	0.2264
48	1411.93	1.44	0.04517	0.7993	0.2313
49	1440.51	1.44	0.04525	0.8008	0.2363
50	1467.72	1.44	0.04529	0.8023	0.2412
51	1497.01	1.44	0.04525	0.8023	0.2461
52	1527.85	1.44	0.04529	0.8031	0.251
53	1553.35	1.44	0.04534	0.8039	0.2559
54	1581.68	1.44	0.04538	0.8054	0.2608
55	1611.88	1.44	0.04581	0.8061	0.2658
56	1640.02	1.44	0.04607	0.8069	0.2707
57	1670.18	1.44	0.04641	0.8084	0.2756
58	1699.23	1.44	0.04667	0.8077	0.2805
59	1723.65	1.44	0.04684	0.8077	0.2855
60	1753.88	1.44	0.04705	0.8107	0.2904
61	1757.84	1.44	0.0471	0.8107	0.291

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-003 S-8
Sample No.: S-8
Test No.: 40.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/30/15
Sample Type: 3" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.5'
Elevation: ----

Soil Description: DARK GRAY LEAN CLAY
Remarks: TEST PERFORMED AS PER ASTM D 3080

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	2.897	0.04584	0	0
2	114.87	2.9	0.04725	0.2106	0.004953
3	145.95	2.9	0.04841	0.4274	0.00986
4	176.59	2.9	0.04916	0.58	0.01477
5	202.41	2.9	0.04974	0.6846	0.01972
6	232.48	2.9	0.0504	0.7905	0.02463
7	261.87	2.9	0.05081	0.8712	0.02953
8	290.11	2.9	0.05106	0.9393	0.03449
9	321.20	2.9	0.05114	0.9985	0.03939
10	352.66	2.9	0.05123	1.046	0.0443
11	382.71	2.9	0.05123	1.086	0.04925
12	414.39	2.9	0.05114	1.122	0.05416
13	438.31	2.9	0.05106	1.144	0.05907
14	468.23	2.897	0.05098	1.164	0.06402
15	494.07	2.9	0.05098	1.175	0.06892
16	525.08	2.9	0.05106	1.189	0.07383
17	555.16	2.9	0.05114	1.202	0.07878
18	584.30	2.9	0.05131	1.212	0.08369
19	613.31	2.9	0.05139	1.22	0.0886
20	638.98	2.9	0.05156	1.225	0.0935
21	665.57	2.9	0.05206	1.232	0.09846
22	698.58	2.9	0.05247	1.237	0.1034
23	723.48	2.9	0.0528	1.243	0.1083
24	754.38	2.9	0.05347	1.249	0.1132
25	779.70	2.9	0.05371	1.253	0.1181
26	807.48	2.9	0.05396	1.256	0.123
27	835.84	2.9	0.05421	1.261	0.128
28	866.30	2.9	0.05454	1.268	0.1329
29	897.54	2.9	0.05496	1.275	0.1378
30	923.22	2.9	0.05546	1.277	0.1428
31	948.87	2.897	0.05579	1.281	0.1477
32	977.74	2.9	0.05595	1.283	0.1526
33	1008.50	2.9	0.05628	1.287	0.1575
34	1036.20	2.9	0.05645	1.292	0.1624
35	1065.14	2.9	0.05678	1.299	0.1673
36	1090.22	2.9	0.05703	1.301	0.1723
37	1121.83	2.9	0.05728	1.307	0.1772
38	1150.05	2.9	0.05728	1.309	0.1821
39	1179.40	2.9	0.05769	1.315	0.187
40	1211.30	2.9	0.05802	1.32	0.192
41	1235.54	2.9	0.05836	1.321	0.1969
42	1267.50	2.9	0.05861	1.326	0.2018
43	1295.04	2.9	0.05902	1.333	0.2067
44	1325.43	2.9	0.05943	1.339	0.2116
45	1350.23	2.897	0.05968	1.345	0.2165
46	1376.84	2.9	0.06026	1.35	0.2215
47	1410.97	2.9	0.06068	1.355	0.2264
48	1438.72	2.902	0.06109	1.36	0.2313
49	1465.83	2.9	0.06117	1.368	0.2363
50	1495.50	2.9	0.06142	1.376	0.2412
51	1524.98	2.897	0.06159	1.378	0.2461
52	1553.26	2.9	0.06184	1.386	0.251
53	1581.27	2.9	0.06167	1.389	0.2559
54	1612.55	2.9	0.06192	1.397	0.2608
55	1641.33	2.9	0.06234	1.401	0.2658
56	1668.07	2.9	0.06275	1.406	0.2707
57	1694.82	2.897	0.06333	1.406	0.2756
58	1722.63	2.9	0.06416	1.411	0.2805
59	1752.47	2.9	0.06466	1.418	0.2855
60	1780.46	2.9	0.06507	1.425	0.2904
61	1807.89	2.9	0.06532	1.43	0.2941

DIRECT SHEAR TEST DATA

Project: FERMILAB
Boring No.: HEN-003 S-8
Sample No.: S-8
Test No.: 60.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/30/15
Sample Type: 3" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.5'
Elevation: ----

Soil Description: DARK GRAY LEAN CLAY
Remarks: TEST PERFORMED AS PER ASTM D 3080

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	4.327	0.06641	0	0
2	86.54	4.328	0.06774	0.1957	0.004953
3	113.71	4.328	0.06836	0.4534	0.00986
4	146.70	4.328	0.06918	0.6917	0.01477
5	178.06	4.328	0.0695	0.9147	0.01972
6	210.27	4.327	0.06956	1.123	0.02463
7	240.13	4.329	0.06994	1.287	0.02953
8	268.05	4.328	0.07057	1.421	0.03449
9	298.27	4.328	0.07126	1.546	0.03939
10	328.20	4.329	0.0717	1.656	0.0443
11	354.47	4.328	0.07189	1.735	0.04925
12	388.91	4.328	0.0722	1.825	0.05416
13	415.00	4.328	0.07245	1.883	0.05907
14	444.61	4.329	0.07277	1.938	0.06402
15	472.16	4.328	0.07289	1.98	0.06892
16	499.33	4.328	0.07314	2.013	0.07383
17	533.88	4.328	0.07352	2.048	0.07878
18	565.33	4.328	0.07402	2.082	0.08369
19	592.80	4.328	0.07459	2.109	0.0886
20	623.55	4.328	0.07497	2.139	0.0935
21	648.04	4.328	0.07553	2.155	0.09846
22	676.07	4.328	0.07604	2.172	0.1034
23	703.78	4.328	0.07629	2.181	0.1083
24	734.95	4.328	0.07711	2.187	0.1132
25	764.15	4.328	0.0778	2.191	0.1181
26	793.49	4.327	0.07887	2.194	0.123
27	819.91	4.328	0.07943	2.204	0.128
28	847.22	4.328	0.08019	2.214	0.1329
29	876.38	4.328	0.08101	2.207	0.1378
30	904.29	4.327	0.0817	2.211	0.1428
31	933.31	4.328	0.0822	2.209	0.1477
32	960.71	4.328	0.0827	2.207	0.1526
33	989.71	4.328	0.08371	2.198	0.1575
34	1016.16	4.328	0.08421	2.184	0.1624
35	1046.73	4.328	0.08509	2.167	0.1673
36	1075.11	4.328	0.0856	2.149	0.1723
37	1100.97	4.327	0.08641	2.139	0.1772
38	1129.39	4.328	0.08698	2.135	0.1821
39	1159.96	4.328	0.08805	2.128	0.187
40	1187.52	4.328	0.08918	2.123	0.192
41	1218.23	4.328	0.08981	2.12	0.1969
42	1245.98	4.328	0.09069	2.115	0.2018
43	1274.07	4.328	0.0917	2.11	0.2067
44	1302.20	4.327	0.09258	2.103	0.2116
45	1333.73	4.327	0.09302	2.104	0.2165
46	1360.22	4.327	0.09396	2.103	0.2215
47	1391.01	4.327	0.09503	2.098	0.2264
48	1419.79	4.328	0.09667	2.09	0.2313
49	1447.73	4.328	0.09742	2.086	0.2363
50	1475.92	4.327	0.0978	2.08	0.2412
51	1504.97	4.329	0.09887	2.07	0.2461
52	1534.21	4.327	0.09962	2.068	0.251
53	1561.65	4.328	0.1008	2.061	0.2559
54	1590.39	4.328	0.1018	2.057	0.2608
55	1620.96	4.328	0.1031	2.054	0.2658
56	1648.88	4.328	0.1038	2.054	0.2707
57	1679.49	4.327	0.105	2.048	0.2756
58	1708.47	4.327	0.1064	2.045	0.2805
59	1733.25	4.328	0.1072	2.045	0.2855
60	1763.44	4.328	0.1082	2.045	0.2904
61	1786.77	4.328	0.1091	2.049	0.2947

DIRECT SHEAR TEST by ASTM D3080

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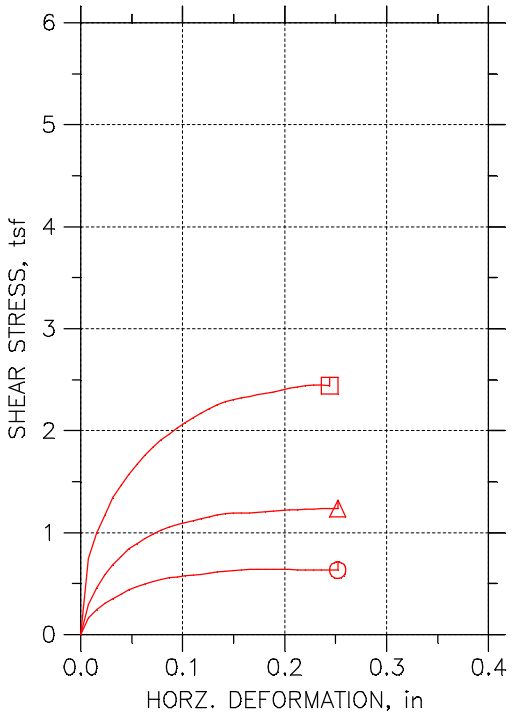

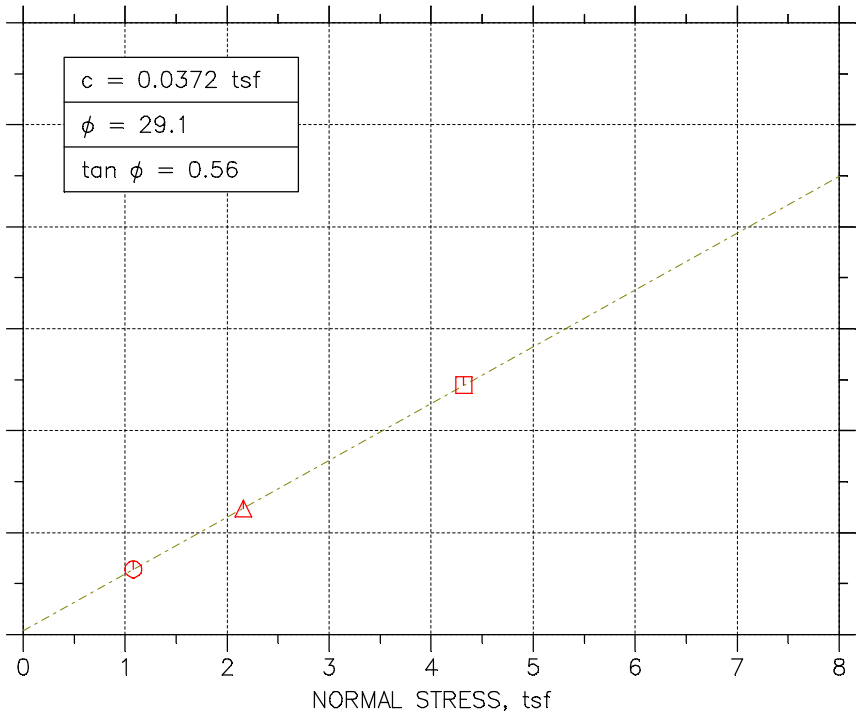

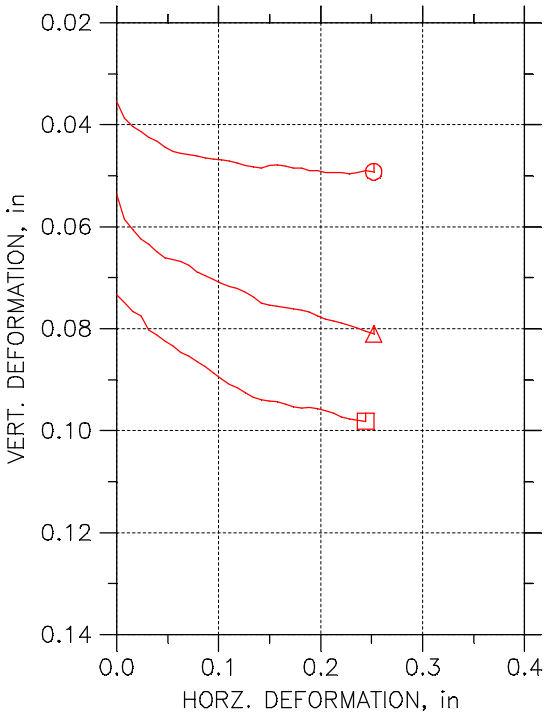

Symbol		⏲	△	⊡	
Test No.		15 PSI	30 PSI	60 PSI	
Sample No.		S-7	S-7	S-7	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.5709	2.4937	2.4854	
	Area, in^2	5.191	4.884	4.8517	
	Height, in	0.99843	0.98228	0.9622	
	Water Content, %	29.74	29.77	29.48	
	Dry Density, pcf	82.742	90.834	92.776	
	Saturation, %	76.89	93.13	96.59	
	Void Ratio	1.0522	0.86938	0.83025	
Consol. Height, in		0.963	0.93324	0.89292	
Consol. Void Ratio		0.9794	0.77604	0.69847	
Final	Water Content, %	34.40	26.34	23.67	
	Dry Density, pcf	87.034	98.998	103.32	
	Saturation, %	98.39	100.17	100.04	
	Void Ratio	0.95102	0.71522	0.64355	
Normal Stress, tsf		1.0798	2.1597	4.3201	
Max. Shear Stress, tsf		0.64126	1.2376	2.446	
Ult. Shear Stress, tsf		0.63334	1.2376	2.4421	
Time to Failure, min		895.63	1225.4	1252	
Disp. Rate, in/min		0.000207	0.000207	0.000207	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		45	45	45	
Plastic Limit		23	23	23	
Plasticity Index		22	22	22	

Project: DYNEGY HENNEPIN	
Location: HENNEPIN, IL	
Project No.: MR155233	
Boring No.: HEN-004 S7	
Sample Type: 3.0" ST	
Description: VERY DARK GRAY LEAN CLAY CL- ORGANICS NOTED	
Remarks: TEST PERFORMED AS PER ASTM D3080.	347

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DIRECT SHEAR TEST DATA

Terracon
Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-004 S7
Sample No.: S-7
Test No.: 15 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/6/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 20.0'-22.0'
Elevation: ----

Soil Description: VERY DARK GRAY LEAN CLAY CL- ORGANICS NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	1.079	0.03543	0	0
2	52.87	1.08	0.03877	0.1643	0.007876
3	92.18	1.08	0.04041	0.2425	0.01575
4	132.36	1.079	0.04135	0.3092	0.02363
5	171.72	1.08	0.04249	0.3538	0.0315
6	207.28	1.08	0.04325	0.3968	0.03938
7	247.73	1.08	0.04438	0.4399	0.04725
8	286.40	1.08	0.04526	0.472	0.05513
9	322.72	1.08	0.04558	0.4953	0.06301
10	362.86	1.08	0.04583	0.5181	0.07088
11	402.61	1.08	0.04615	0.5388	0.07876
12	441.62	1.08	0.04646	0.5562	0.08663
13	477.07	1.08	0.04671	0.568	0.09451
14	515.28	1.08	0.0469	0.5774	0.1024
15	554.10	1.08	0.04709	0.5853	0.1103
16	589.91	1.08	0.04747	0.5933	0.1181
17	631.34	1.08	0.04797	0.6051	0.126
18	664.33	1.08	0.04829	0.6145	0.1339
19	703.46	1.08	0.04848	0.6234	0.1418
20	745.35	1.08	0.04804	0.6289	0.1496
21	783.16	1.08	0.04791	0.6328	0.1575
22	820.22	1.08	0.04816	0.6373	0.1654
23	858.73	1.08	0.04854	0.6393	0.1733
24	895.63	1.08	0.04848	0.6413	0.1811
25	935.53	1.08	0.04898	0.6403	0.189
26	971.85	1.079	0.04905	0.6393	0.1969
27	1012.19	1.08	0.04936	0.6373	0.2048
28	1048.66	1.081	0.04942	0.6363	0.2126
29	1085.79	1.08	0.04942	0.6348	0.2205
30	1123.47	1.08	0.04961	0.6328	0.2284
31	1162.13	1.08	0.04942	0.6333	0.2362
32	1199.13	1.079	0.04905	0.6324	0.2441
33	1236.88	1.08	0.04923	0.6333	0.252

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-004 S7
Sample No.: S-7
Test No.: 30 PSI

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/6/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: BCM
Depth: 20.0'-22.0'
Elevation: ----

Soil Description: VERY DARK GRAY LEAN CLAY CL- ORGANICS NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	2.158	0.05365	0	0
2	44.38	2.16	0.05856	0.2976	0.007876
3	84.25	2.16	0.06058	0.4585	0.01575
4	125.18	2.159	0.06241	0.5878	0.02363
5	162.47	2.16	0.06348	0.6841	0.0315
6	197.93	2.16	0.06493	0.7629	0.03938
7	240.57	2.16	0.06613	0.8389	0.04725
8	274.16	2.16	0.06644	0.8908	0.05513
9	313.67	2.159	0.06689	0.942	0.06301
10	351.00	2.16	0.06764	0.9844	0.07088
11	389.72	2.159	0.06878	1.023	0.07876
12	427.42	2.159	0.06953	1.056	0.08663
13	466.41	2.159	0.07029	1.082	0.09451
14	502.85	2.16	0.07111	1.102	0.1024
15	538.11	2.16	0.07168	1.119	0.1103
16	576.81	2.16	0.07212	1.138	0.1181
17	619.31	2.16	0.07287	1.157	0.126
18	652.41	2.159	0.07376	1.171	0.1339
19	693.77	2.159	0.07496	1.184	0.1418
20	731.23	2.16	0.0754	1.19	0.1496
21	767.99	2.16	0.07565	1.19	0.1575
22	806.68	2.16	0.0759	1.192	0.1654
23	843.01	2.16	0.07609	1.196	0.1733
24	882.66	2.16	0.07634	1.203	0.1811
25	918.72	2.16	0.07672	1.211	0.189
26	955.92	2.16	0.07748	1.218	0.1969
27	995.76	2.16	0.07817	1.221	0.2048
28	1033.70	2.16	0.07849	1.226	0.2126
29	1073.13	2.16	0.07893	1.229	0.2205
30	1108.90	2.16	0.07937	1.231	0.2284
31	1147.19	2.16	0.07987	1.234	0.2362
32	1185.23	2.16	0.0805	1.236	0.2441
33	1225.37	2.16	0.08101	1.238	0.252

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-004 S7
Sample No.: S-7
Test No.: 60 PSI

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/6/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: BCM
Depth: 20.0'-22.0'
Elevation: ----

Soil Description: VERY DARK GRAY LEAN CLAY CL- ORGANICS NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	4.319	0.07332	0	0
2	141.08	4.319	0.07483	0.744	0.007876
3	182.59	4.319	0.07659	1.001	0.01575
4	219.18	4.318	0.07754	1.176	0.02363
5	259.25	4.318	0.08025	1.34	0.0315
6	297.64	4.319	0.08126	1.465	0.03938
7	335.60	4.319	0.08233	1.571	0.04725
8	374.97	4.319	0.08334	1.67	0.05513
9	411.17	4.319	0.08466	1.754	0.06301
10	453.03	4.319	0.08536	1.841	0.07088
11	491.17	4.319	0.08637	1.907	0.07876
12	528.00	4.319	0.08744	1.966	0.08663
13	567.37	4.319	0.08863	2.025	0.09451
14	604.60	4.319	0.08977	2.075	0.1024
15	643.89	4.319	0.0909	2.128	0.1103
16	680.77	4.319	0.0916	2.174	0.1181
17	717.15	4.319	0.09261	2.214	0.126
18	754.96	4.318	0.09349	2.254	0.1339
19	791.57	4.319	0.09393	2.282	0.1418
20	831.59	4.319	0.09425	2.306	0.1496
21	873.07	4.319	0.09437	2.323	0.1575
22	908.73	4.318	0.09488	2.335	0.1654
23	946.00	4.319	0.09538	2.351	0.1733
24	984.76	4.319	0.09557	2.366	0.1811
25	1022.43	4.319	0.09544	2.377	0.189
26	1061.30	4.319	0.0957	2.395	0.1969
27	1100.41	4.319	0.09607	2.414	0.2048
28	1137.14	4.319	0.09658	2.428	0.2126
29	1175.39	4.319	0.09733	2.443	0.2205
30	1213.75	4.319	0.09771	2.446	0.2284
31	1251.96	4.32	0.0979	2.446	0.2362
32	1288.97	4.319	0.09815	2.442	0.2441

DIRECT SHEAR TEST by ASTM D3080

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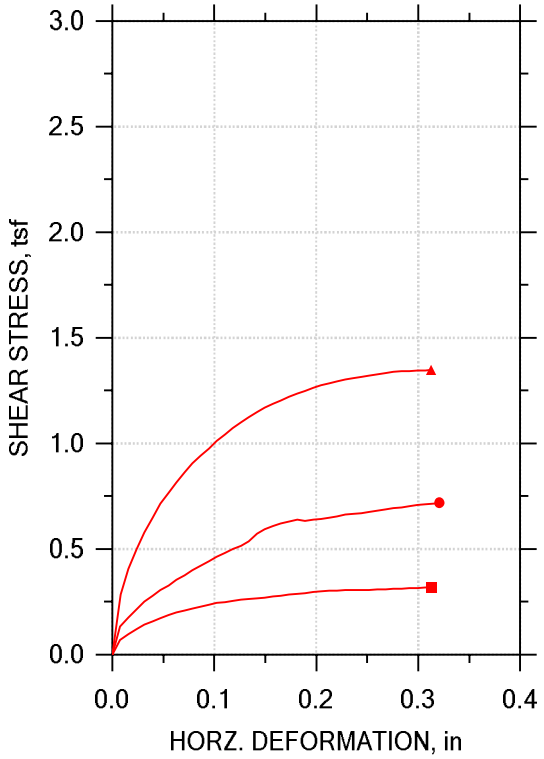

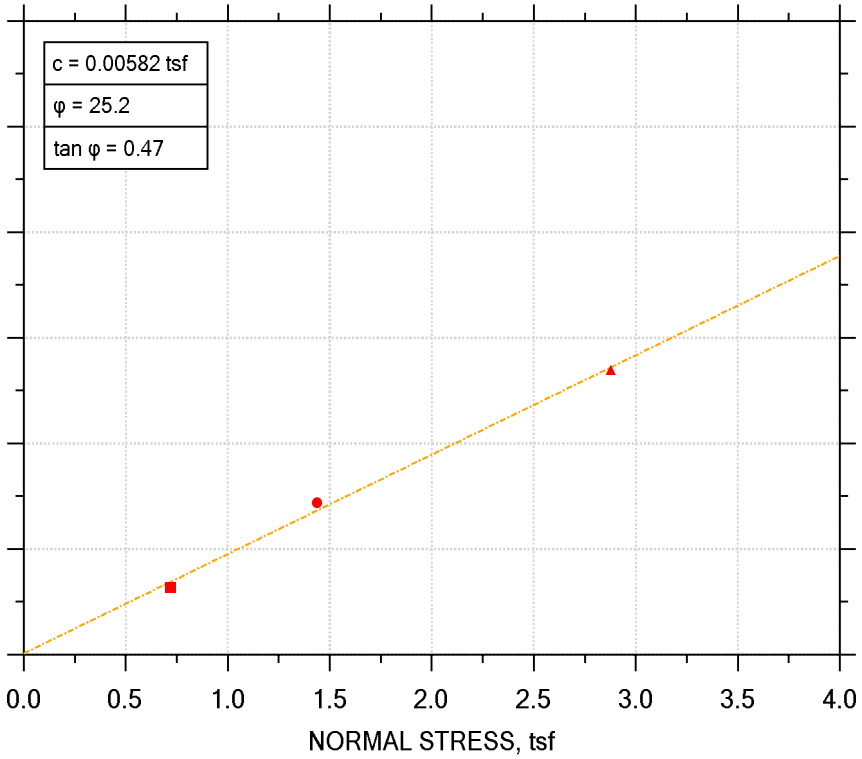

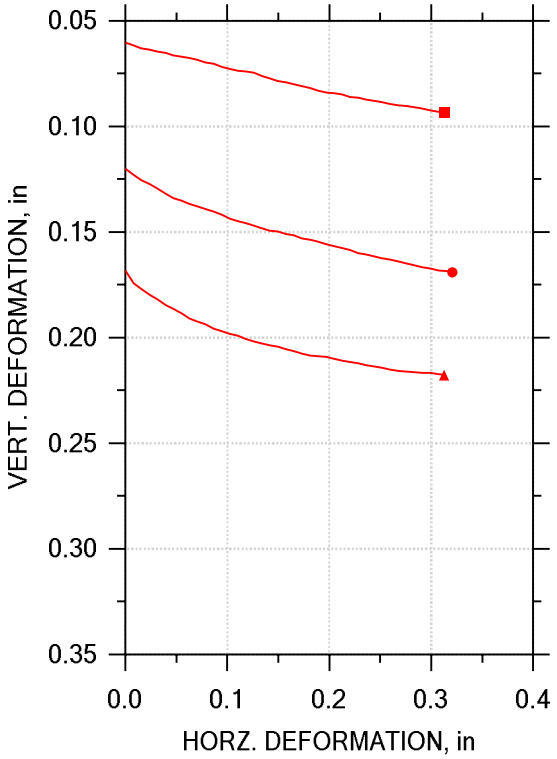

Symbol		■	●	▲	
Test No.		10 PSI	20 PSI	40 PSI	
Sample No.		S-4	S-4	S-4	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.4823	2.4862	2.4819	
	Area, in²	4.8394	4.8548	4.8379	
	Height, in	1.002	0.98622	1.0028	
	Water Content, %	53.29	53.23	53.48	
	Dry Density, pcf	68.32	67.84	67.67	
	Saturation, %	98.07	96.80	96.84	
	Void Ratio	1.4671	1.4847	1.4909	
Consol. Height, in		0.94176	0.86607	0.83469	
Consol. Void Ratio		1.3189	1.182	1.0734	
Final	Water Content, %	45.63	39.25	34.99	
	Dry Density, pcf	75.33	81.87	86.43	
	Saturation, %	99.55	100.09	99.42	
	Void Ratio	1.2376	1.0587	0.9502	
Normal Stress, tsf		0.71768	1.4381	2.8781	
Max. Shear Stress, tsf		0.3191	0.71924	1.348	
Ult. Shear Stress, tsf		0.3191	0.71924	1.348	
Time to Failure, min		80.5	80.604	81.975	
Disp. Rate, in/min		0.0039961	0.0039961	0.0039961	
Estimated Specific Gravity		2.70	2.70	2.70	
Liquid Limit		43	43	43	
Plastic Limit		24	24	24	
Plasticity Index		19	19	19	

Project: DYNEGY HENNEPIN

Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HEN-005 S4

Sample Type: 3.0" ST

Description: DARK GRAY LEAN CLAY WITH SAND AND FLY ASH

Remarks: TEST PERFORMED AS PER ASTM D3080.

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-005 S4
Sample No.: S-4
Test No.: 10 PSI

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/30/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: BCM
Depth: 12.5'-14.5'
Elevation: ----

Soil Description: DARK GRAY LEAN CLAY WITH SAND AND FLY ASH
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.718	0.06020	0.000	0.0000	0.0000
2	4.00	0.718	0.06153	0.0683	0.007876	0.007876
3	6.06	0.717	0.06310	0.0981	0.01575	0.01575
4	8.07	0.718	0.06380	0.121	0.02363	0.02363
5	10.15	0.718	0.06449	0.141	0.03150	0.03150
6	11.97	0.718	0.06531	0.157	0.03938	0.03938
7	13.94	0.718	0.06632	0.173	0.04725	0.04725
8	15.92	0.718	0.06689	0.187	0.05513	0.05513
9	17.78	0.717	0.06764	0.199	0.06301	0.06301
10	19.76	0.718	0.06859	0.209	0.07088	0.07088
11	21.79	0.718	0.06985	0.219	0.07876	0.07876
12	23.83	0.718	0.07042	0.228	0.08663	0.08663
13	25.79	0.718	0.07168	0.237	0.09451	0.09451
14	27.77	0.717	0.07281	0.244	0.1024	0.1024
15	29.83	0.718	0.07357	0.250	0.1103	0.1103
16	31.69	0.718	0.07395	0.255	0.1182	0.1182
17	33.69	0.718	0.07451	0.259	0.1260	0.1260
18	35.65	0.717	0.07596	0.264	0.1339	0.1339
19	37.72	0.717	0.07729	0.267	0.1418	0.1418
20	39.63	0.718	0.07842	0.271	0.1496	0.1496
21	41.54	0.718	0.07905	0.275	0.1575	0.1575
22	43.63	0.718	0.07987	0.279	0.1654	0.1654
23	45.58	0.717	0.08094	0.284	0.1733	0.1733
24	47.50	0.718	0.08189	0.288	0.1811	0.1811
25	49.57	0.718	0.08315	0.292	0.1890	0.1890
26	51.56	0.718	0.08391	0.296	0.1969	0.1969
27	53.48	0.718	0.08435	0.299	0.2048	0.2048
28	55.29	0.718	0.08485	0.302	0.2126	0.2126
29	57.40	0.718	0.08592	0.304	0.2205	0.2205
30	59.23	0.718	0.08649	0.305	0.2284	0.2284
31	61.35	0.718	0.08725	0.306	0.2362	0.2362
32	63.17	0.718	0.08788	0.307	0.2441	0.2441
33	65.13	0.718	0.08838	0.307	0.2520	0.2520
34	67.13	0.718	0.08933	0.308	0.2599	0.2599
35	69.22	0.718	0.09002	0.309	0.2677	0.2677
36	71.18	0.718	0.09046	0.311	0.2756	0.2756
37	73.11	0.718	0.09097	0.313	0.2835	0.2835
38	75.10	0.718	0.09153	0.315	0.2914	0.2914
39	77.07	0.718	0.09242	0.317	0.2992	0.2992
40	78.86	0.718	0.09298	0.318	0.3071	0.3071
41	80.50	0.718	0.09324	0.319	0.3129	0.3129

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-005 S4
Sample No.: S-4
Test No.: 20 PSI

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/30/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: BCM
Depth: 12.5'-14.5'
Elevation: ----

Soil Description: DARK GRAY LEAN CLAY WITH SAND AND FLY ASH
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.43	0.1202	0.000	0.0000	0.0000
2	2.29	1.43	0.1228	0.133	0.007876	0.007876
3	4.23	1.43	0.1253	0.176	0.01575	0.01575
4	6.22	1.44	0.1272	0.215	0.02363	0.02363
5	8.28	1.44	0.1295	0.250	0.03150	0.03150
6	10.27	1.44	0.1319	0.279	0.03938	0.03938
7	12.30	1.44	0.1338	0.306	0.04725	0.04725
8	14.12	1.44	0.1352	0.329	0.05513	0.05513
9	16.11	1.44	0.1365	0.354	0.06301	0.06301
10	18.07	1.44	0.1380	0.377	0.07088	0.07088
11	19.97	1.44	0.1391	0.399	0.07876	0.07876
12	21.95	1.44	0.1404	0.421	0.08663	0.08663
13	23.99	1.44	0.1420	0.443	0.09451	0.09451
14	26.02	1.44	0.1436	0.463	0.1024	0.1024
15	27.95	1.44	0.1449	0.482	0.1103	0.1103
16	29.93	1.44	0.1457	0.499	0.1181	0.1181
17	31.99	1.44	0.1471	0.514	0.1260	0.1260
18	33.87	1.44	0.1482	0.535	0.1339	0.1339
19	35.86	1.44	0.1493	0.574	0.1418	0.1418
20	37.86	1.44	0.1498	0.594	0.1496	0.1496
21	39.90	1.44	0.1510	0.610	0.1575	0.1575
22	41.78	1.44	0.1517	0.620	0.1654	0.1654
23	43.73	1.44	0.1530	0.630	0.1733	0.1733
24	45.75	1.44	0.1538	0.638	0.1811	0.1811
25	47.75	1.44	0.1545	0.633	0.1890	0.1890
26	49.63	1.44	0.1559	0.638	0.1969	0.1969
27	51.74	1.44	0.1567	0.644	0.2048	0.2048
28	53.71	1.44	0.1577	0.650	0.2126	0.2126
29	55.61	1.44	0.1585	0.656	0.2205	0.2205
30	57.47	1.44	0.1599	0.662	0.2284	0.2284
31	59.60	1.44	0.1606	0.667	0.2362	0.2362
32	61.41	1.44	0.1615	0.670	0.2441	0.2441
33	63.52	1.44	0.1625	0.677	0.2520	0.2520
34	65.33	1.44	0.1631	0.683	0.2599	0.2599
35	67.28	1.44	0.1640	0.688	0.2677	0.2677
36	69.30	1.44	0.1649	0.693	0.2756	0.2756
37	71.37	1.44	0.1657	0.698	0.2835	0.2835
38	73.34	1.44	0.1666	0.703	0.2914	0.2914
39	75.29	1.44	0.1674	0.708	0.2993	0.2993
40	77.30	1.44	0.1682	0.711	0.3071	0.3071
41	79.27	1.44	0.1686	0.715	0.3150	0.3150
42	80.60	1.44	0.1691	0.719	0.3205	0.3205

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-005 S4
Sample No.: S-4
Test No.: 40 PSI

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/30/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: BCM
Depth: 12.5'-14.5'
Elevation: ----

Soil Description: DARK GRAY LEAN CLAY WITH SAND AND FLY ASH
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	2.88	0.1681	0.000	0.0000	0.0000
2	5.35	2.87	0.1742	0.285	0.007923	0.007923
3	7.35	2.87	0.1768	0.407	0.01575	0.01575
4	9.37	2.88	0.1797	0.499	0.02363	0.02363
5	11.37	2.88	0.1819	0.577	0.03150	0.03150
6	13.39	2.88	0.1845	0.648	0.03938	0.03938
7	15.49	2.88	0.1865	0.714	0.04725	0.04725
8	17.43	2.88	0.1886	0.766	0.05513	0.05513
9	19.35	2.88	0.1908	0.815	0.06301	0.06301
10	21.38	2.88	0.1925	0.863	0.07088	0.07088
11	23.40	2.88	0.1937	0.905	0.07876	0.07876
12	25.34	2.88	0.1957	0.943	0.08663	0.08663
13	27.19	2.88	0.1971	0.976	0.09451	0.09451
14	29.19	2.88	0.1981	1.01	0.1024	0.1024
15	31.08	2.88	0.1992	1.04	0.1103	0.1103
16	33.09	2.88	0.2007	1.07	0.1181	0.1181
17	35.10	2.88	0.2018	1.10	0.1260	0.1260
18	37.22	2.88	0.2029	1.12	0.1339	0.1339
19	39.11	2.88	0.2037	1.15	0.1418	0.1418
20	41.16	2.88	0.2044	1.17	0.1496	0.1496
21	43.03	2.88	0.2054	1.19	0.1575	0.1575
22	45.09	2.88	0.2064	1.20	0.1654	0.1654
23	47.11	2.88	0.2077	1.22	0.1733	0.1733
24	49.03	2.88	0.2085	1.24	0.1811	0.1811
25	51.03	2.88	0.2089	1.25	0.1890	0.1890
26	52.98	2.88	0.2092	1.26	0.1969	0.1969
27	54.99	2.88	0.2100	1.28	0.2048	0.2048
28	56.80	2.88	0.2108	1.29	0.2126	0.2126
29	58.83	2.88	0.2116	1.29	0.2205	0.2205
30	60.98	2.88	0.2122	1.30	0.2284	0.2284
31	62.85	2.88	0.2131	1.31	0.2362	0.2362
32	64.77	2.88	0.2137	1.32	0.2441	0.2441
33	66.81	2.88	0.2144	1.32	0.2520	0.2520
34	68.70	2.88	0.2153	1.33	0.2599	0.2599
35	70.65	2.88	0.2157	1.33	0.2677	0.2677
36	72.65	2.88	0.2161	1.34	0.2756	0.2756
37	74.82	2.88	0.2164	1.34	0.2835	0.2835
38	76.70	2.88	0.2165	1.34	0.2914	0.2914
39	78.62	2.88	0.2167	1.35	0.2992	0.2992
40	80.39	2.88	0.2172	1.35	0.3071	0.3071
41	81.97	2.88	0.2177	1.35	0.3126	0.3126

DIRECT SHEAR TEST by ASTM D3080

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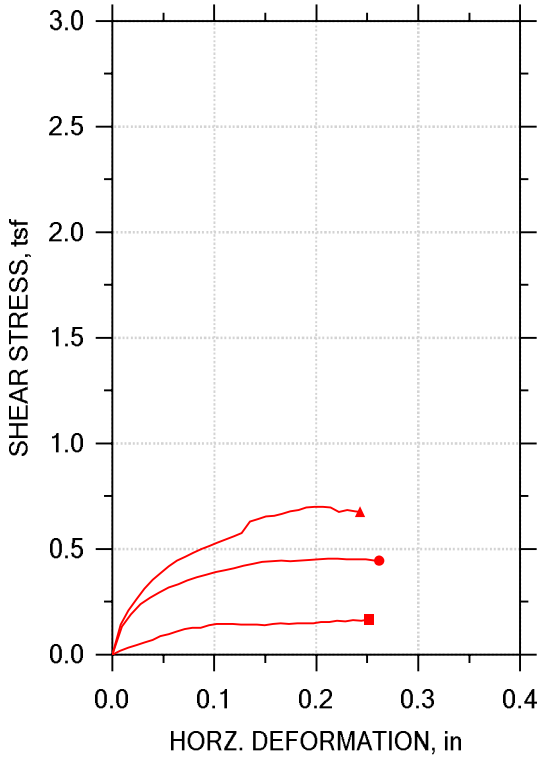

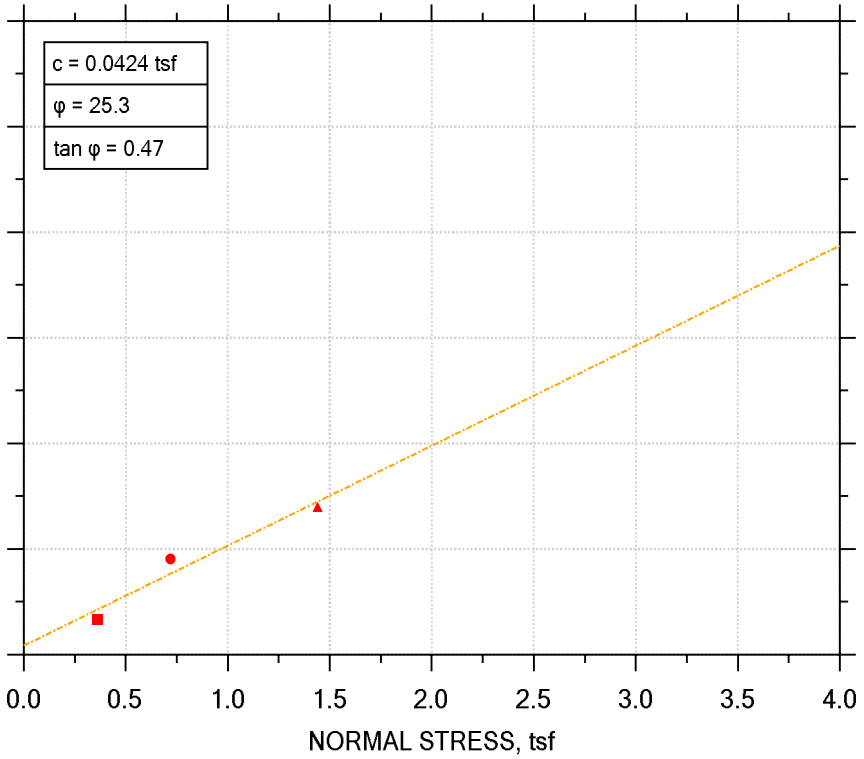

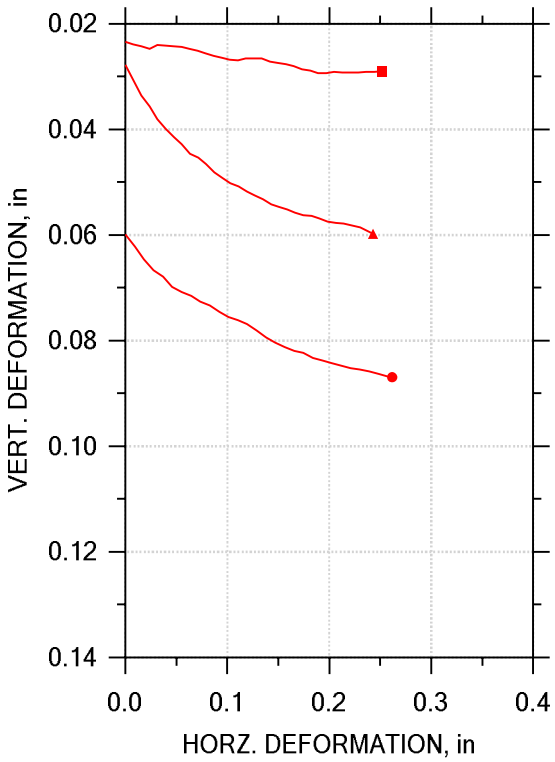

Symbol		■	●	▲	
Test No.		5.0 PSI	10.0 PSI	20.0 PSI	
Sample No.		S-4	S-4	S-4	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.5744	2.5728	2.5728	
	Area, in²	5.2053	5.1989	5.1989	
	Height, in	0.99685	0.99134	0.99134	
	Water Content, %	43.92	43.72	43.94	
	Dry Density, pcf	68.44	68.81	69.02	
	Saturation, %	81.69	82.05	82.92	
	Void Ratio	1.4355	1.4225	1.415	
Consol. Height, in		0.97344	0.93151	0.9636	
Consol. Void Ratio		1.3783	1.2763	1.3474	
Final	Water Content, %	49.94	45.37	46.75	
	Dry Density, pcf	70.49	75.42	73.45	
	Saturation, %	97.71	100.11	98.33	
	Void Ratio	1.3647	1.2101	1.2694	
Normal Stress, tsf		0.3602	0.71979	1.4396	
Max. Shear Stress, tsf		0.16591	0.45364	0.70049	
Ult. Shear Stress, tsf		0.16591	0.44507	0.67713	
Time to Failure, min		4266.5	1139.6	1013.5	
Disp. Rate, in/min		5.9055e-05	0.00020472	0.00020472	
Estimated Specific Gravity		2.67	2.67	2.67	
Liquid Limit		NP	NP	NP	
Plastic Limit		NP	NP	NP	
Plasticity Index		NP	NP	NP	

Project: DYNEGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN-008 S4
Sample Type: 3.0" ST
Description: FLY ASH / LEAN CLAY WITH SAND MIX SAMPLE TAKEN FROM THE FLY ASH STRATA
Remarks: TEST PERFORMED AS PER ASTM D3080.

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-008 S4
Sample No.: S-4
Test No.: 5.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/146/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: FLY ASH / LEAN CLAY WITH SAND MIX SAMPLE TAKEN FROM THE FLY ASH STRATA
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.359	0.02341	0.000	0.0000	0.0000
2	130.95	0.359	0.02385	0.0182	0.007876	0.007876
3	252.94	0.359	0.02424	0.0338	0.01575	0.01575
4	379.00	0.360	0.02471	0.0446	0.02363	0.02363
5	526.83	0.359	0.02406	0.0578	0.03150	0.03150
6	657.29	0.359	0.02411	0.0702	0.03938	0.03938
7	817.53	0.359	0.02428	0.0875	0.04725	0.04725
8	933.21	0.359	0.02437	0.0982	0.05513	0.05513
9	1068.43	0.359	0.02476	0.110	0.06301	0.06301
10	1213.40	0.359	0.02510	0.121	0.07088	0.07088
11	1339.35	0.359	0.02558	0.128	0.07876	0.07876
12	1469.39	0.359	0.02601	0.127	0.08663	0.08663
13	1605.55	0.359	0.02645	0.139	0.09451	0.09451
14	1727.16	0.359	0.02679	0.146	0.1024	0.1024
15	1864.59	0.359	0.02697	0.144	0.1103	0.1103
16	1999.57	0.359	0.02649	0.144	0.1181	0.1181
17	2145.44	0.359	0.02653	0.141	0.1260	0.1260
18	2273.92	0.359	0.02658	0.142	0.1339	0.1339
19	2405.83	0.359	0.02710	0.143	0.1418	0.1418
20	2539.29	0.359	0.02740	0.140	0.1496	0.1496
21	2670.74	0.359	0.02762	0.146	0.1575	0.1575
22	2795.67	0.359	0.02796	0.147	0.1654	0.1654
23	2917.16	0.359	0.02857	0.146	0.1733	0.1733
24	3055.69	0.359	0.02887	0.149	0.1811	0.1811
25	3181.49	0.359	0.02931	0.149	0.1890	0.1890
26	3308.15	0.359	0.02939	0.149	0.1968	0.1968
27	3445.58	0.359	0.02909	0.155	0.2047	0.2047
28	3579.69	0.359	0.02922	0.155	0.2126	0.2126
29	3731.12	0.359	0.02918	0.159	0.2205	0.2205
30	3860.05	0.359	0.02922	0.157	0.2284	0.2284
31	3999.46	0.359	0.02909	0.164	0.2362	0.2362
32	4141.08	0.359	0.02905	0.162	0.2441	0.2441
33	4266.47	0.360	0.02900	0.166	0.2520	0.2520

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-008 S4
Sample No.: S-4
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/28/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: FLY ASH / LEAN CLAY WITH SAND MIX SAMPLE TAKEN FROM THE FLY ASH STRATA
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.719	0.05983	0.000	0.0000	0.0000
2	158.45	0.719	0.06222	0.132	0.009199	0.009199
3	205.56	0.720	0.06455	0.191	0.01840	0.01840
4	254.95	0.720	0.06663	0.238	0.02760	0.02760
5	299.15	0.719	0.06783	0.270	0.03679	0.03679
6	341.39	0.720	0.06979	0.295	0.04599	0.04599
7	391.35	0.720	0.07073	0.319	0.05519	0.05519
8	431.04	0.720	0.07155	0.335	0.06439	0.06439
9	476.57	0.720	0.07262	0.352	0.07359	0.07359
10	520.20	0.720	0.07332	0.365	0.08279	0.08279
11	563.92	0.720	0.07458	0.379	0.09199	0.09199
12	606.27	0.720	0.07546	0.390	0.1012	0.1012
13	652.13	0.720	0.07615	0.400	0.1104	0.1104
14	695.38	0.720	0.07691	0.410	0.1196	0.1196
15	736.80	0.719	0.07811	0.423	0.1288	0.1288
16	782.53	0.720	0.07937	0.431	0.1380	0.1380
17	831.29	0.720	0.08038	0.440	0.1472	0.1472
18	870.18	0.720	0.08120	0.443	0.1564	0.1564
19	918.37	0.720	0.08189	0.444	0.1656	0.1656
20	962.28	0.720	0.08233	0.443	0.1748	0.1748
21	1005.17	0.720	0.08328	0.446	0.1840	0.1840
22	1050.60	0.720	0.08378	0.450	0.1932	0.1932
23	1091.31	0.720	0.08429	0.453	0.2024	0.2024
24	1139.63	0.720	0.08479	0.454	0.2116	0.2116
25	1181.83	0.720	0.08517	0.453	0.2208	0.2208
26	1225.69	0.719	0.08542	0.452	0.2300	0.2300
27	1272.35	0.720	0.08580	0.451	0.2392	0.2392
28	1316.66	0.720	0.08630	0.450	0.2483	0.2483
29	1362.97	0.720	0.08674	0.445	0.2575	0.2575
30	1382.74	0.720	0.08693	0.445	0.2614	0.2614

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-008 S4
Sample No.: S-4
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/29/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: FLY ASH / LEAN CLAY WITH SAND MIX SAMPLE TAKEN FROM THE FLY ASH STRATA
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.44	0.02774	0.000	0.0000	0.0000
2	84.76	1.44	0.03083	0.143	0.007935	0.007935
3	122.53	1.44	0.03360	0.209	0.01587	0.01587
4	160.70	1.44	0.03562	0.264	0.02381	0.02381
5	200.90	1.44	0.03808	0.314	0.03174	0.03174
6	240.99	1.44	0.03990	0.354	0.03968	0.03968
7	279.87	1.44	0.04142	0.388	0.04761	0.04761
8	319.42	1.44	0.04274	0.418	0.05555	0.05555
9	357.55	1.44	0.04457	0.444	0.06348	0.06348
10	393.06	1.44	0.04533	0.464	0.07142	0.07142
11	433.53	1.44	0.04652	0.482	0.07935	0.07935
12	471.68	1.44	0.04816	0.499	0.08729	0.08729
13	508.29	1.44	0.04917	0.515	0.09522	0.09522
14	548.55	1.44	0.05018	0.531	0.1032	0.1032
15	588.53	1.44	0.05075	0.545	0.1111	0.1111
16	627.66	1.44	0.05176	0.559	0.1190	0.1190
17	663.82	1.44	0.05245	0.575	0.1270	0.1270
18	703.53	1.44	0.05321	0.630	0.1349	0.1349
19	742.80	1.44	0.05415	0.641	0.1428	0.1428
20	779.75	1.44	0.05472	0.655	0.1508	0.1508
21	821.94	1.44	0.05510	0.657	0.1587	0.1587
22	855.16	1.44	0.05579	0.666	0.1666	0.1666
23	894.84	1.44	0.05630	0.680	0.1746	0.1746
24	937.49	1.44	0.05636	0.685	0.1825	0.1825
25	975.40	1.44	0.05686	0.698	0.1904	0.1904
26	1013.53	1.44	0.05743	0.700	0.1984	0.1984
27	1052.23	1.44	0.05775	0.700	0.2063	0.2063
28	1089.85	1.44	0.05787	0.698	0.2142	0.2142
29	1130.18	1.44	0.05819	0.676	0.2221	0.2221
30	1166.99	1.44	0.05856	0.684	0.2301	0.2301
31	1208.40	1.44	0.05926	0.680	0.2380	0.2380
32	1235.66	1.44	0.05976	0.677	0.2431	0.2431

DIRECT SHEAR TEST by ASTM D3080

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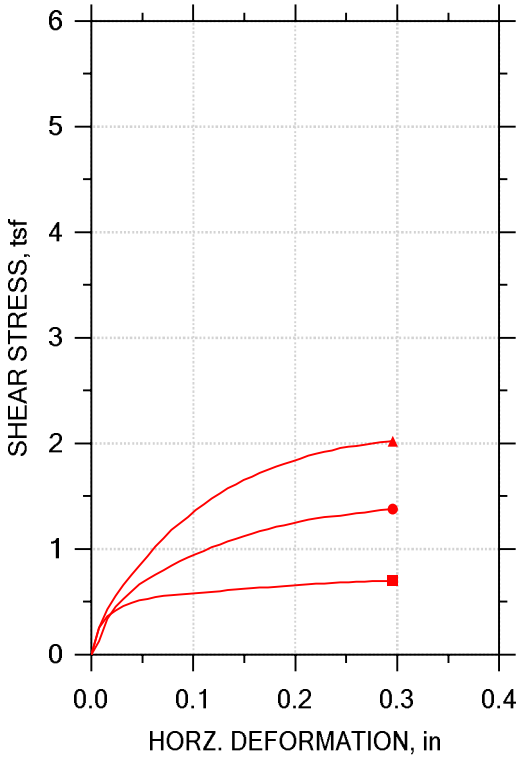

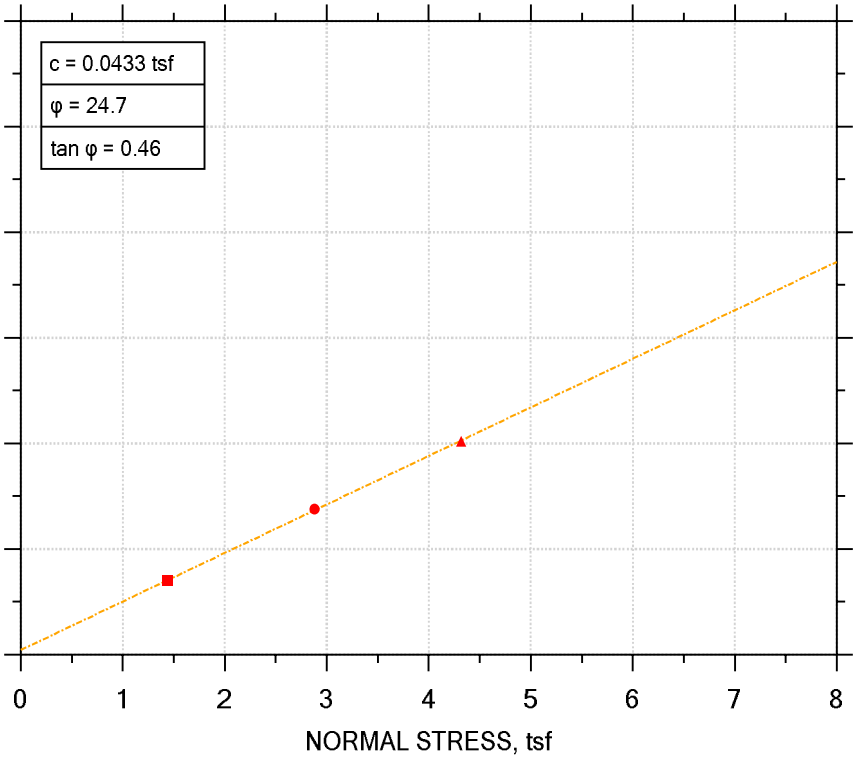

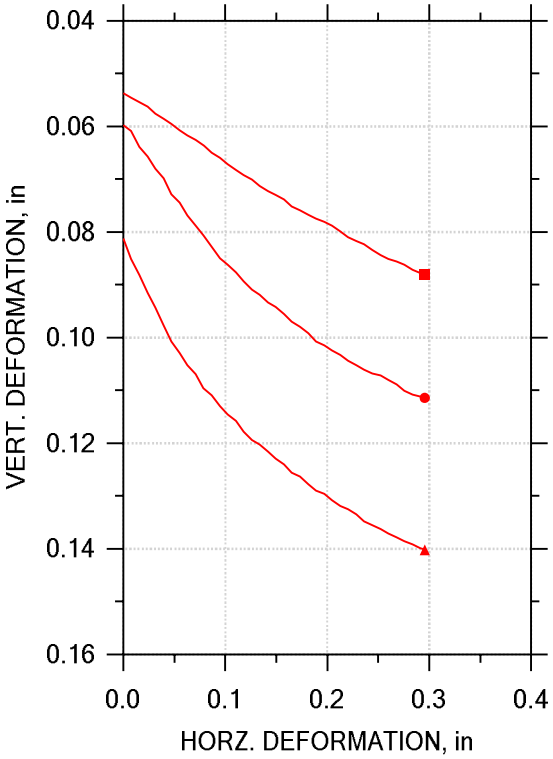

Symbol		■	●	▲	
Test No.		20.0 PSI	40.0 PSI	60.0 PSI	
Sample No.		S-9	S-9	S-9	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.498	2.4992	2.5059	
	Area, in²	4.901	4.9056	4.932	
	Height, in	0.99213	0.99961	0.99291	
	Water Content, %	26.32	26.88	27.01	
	Dry Density, pcf	99.41	98.96	97.46	
	Saturation, %	101.09	102.13	98.98	
	Void Ratio	0.70807	0.71592	0.74226	
Consol. Height, in		0.93839	0.93984	0.91168	
Consol. Void Ratio		0.61555	0.61332	0.59971	
Final	Water Content, %	20.28	18.96	17.91	
	Dry Density, pcf	109.1	111.4	113.5	
	Saturation, %	99.11	98.29	98.16	
	Void Ratio	0.55655	0.52466	0.49629	
Normal Stress, tsf		1.4387	2.8784	4.3182	
Max. Shear Stress, tsf		0.69878	1.3783	2.0224	
Ult. Shear Stress, tsf		0.69878	1.3783	2.0224	
Time to Failure, min		74.891	75.103	74.824	
Disp. Rate, in/min		0.0039823	0.0039823	0.0039823	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		30	30	30	
Plastic Limit		15	15	15	
Plasticity Index		15	15	15	

Project: DYNEGY HENNEPIN

Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HEN-012 S-9

Sample Type: TRIMMED

Description: BROWN AND GRAYISH BROWN LEAN CLAY WITH SAND CL 359

Remarks:

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-012 S-9
Sample No.: S-9
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/30/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: BCM
Depth: 30.0'-32.0'
Elevation: ----

Soil Description: BROWN AND GRAYISH BROWN LEAN CLAY WITH SAND CL
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.44	0.05374	0.000	0.0000	0.0000
2	2.36	1.44	0.05449	0.255	0.007902	0.007902
3	4.41	1.44	0.05541	0.361	0.01580	0.01580
4	6.20	1.44	0.05620	0.419	0.02364	0.02364
5	8.36	1.44	0.05759	0.461	0.03154	0.03154
6	10.28	1.44	0.05849	0.491	0.03940	0.03940
7	12.21	1.44	0.05946	0.514	0.04727	0.04727
8	14.37	1.44	0.06072	0.530	0.05514	0.05514
9	16.51	1.44	0.06170	0.545	0.06300	0.06300
10	18.51	1.44	0.06253	0.557	0.07087	0.07087
11	20.48	1.44	0.06368	0.563	0.07884	0.07884
12	22.37	1.44	0.06492	0.571	0.08664	0.08664
13	24.20	1.44	0.06593	0.574	0.09451	0.09451
14	26.24	1.44	0.06710	0.580	0.1024	0.1024
15	28.30	1.44	0.06820	0.586	0.1102	0.1102
16	30.30	1.44	0.06917	0.594	0.1181	0.1181
17	32.31	1.44	0.07004	0.603	0.1260	0.1260
18	34.44	1.44	0.07130	0.612	0.1339	0.1339
19	36.46	1.44	0.07221	0.620	0.1417	0.1417
20	38.12	1.44	0.07295	0.626	0.1497	0.1497
21	40.00	1.44	0.07385	0.630	0.1575	0.1575
22	42.18	1.44	0.07515	0.634	0.1654	0.1654
23	44.09	1.44	0.07589	0.638	0.1732	0.1732
24	46.27	1.44	0.07673	0.645	0.1811	0.1811
25	48.21	1.44	0.07745	0.650	0.1890	0.1890
26	50.13	1.44	0.07809	0.656	0.1969	0.1969
27	52.19	1.44	0.07879	0.662	0.2048	0.2048
28	54.02	1.44	0.07987	0.668	0.2126	0.2126
29	55.82	1.44	0.08097	0.671	0.2205	0.2205
30	57.85	1.44	0.08169	0.675	0.2283	0.2283
31	59.94	1.44	0.08230	0.678	0.2362	0.2362
32	61.95	1.44	0.08334	0.682	0.2441	0.2441
33	64.02	1.44	0.08442	0.687	0.2520	0.2520
34	65.84	1.44	0.08511	0.689	0.2598	0.2598
35	68.00	1.44	0.08554	0.692	0.2678	0.2678
36	69.87	1.44	0.08624	0.695	0.2757	0.2757
37	71.73	1.44	0.08714	0.696	0.2835	0.2835
38	73.67	1.44	0.08770	0.697	0.2914	0.2914
39	74.89	1.44	0.08801	0.699	0.2959	0.2959

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-012 S-9
Sample No.: S-9
Test No.: 40.0 PSI

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/30/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: BCM
Depth: 30.0'-32.0'
Elevation: ----

Soil Description: BROWN AND GRAYISH BROWN LEAN CLAY WITH SAND CL
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	2.88	0.05977	0.000	0.0000	0.0000
2	2.06	2.88	0.06089	0.127	0.007902	0.007902
3	4.31	2.88	0.06384	0.341	0.01577	0.01577
4	6.41	2.88	0.06564	0.452	0.02364	0.02364
5	8.28	2.88	0.06802	0.530	0.03150	0.03150
6	10.21	2.88	0.06982	0.600	0.03947	0.03947
7	12.15	2.88	0.07283	0.663	0.04727	0.04727
8	14.13	2.88	0.07441	0.714	0.05514	0.05514
9	16.14	2.88	0.07686	0.757	0.06300	0.06300
10	18.27	2.88	0.07875	0.799	0.07087	0.07087
11	20.38	2.88	0.08055	0.841	0.07877	0.07877
12	22.34	2.88	0.08280	0.882	0.08664	0.08664
13	24.49	2.88	0.08496	0.920	0.09451	0.09451
14	26.26	2.88	0.08615	0.954	0.1024	0.1024
15	28.11	2.88	0.08759	0.985	0.1102	0.1102
16	30.15	2.88	0.08930	1.02	0.1181	0.1181
17	32.26	2.88	0.09089	1.04	0.1260	0.1260
18	34.35	2.88	0.09193	1.07	0.1339	0.1339
19	36.34	2.88	0.09330	1.10	0.1417	0.1417
20	38.37	2.88	0.09418	1.12	0.1496	0.1496
21	40.32	2.88	0.09548	1.15	0.1575	0.1575
22	42.32	2.88	0.09696	1.17	0.1654	0.1654
23	44.13	2.88	0.09798	1.19	0.1732	0.1732
24	46.14	2.88	0.09912	1.21	0.1811	0.1811
25	48.23	2.88	0.1007	1.23	0.1890	0.1890
26	50.29	2.88	0.1015	1.24	0.1969	0.1969
27	52.22	2.88	0.1025	1.26	0.2047	0.2047
28	54.25	2.88	0.1032	1.28	0.2126	0.2126
29	56.19	2.88	0.1044	1.29	0.2205	0.2205
30	58.34	2.88	0.1053	1.30	0.2283	0.2283
31	59.96	2.88	0.1060	1.31	0.2362	0.2362
32	61.98	2.88	0.1068	1.32	0.2441	0.2441
33	64.03	2.88	0.1072	1.33	0.2520	0.2520
34	66.11	2.88	0.1080	1.34	0.2598	0.2598
35	68.11	2.88	0.1089	1.35	0.2678	0.2678
36	70.11	2.88	0.1101	1.36	0.2757	0.2757
37	72.14	2.88	0.1108	1.37	0.2835	0.2835
38	74.07	2.88	0.1112	1.38	0.2914	0.2914
39	75.10	2.88	0.1114	1.38	0.2953	0.2953

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-012 S-9
Sample No.: S-9
Test No.: 60.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/29/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

Soil Description: BROWN AND GRAYISH BROWN LEAN CLAY WITH SAND CL
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	4.31	0.08124	0.000	0.0000	0.0000
2	2.11	4.31	0.08504	0.255	0.007902	0.007902
3	3.99	4.31	0.08810	0.430	0.01587	0.01587
4	5.99	4.31	0.09148	0.557	0.02364	0.02364
5	8.00	4.31	0.09436	0.659	0.03150	0.03150
6	10.07	4.31	0.09768	0.755	0.03944	0.03944
7	12.06	4.32	0.1007	0.842	0.04727	0.04727
8	14.23	4.32	0.1029	0.931	0.05514	0.05514
9	16.27	4.32	0.1053	1.02	0.06300	0.06300
10	18.25	4.32	0.1070	1.10	0.07087	0.07087
11	20.40	4.32	0.1095	1.18	0.07877	0.07877
12	22.17	4.32	0.1109	1.24	0.08664	0.08664
13	24.09	4.32	0.1130	1.30	0.09451	0.09451
14	26.17	4.32	0.1145	1.37	0.1024	0.1024
15	28.27	4.32	0.1158	1.42	0.1103	0.1103
16	30.44	4.32	0.1178	1.48	0.1181	0.1181
17	32.30	4.32	0.1194	1.53	0.1260	0.1260
18	34.32	4.32	0.1202	1.58	0.1339	0.1339
19	36.24	4.32	0.1216	1.61	0.1417	0.1417
20	38.28	4.32	0.1229	1.66	0.1496	0.1496
21	40.11	4.32	0.1240	1.69	0.1575	0.1575
22	42.17	4.32	0.1256	1.72	0.1654	0.1654
23	44.24	4.32	0.1263	1.75	0.1732	0.1732
24	46.21	4.32	0.1278	1.78	0.1811	0.1811
25	48.15	4.32	0.1289	1.81	0.1890	0.1890
26	50.11	4.32	0.1296	1.83	0.1969	0.1969
27	52.12	4.32	0.1308	1.86	0.2047	0.2047
28	54.28	4.32	0.1319	1.89	0.2126	0.2126
29	55.96	4.32	0.1325	1.90	0.2205	0.2205
30	57.96	4.32	0.1335	1.92	0.2283	0.2283
31	60.01	4.32	0.1348	1.94	0.2362	0.2362
32	62.07	4.32	0.1355	1.96	0.2441	0.2441
33	64.02	4.32	0.1362	1.97	0.2520	0.2520
34	65.98	4.32	0.1370	1.98	0.2598	0.2598
35	68.04	4.32	0.1379	1.99	0.2678	0.2678
36	70.01	4.32	0.1386	2.00	0.2756	0.2756
37	72.03	4.32	0.1392	2.01	0.2835	0.2835
38	73.88	4.32	0.1399	2.02	0.2914	0.2914
39	74.82	4.32	0.1402	2.02	0.2953	0.2953

DIRECT SHEAR TEST by ASTM D3080

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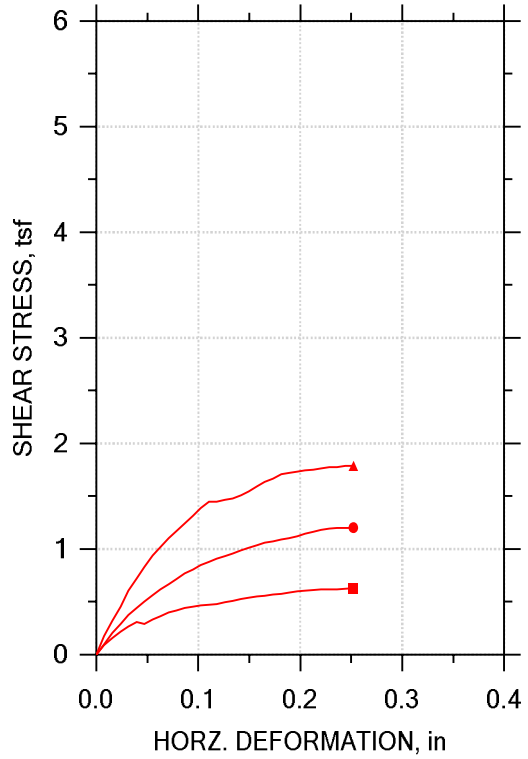

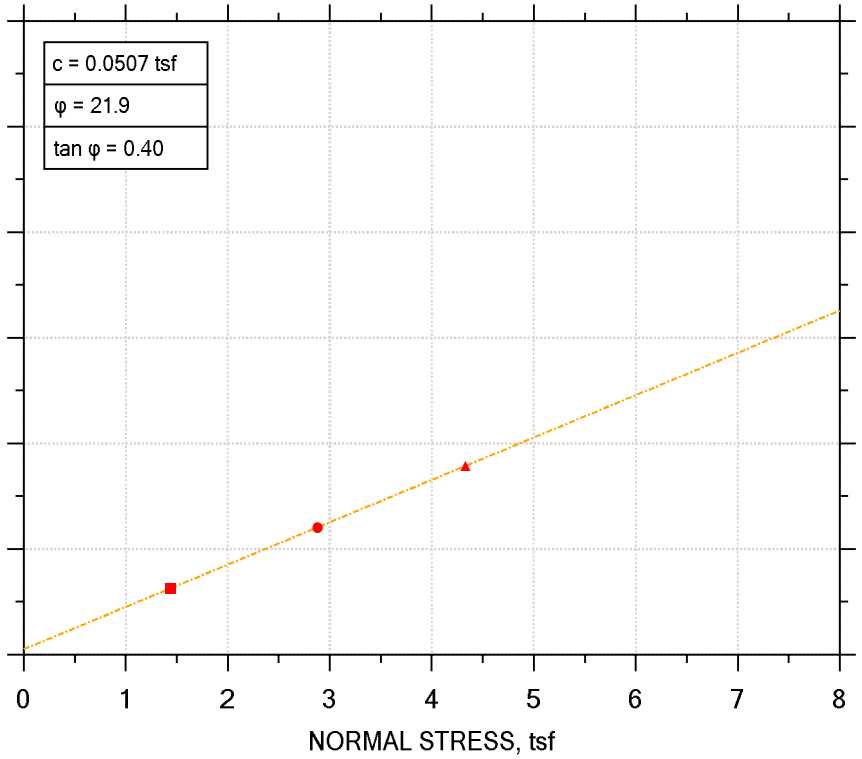

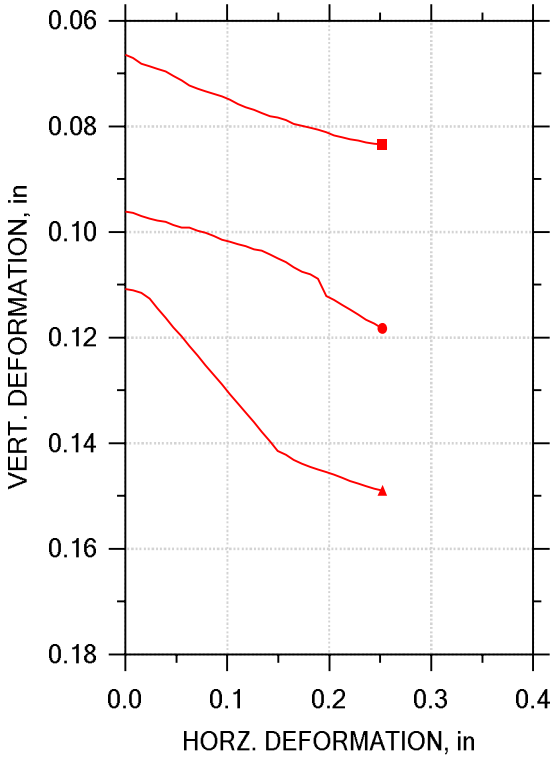

Symbol		■	●	▲	
Test No.		20.0 PSI	40.0 PSI	60.0 PSI	
Sample No.		S-10	S-10	S-10	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.5004	2.4969	2.4925	
	Area, in²	4.9103	4.8964	4.8794	
	Height, in	0.98937	0.99173	0.9937	
	Water Content, %	63.41	63.89	63.12	
	Dry Density, pcf	59.35	58.29	59.56	
	Saturation, %	92.67	90.85	92.76	
	Void Ratio	1.8612	1.9129	1.8508	
Consol. Height, in		0.92292	0.89565	0.88288	
Consol. Void Ratio		1.669	1.6307	1.5329	
Final	Water Content, %	59.75	57.69	52.17	
	Dry Density, pcf	64.81	66.19	70.06	
	Saturation, %	100.32	100.23	99.68	
	Void Ratio	1.62	1.5655	1.4235	
Normal Stress, tsf		1.4387	2.8788	4.328	
Max. Shear Stress, tsf		0.62916	1.2024	1.788	
Ult. Shear Stress, tsf		0.62916	1.2019	1.788	
Time to Failure, min		63.266	61.596	63.531	
Disp. Rate, in/min		0.004	0.004	0.004	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		70	70	70	
Plastic Limit		38	38	38	
Plasticity Index		32	32	32	

Project: DYNEGY HENNEPIN	
Location: HENNEPIN, IL	
Project No.: MR155233	
Boring No.: HEN-014 S-10	
Sample Type: TRIMMED	
Description: VERY DARK BROWNISH GRAY ORGANIC SILT MH	363
Remarks:	

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-014 S-10
Sample No.: S-10
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: VERY DARK BROWNISH GRAY ORGANIC SILT MH
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.44	0.06645	0.000	0.0000	0.0000
2	1.99	1.44	0.06706	0.0884	0.007867	0.007867
3	3.95	1.44	0.06811	0.159	0.01577	0.01577
4	5.72	1.44	0.06858	0.215	0.02364	0.02364
5	7.78	1.44	0.06906	0.268	0.03150	0.03150
6	9.71	1.44	0.06958	0.306	0.03937	0.03937
7	11.55	1.44	0.07038	0.293	0.04724	0.04724
8	13.80	1.44	0.07126	0.333	0.05514	0.05514
9	15.82	1.44	0.07223	0.366	0.06300	0.06300
10	17.89	1.44	0.07286	0.397	0.07087	0.07087
11	19.81	1.44	0.07329	0.420	0.07874	0.07874
12	21.66	1.44	0.07380	0.443	0.08664	0.08664
13	23.47	1.44	0.07425	0.455	0.09451	0.09451
14	25.50	1.44	0.07490	0.466	0.1024	0.1024
15	27.62	1.44	0.07571	0.470	0.1103	0.1103
16	29.65	1.44	0.07641	0.477	0.1181	0.1181
17	31.63	1.44	0.07682	0.494	0.1260	0.1260
18	33.73	1.44	0.07749	0.511	0.1339	0.1339
19	35.77	1.44	0.07807	0.528	0.1418	0.1418
20	37.40	1.44	0.07832	0.541	0.1496	0.1496
21	39.24	1.44	0.07877	0.552	0.1575	0.1575
22	41.37	1.44	0.07947	0.560	0.1654	0.1654
23	43.43	1.44	0.07990	0.569	0.1732	0.1732
24	45.55	1.44	0.08028	0.575	0.1811	0.1811
25	47.50	1.44	0.08061	0.586	0.1890	0.1890
26	49.45	1.44	0.08111	0.597	0.1968	0.1968
27	51.42	1.44	0.08169	0.605	0.2047	0.2047
28	53.26	1.44	0.08205	0.612	0.2126	0.2126
29	55.04	1.44	0.08241	0.617	0.2205	0.2205
30	57.01	1.44	0.08271	0.619	0.2283	0.2283
31	59.20	1.44	0.08306	0.620	0.2362	0.2362
32	61.20	1.44	0.08324	0.626	0.2441	0.2441
33	63.27	1.44	0.08342	0.629	0.2520	0.2520

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-014 S-10
Sample No.: S-10
Test No.: 40.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: VERY DARK BROWNISH GRAY ORGANIC SILT MH
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	2.88	0.09608	0.000	0.0000	0.0000
2	2.14	2.88	0.09638	0.0973	0.007867	0.007867
3	4.46	2.88	0.09696	0.206	0.01577	0.01577
4	6.38	2.88	0.09744	0.291	0.02364	0.02364
5	8.47	2.88	0.09783	0.374	0.03150	0.03150
6	10.24	2.88	0.09812	0.442	0.03937	0.03937
7	12.06	2.88	0.09869	0.505	0.04724	0.04724
8	14.09	2.88	0.09913	0.564	0.05517	0.05517
9	16.18	2.88	0.09922	0.616	0.06300	0.06300
10	18.35	2.88	0.09981	0.664	0.07087	0.07087
11	20.32	2.88	0.1001	0.716	0.07874	0.07874
12	22.33	2.88	0.1008	0.768	0.08660	0.08660
13	24.20	2.88	0.1014	0.807	0.09451	0.09451
14	26.17	2.88	0.1018	0.850	0.1024	0.1024
15	27.99	2.88	0.1023	0.881	0.1102	0.1102
16	29.96	2.88	0.1027	0.908	0.1181	0.1181
17	32.02	2.88	0.1033	0.934	0.1260	0.1260
18	34.18	2.88	0.1035	0.958	0.1339	0.1339
19	36.19	2.88	0.1043	0.988	0.1417	0.1417
20	38.09	2.88	0.1050	1.01	0.1496	0.1496
21	40.08	2.88	0.1058	1.04	0.1575	0.1575
22	42.07	2.88	0.1066	1.06	0.1653	0.1653
23	43.72	2.88	0.1075	1.07	0.1732	0.1732
24	45.68	2.88	0.1080	1.09	0.1811	0.1811
25	47.72	2.88	0.1088	1.10	0.1890	0.1890
26	49.91	2.88	0.1121	1.12	0.1969	0.1969
27	51.97	2.88	0.1128	1.14	0.2047	0.2047
28	53.89	2.88	0.1138	1.16	0.2126	0.2126
29	55.91	2.88	0.1147	1.18	0.2205	0.2205
30	57.81	2.88	0.1156	1.20	0.2283	0.2283
31	59.72	2.88	0.1166	1.20	0.2362	0.2362
32	61.60	2.88	0.1174	1.20	0.2441	0.2441
33	63.64	2.88	0.1183	1.20	0.2520	0.2520

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-014 S-10
Sample No.: S-10
Test No.: 60.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: VERY DARK BROWNISH GRAY ORGANIC SILT MH
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	4.32	0.1108	0.000	0.0000	0.0000
2	1.96	4.32	0.1110	0.174	0.007867	0.007867
3	3.96	4.32	0.1115	0.324	0.01577	0.01577
4	6.07	4.32	0.1126	0.454	0.02364	0.02364
5	8.38	4.32	0.1144	0.603	0.03150	0.03150
6	10.29	4.33	0.1162	0.722	0.03937	0.03937
7	12.37	4.32	0.1180	0.833	0.04724	0.04724
8	14.20	4.32	0.1198	0.936	0.05514	0.05514
9	15.96	4.33	0.1216	1.02	0.06304	0.06304
10	17.98	4.33	0.1234	1.10	0.07087	0.07087
11	20.04	4.33	0.1252	1.17	0.07874	0.07874
12	22.18	4.33	0.1270	1.24	0.08660	0.08660
13	24.18	4.33	0.1288	1.31	0.09451	0.09451
14	26.19	4.33	0.1307	1.39	0.1024	0.1024
15	28.05	4.33	0.1325	1.45	0.1102	0.1102
16	30.04	4.33	0.1342	1.45	0.1181	0.1181
17	31.83	4.33	0.1361	1.47	0.1260	0.1260
18	33.83	4.33	0.1378	1.48	0.1339	0.1339
19	35.92	4.33	0.1396	1.51	0.1417	0.1417
20	37.97	4.33	0.1414	1.54	0.1496	0.1496
21	39.90	4.33	0.1421	1.59	0.1575	0.1575
22	41.91	4.33	0.1432	1.64	0.1653	0.1653
23	43.88	4.33	0.1439	1.67	0.1732	0.1732
24	45.98	4.33	0.1445	1.71	0.1811	0.1811
25	47.55	4.33	0.1449	1.72	0.1890	0.1890
26	49.50	4.33	0.1454	1.73	0.1968	0.1968
27	51.56	4.33	0.1460	1.74	0.2047	0.2047
28	53.71	4.33	0.1466	1.75	0.2126	0.2126
29	55.70	4.33	0.1472	1.76	0.2205	0.2205
30	57.68	4.33	0.1476	1.77	0.2283	0.2283
31	59.68	4.33	0.1481	1.78	0.2362	0.2362
32	61.60	4.33	0.1487	1.79	0.2441	0.2441
33	63.53	4.33	0.1489	1.79	0.2520	0.2520

DIRECT SHEAR TEST by ASTM D3080

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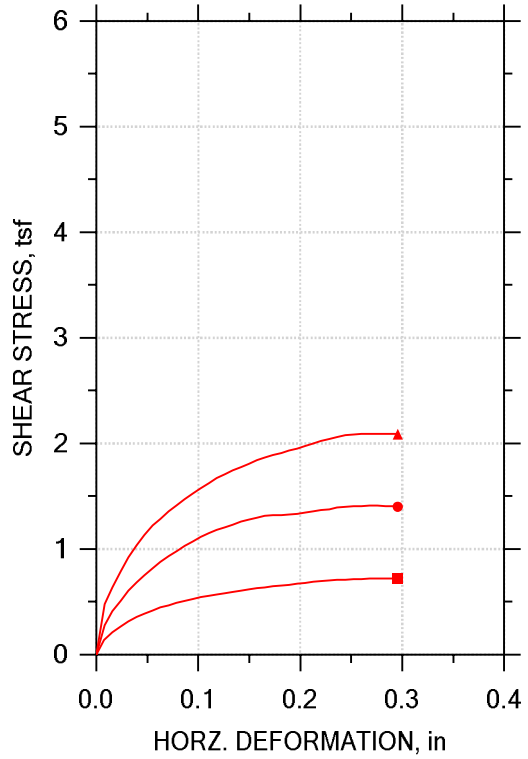

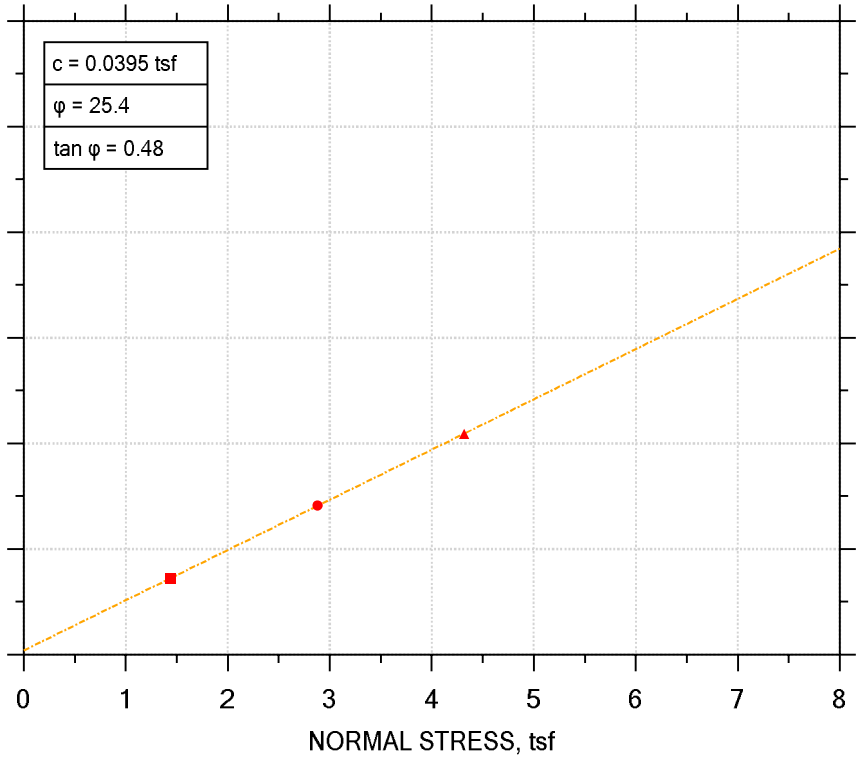

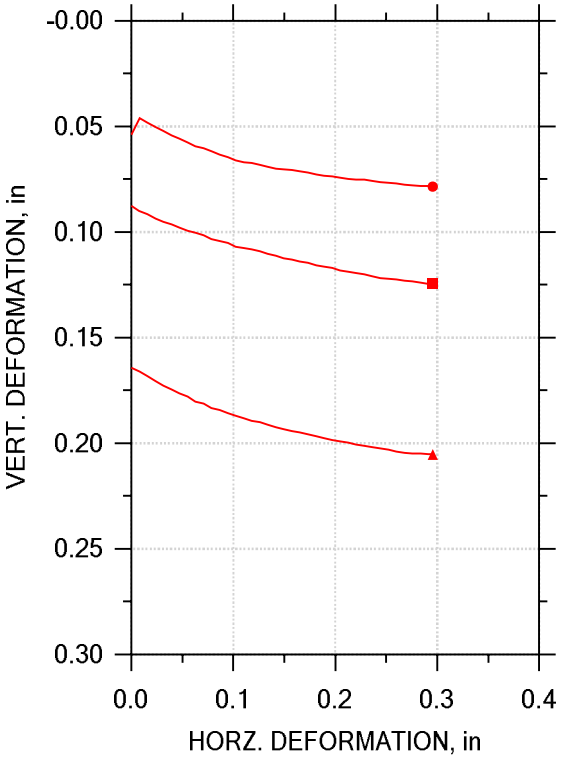

Symbol		■	●	▲	
Test No.		20.0 PSI	40.0 PSI	60.0 PSI	
Sample No.		S-9	S-10	S-10	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.4988	2.4925	2.4949	
	Area, in²	4.9041	4.8794	4.8887	
	Height, in	0.99685	0.9937	0.99921	
	Water Content, %	50.74	50.66	50.36	
	Dry Density, pcf	63.80	64.49	64.25	
	Saturation, %	83.06	84.38	83.37	
	Void Ratio	1.6615	1.6331	1.6429	
Consol. Height, in		0.90913	0.93973	0.83483	
Consol. Void Ratio		1.4273	1.4901	1.2081	
Final	Water Content, %	47.61	52.20	40.38	
	Dry Density, pcf	72.91	70.02	80.86	
	Saturation, %	97.45	99.63	99.86	
	Void Ratio	1.3288	1.4251	1.0999	
Normal Stress, tsf		1.4387	2.8787	4.3188	
Max. Shear Stress, tsf		0.72169	1.4131	2.0916	
Ult. Shear Stress, tsf		0.72113	1.4013	2.0888	
Time to Failure, min		73.304	70.325	72.709	
Disp. Rate, in/min		0.004	0.004	0.004	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		60	60	60	
Plastic Limit		35	35	35	
Plasticity Index		25	25	25	

Project: DYNEGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN-017 S-9
Sample Type: TRIMMED
Description: DARK BROWNISH GRAY ORGANIC CLAY WITH SAND OL- SAND SEAMS AND SHELL NOTED
Remarks:

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-017 S-9
Sample No.: S-9
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

Soil Description: DARK BROWNISH GRAY ORGANIC CLAY WITH SAND OL- SAND SEAMS AND SHELL NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.44	0.08772	0.000	0.0000	0.0000
2	2.20	1.44	0.08988	0.137	0.007902	0.007902
3	4.24	1.44	0.09150	0.210	0.01577	0.01577
4	6.12	1.44	0.09370	0.266	0.02374	0.02374
5	8.04	1.44	0.09516	0.314	0.03150	0.03150
6	10.02	1.44	0.09638	0.355	0.03940	0.03940
7	11.96	1.44	0.09802	0.391	0.04727	0.04727
8	13.90	1.44	0.09928	0.419	0.05517	0.05517
9	16.08	1.44	0.1002	0.446	0.06300	0.06300
10	18.20	1.44	0.1016	0.468	0.07091	0.07091
11	20.21	1.44	0.1033	0.491	0.07877	0.07877
12	22.29	1.44	0.1041	0.511	0.08664	0.08664
13	24.05	1.44	0.1051	0.528	0.09451	0.09451
14	25.85	1.44	0.1068	0.544	0.1024	0.1024
15	27.87	1.44	0.1076	0.557	0.1102	0.1102
16	29.97	1.44	0.1082	0.569	0.1182	0.1182
17	32.12	1.44	0.1092	0.582	0.1260	0.1260
18	34.05	1.44	0.1103	0.593	0.1339	0.1339
19	36.06	1.44	0.1112	0.606	0.1417	0.1417
20	38.04	1.44	0.1126	0.617	0.1496	0.1496
21	39.95	1.44	0.1131	0.628	0.1575	0.1575
22	41.73	1.44	0.1139	0.637	0.1654	0.1654
23	43.68	1.44	0.1147	0.646	0.1732	0.1732
24	45.76	1.44	0.1158	0.655	0.1811	0.1811
25	47.81	1.44	0.1163	0.663	0.1890	0.1890
26	49.83	1.44	0.1171	0.672	0.1969	0.1969
27	51.86	1.44	0.1181	0.681	0.2047	0.2047
28	53.73	1.44	0.1188	0.688	0.2126	0.2126
29	55.82	1.44	0.1195	0.698	0.2205	0.2205
30	57.41	1.44	0.1200	0.702	0.2283	0.2283
31	59.37	1.44	0.1210	0.707	0.2362	0.2362
32	61.47	1.44	0.1219	0.710	0.2441	0.2441
33	63.59	1.44	0.1222	0.713	0.2520	0.2520
34	65.57	1.44	0.1224	0.717	0.2598	0.2598
35	67.56	1.44	0.1230	0.718	0.2678	0.2678
36	69.58	1.44	0.1235	0.720	0.2756	0.2756
37	71.39	1.44	0.1240	0.721	0.2835	0.2835
38	73.30	1.44	0.1245	0.722	0.2914	0.2914
39	74.33	1.44	0.1246	0.721	0.2958	0.2958

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-014 S-10
Sample No.: S-10
Test No.: 40.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: DARK BROWNISH GRAY ORGANIC CLAY WITH SAND OL- SAND SEAMS AND SHELL NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	2.88	0.05397	0.000	0.0000	0.0000
2	2.48	2.88	0.04592	0.281	0.007936	0.007936
3	4.74	2.88	0.04821	0.415	0.01577	0.01577
4	6.92	2.88	0.05017	0.508	0.02364	0.02364
5	9.08	2.88	0.05215	0.604	0.03154	0.03154
6	11.02	2.88	0.05413	0.684	0.03940	0.03940
7	12.91	2.88	0.05577	0.754	0.04727	0.04727
8	14.79	2.88	0.05759	0.819	0.05514	0.05514
9	16.83	2.88	0.05936	0.881	0.06300	0.06300
10	18.90	2.88	0.06031	0.936	0.07091	0.07091
11	20.98	2.88	0.06175	0.984	0.07881	0.07881
12	22.90	2.88	0.06337	1.03	0.08664	0.08664
13	24.97	2.88	0.06458	1.08	0.09451	0.09451
14	27.05	2.88	0.06620	1.12	0.1024	0.1024
15	28.75	2.88	0.06688	1.15	0.1102	0.1102
16	30.65	2.88	0.06735	1.18	0.1181	0.1181
17	32.80	2.88	0.06820	1.21	0.1260	0.1260
18	34.81	2.88	0.06915	1.23	0.1339	0.1339
19	36.91	2.88	0.07005	1.26	0.1417	0.1417
20	38.79	2.88	0.07031	1.28	0.1496	0.1496
21	40.72	2.88	0.07061	1.30	0.1575	0.1575
22	42.75	2.88	0.07131	1.31	0.1654	0.1654
23	44.66	2.88	0.07191	1.32	0.1733	0.1733
24	46.49	2.88	0.07265	1.32	0.1811	0.1811
25	48.46	2.88	0.07326	1.33	0.1890	0.1890
26	50.53	2.88	0.07373	1.34	0.1969	0.1969
27	52.55	2.88	0.07427	1.35	0.2047	0.2047
28	54.57	2.88	0.07474	1.36	0.2126	0.2126
29	56.40	2.88	0.07513	1.37	0.2205	0.2205
30	58.54	2.88	0.07531	1.38	0.2283	0.2283
31	60.49	2.88	0.07567	1.39	0.2362	0.2362
32	62.38	2.88	0.07632	1.40	0.2441	0.2441
33	64.23	2.88	0.07663	1.40	0.2520	0.2520
34	66.35	2.88	0.07711	1.41	0.2598	0.2598
35	68.36	2.88	0.07753	1.41	0.2678	0.2678
36	70.32	2.88	0.07787	1.41	0.2756	0.2756
37	72.11	2.88	0.07805	1.41	0.2835	0.2835
38	74.02	2.88	0.07830	1.41	0.2914	0.2914
39	75.19	2.88	0.07850	1.40	0.2954	0.2954

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-014 S-10
Sample No.: S-10
Test No.: 60.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 35.0'-37.0'
Elevation: ----

Soil Description: DARK BROWNISH GRAY ORGANIC CLAY WITH SAND OL- SAND SEAMS AND SHELL NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	4.32	0.1644	0.000	0.0000	0.0000
2	2.87	4.32	0.1661	0.476	0.007936	0.007936
3	5.02	4.32	0.1683	0.638	0.01580	0.01580
4	7.32	4.32	0.1706	0.785	0.02364	0.02364
5	9.43	4.32	0.1726	0.920	0.03150	0.03150
6	11.41	4.32	0.1746	1.04	0.03944	0.03944
7	13.32	4.32	0.1764	1.13	0.04727	0.04727
8	15.31	4.32	0.1780	1.23	0.05514	0.05514
9	17.28	4.32	0.1802	1.29	0.06304	0.06304
10	19.26	4.32	0.1812	1.36	0.07087	0.07087
11	21.42	4.32	0.1833	1.41	0.07877	0.07877
12	23.30	4.32	0.1844	1.47	0.08664	0.08664
13	25.32	4.32	0.1857	1.53	0.09454	0.09454
14	27.14	4.32	0.1869	1.58	0.1024	0.1024
15	29.28	4.32	0.1881	1.63	0.1102	0.1102
16	31.25	4.32	0.1893	1.67	0.1181	0.1181
17	33.23	4.32	0.1901	1.71	0.1260	0.1260
18	35.24	4.32	0.1913	1.75	0.1339	0.1339
19	37.22	4.32	0.1924	1.78	0.1417	0.1417
20	39.18	4.32	0.1934	1.81	0.1496	0.1496
21	41.14	4.32	0.1942	1.84	0.1575	0.1575
22	43.17	4.32	0.1948	1.87	0.1654	0.1654
23	45.13	4.32	0.1957	1.89	0.1732	0.1732
24	47.14	4.32	0.1966	1.91	0.1811	0.1811
25	49.12	4.32	0.1976	1.93	0.1890	0.1890
26	51.15	4.32	0.1984	1.95	0.1969	0.1969
27	53.20	4.32	0.1991	1.98	0.2048	0.2048
28	55.12	4.32	0.1997	2.00	0.2126	0.2126
29	56.93	4.32	0.2007	2.02	0.2205	0.2205
30	58.94	4.32	0.2012	2.04	0.2283	0.2283
31	61.01	4.32	0.2019	2.06	0.2362	0.2362
32	63.11	4.32	0.2025	2.08	0.2441	0.2441
33	64.90	4.32	0.2031	2.09	0.2520	0.2520
34	66.86	4.32	0.2039	2.09	0.2598	0.2598
35	68.95	4.32	0.2046	2.09	0.2678	0.2678
36	70.84	4.32	0.2048	2.09	0.2756	0.2756
37	72.71	4.32	0.2050	2.09	0.2835	0.2835
38	74.61	4.32	0.2052	2.09	0.2914	0.2914
39	75.80	4.32	0.2053	2.09	0.2956	0.2956

DIRECT SHEAR TEST by ASTM D3080

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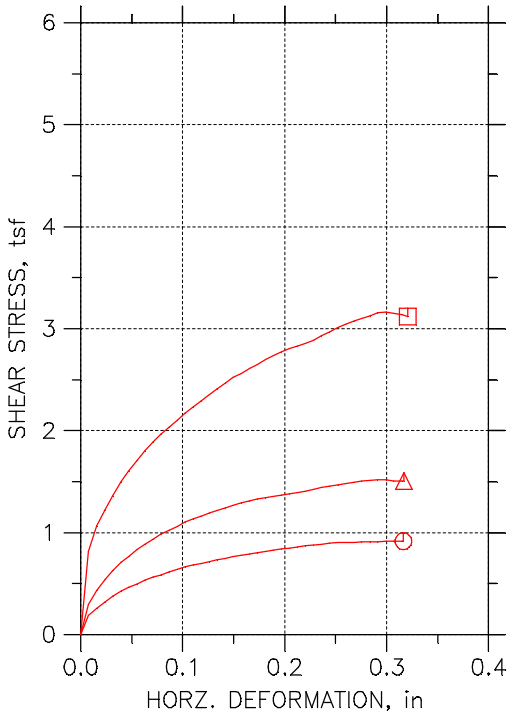

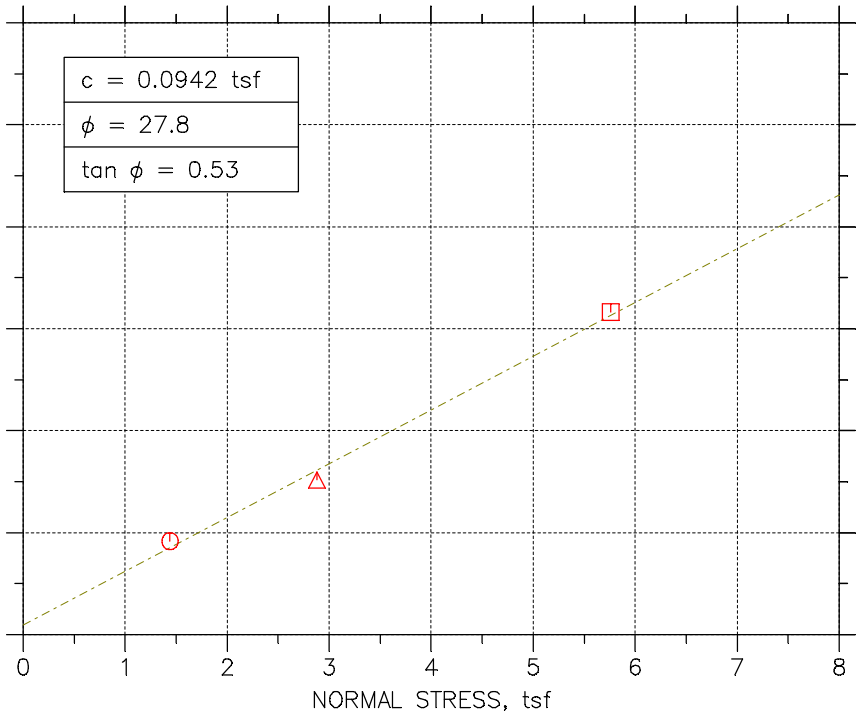

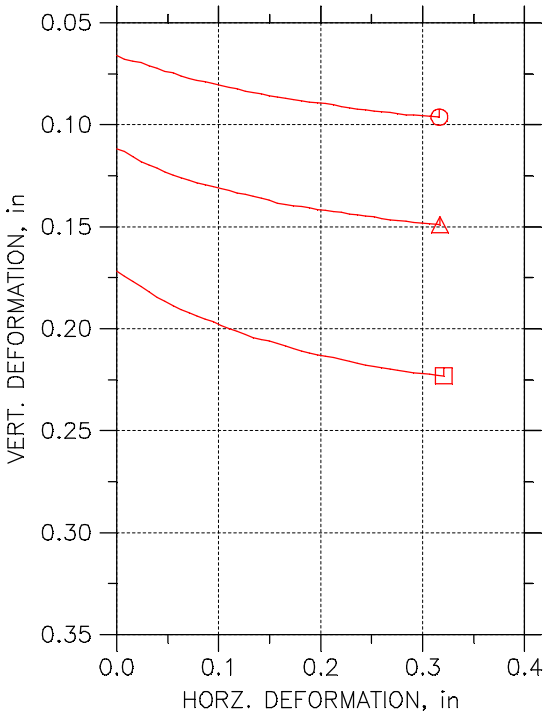

Symbol		⏲	△	⊡	
Test No.		20 PSI	40 PSI	80 PSI	
Sample No.		S-11	S-11	S-11	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.5783	2.574	2.5764	
	Area, in^2	5.2212	5.2037	5.2133	
	Height, in	0.99882	0.99055	0.99331	
	Water Content, %	40.96	40.97	40.38	
	Dry Density, pcf	71.698	72.342	72.172	
	Saturation, %	81.42	82.71	81.20	
	Void Ratio	1.3683	1.3472	1.3528	
Consol. Height, in		0.93345	0.88036	0.82222	
Consol. Void Ratio		1.2133	1.0861	0.94751	
Final	Water Content, %	42.12	36.41	30.26	
	Dry Density, pcf	79.345	85.159	93.078	
	Saturation, %	100.49	99.64	99.85	
	Void Ratio	1.1401	0.99396	0.82432	
Normal Stress, tsf		1.4387	2.8788	5.7589	
Max. Shear Stress, tsf		0.91675	1.517	3.1636	
Ult. Shear Stress, tsf		0.91675	1.5068	3.1176	
Time to Failure, min		80.291	75.783	79.062	
Disp. Rate, in/min		0.004	0.004	0.004	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		27	27	27	
Plastic Limit		20	20	20	
Plasticity Index		7	7	7	

Project: DYNEGY HENNEPIN	
Location: HENNEPIN, IL	
Project No.: MR155233	
Boring No.: HEN-018 S11	
Sample Type: 3.0" ST	
Description: DARK BROWN AND GRAY ORGANIC CLAY WITH SAND OL - SAND SEAMS AND SHELL NOTED	
Remarks: TEST PERFORMED AS PER ASTM D3080.	371

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DIRECT SHEAR TEST DATA

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Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-018 S11
Sample No.: S-11
Test No.: 20 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 40.0'-42.0'
Elevation: ----

Soil Description: DARK BROWN AND GRAY ORGANIC CLAY WITH SAND OL - SAND SEAMS AND SHELL NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	1.439	0.066	0	0
2	2.61	1.437	0.06783	0.1909	0.007876
3	4.60	1.438	0.06884	0.2576	0.01575
4	6.53	1.436	0.06966	0.3184	0.02363
5	8.61	1.436	0.07117	0.3765	0.0315
6	10.63	1.436	0.07243	0.4272	0.03938
7	12.62	1.437	0.07376	0.4666	0.04725
8	14.54	1.437	0.07464	0.4992	0.05513
9	16.54	1.439	0.07622	0.5322	0.06301
10	18.52	1.439	0.07748	0.5621	0.07088
11	20.46	1.438	0.07823	0.5861	0.07876
12	22.45	1.438	0.07893	0.6149	0.08663
13	24.59	1.438	0.07994	0.64	0.09451
14	26.43	1.439	0.08075	0.6634	0.1024
15	28.43	1.439	0.0817	0.6837	0.1103
16	30.42	1.437	0.08227	0.6986	0.1181
17	32.47	1.438	0.08353	0.7173	0.126
18	34.56	1.438	0.08435	0.7354	0.1339
19	36.52	1.438	0.08492	0.7498	0.1418
20	38.29	1.438	0.08567	0.7674	0.1496
21	40.39	1.438	0.0863	0.7808	0.1575
22	42.43	1.438	0.087	0.793	0.1654
23	44.32	1.439	0.08769	0.8048	0.1733
24	46.47	1.438	0.08826	0.8186	0.1811
25	48.52	1.438	0.08901	0.8293	0.189
26	50.45	1.439	0.08927	0.8394	0.1969
27	52.21	1.439	0.08952	0.8495	0.2048
28	54.25	1.439	0.09034	0.857	0.2126
29	56.31	1.438	0.09116	0.8719	0.2205
30	58.23	1.439	0.09185	0.8805	0.2284
31	60.23	1.439	0.09242	0.8863	0.2362
32	62.18	1.439	0.0928	0.8991	0.2441
33	64.11	1.439	0.09336	0.9013	0.252
34	66.08	1.439	0.0938	0.9055	0.2599
35	68.01	1.439	0.09412	0.9061	0.2677
36	70.08	1.438	0.09462	0.9087	0.2756
37	71.98	1.439	0.09513	0.9125	0.2835
38	74.07	1.439	0.09538	0.9103	0.2914
39	76.00	1.439	0.0957	0.9141	0.2992
40	77.97	1.439	0.09595	0.9135	0.3071
41	79.91	1.439	0.0962	0.9162	0.315
42	80.29	1.439	0.09626	0.9167	0.3163

DIRECT SHEAR TEST DATA

Terracon
Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-018 S11
Sample No.: S-11
Test No.: 40 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 40.0'-42.0'
Elevation: ----

Soil Description: DARK BROWN AND GRAY ORGANIC CLAY WITH SAND OL - SAND SEAMS AND SHELL NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	2.88	0.1118	0	0
2	2.24	2.874	0.1132	0.2943	0.007876
3	4.45	2.877	0.1156	0.4329	0.01575
4	6.47	2.879	0.1181	0.5399	0.02363
5	8.39	2.879	0.1197	0.625	0.0315
6	10.46	2.878	0.1212	0.7069	0.03938
7	12.43	2.878	0.1232	0.7647	0.04725
8	14.48	2.877	0.1248	0.8326	0.05513
9	16.38	2.877	0.126	0.8856	0.06301
10	18.29	2.879	0.1272	0.9343	0.07088
11	20.31	2.878	0.1284	0.9867	0.07876
12	22.28	2.877	0.1295	1.025	0.08663
13	24.27	2.878	0.1303	1.061	0.09451
14	26.47	2.879	0.1313	1.103	0.1024
15	28.29	2.878	0.1323	1.135	0.1103
16	30.33	2.878	0.1334	1.164	0.1181
17	32.24	2.878	0.1343	1.19	0.126
18	34.28	2.878	0.1352	1.218	0.1339
19	36.38	2.878	0.1362	1.245	0.1418
20	38.30	2.878	0.137	1.267	0.1496
21	40.17	2.879	0.1384	1.291	0.1575
22	42.16	2.877	0.1391	1.312	0.1654
23	44.26	2.879	0.1396	1.332	0.1733
24	46.14	2.879	0.14	1.343	0.1811
25	48.19	2.879	0.1408	1.355	0.189
26	50.33	2.879	0.1415	1.368	0.1969
27	52.21	2.879	0.142	1.382	0.2048
28	54.03	2.879	0.1425	1.394	0.2126
29	56.02	2.878	0.143	1.407	0.2205
30	58.15	2.879	0.1439	1.426	0.2284
31	60.05	2.879	0.1441	1.441	0.2362
32	62.00	2.879	0.1447	1.454	0.2441
33	64.00	2.879	0.1452	1.468	0.252
34	65.90	2.879	0.1461	1.481	0.2599
35	67.88	2.878	0.1467	1.493	0.2677
36	69.83	2.879	0.1471	1.504	0.2756
37	71.65	2.879	0.1475	1.512	0.2835
38	73.83	2.879	0.1481	1.516	0.2914
39	75.78	2.879	0.1484	1.517	0.2992
40	77.73	2.879	0.1486	1.508	0.3071
41	79.68	2.879	0.149	1.506	0.315
42	80.15	2.879	0.1491	1.507	0.317

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-018 S11
Sample No.: S-11
Test No.: 80 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3.0" ST

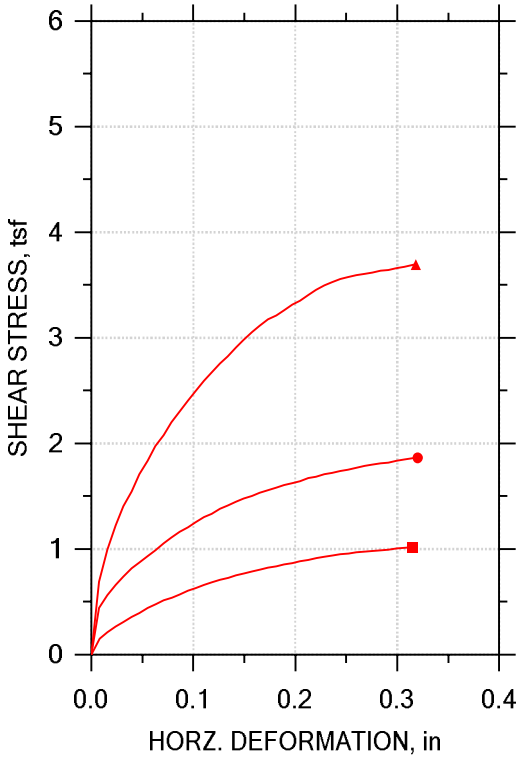
Project No.: MR155233
Checked By: WPQ
Depth: 40.0'-42.0'
Elevation: ----

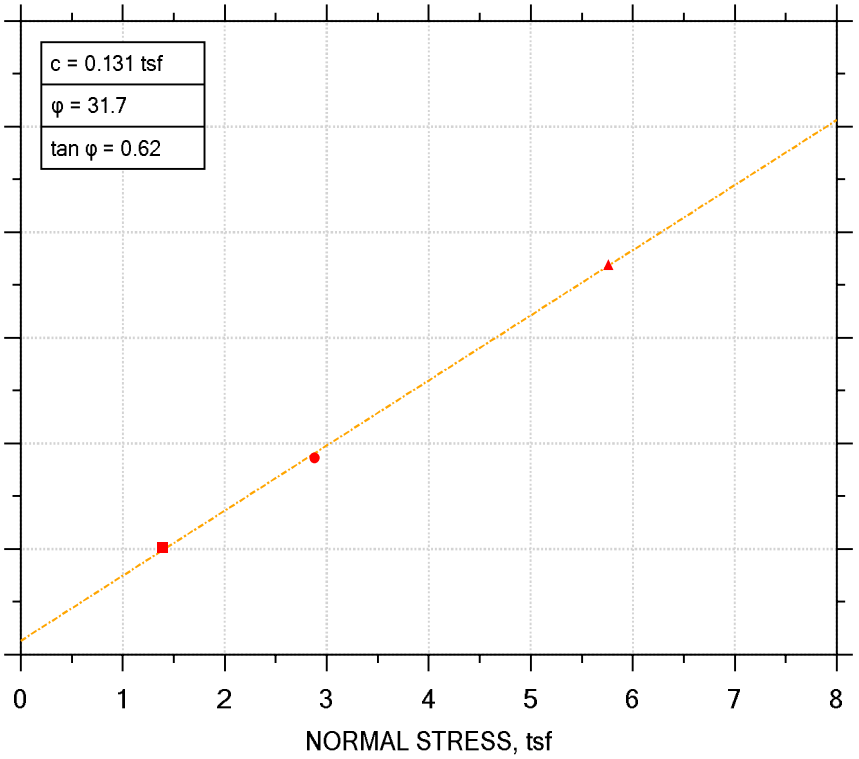
Soil Description: DARK BROWN AND GRAY ORGANIC CLAY WITH SAND OL - SAND SEAMS AND SHELL NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

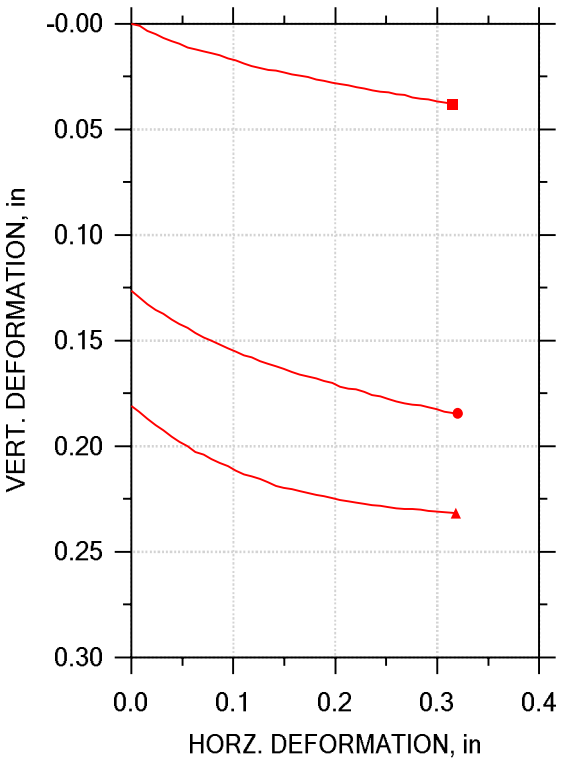
	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	5.76	0.1718	0	0
2	5.76	5.758	0.1742	0.814	0.007876
3	7.82	5.758	0.1767	1.067	0.01575
4	9.78	5.755	0.1792	1.227	0.02363
5	11.79	5.756	0.1819	1.362	0.0315
6	13.84	5.757	0.1845	1.498	0.03938
7	15.81	5.754	0.1865	1.604	0.04725
8	17.73	5.754	0.1887	1.704	0.05518
9	19.75	5.759	0.1906	1.799	0.06301
10	21.92	5.757	0.1921	1.888	0.07088
11	23.73	5.757	0.1936	1.961	0.07876
12	25.77	5.758	0.1953	2.033	0.08663
13	27.88	5.759	0.1966	2.103	0.09451
14	29.82	5.758	0.1983	2.17	0.1024
15	31.77	5.756	0.2	2.236	0.1103
16	33.65	5.758	0.2012	2.29	0.1181
17	35.80	5.757	0.2029	2.354	0.126
18	37.75	5.759	0.2044	2.412	0.1339
19	39.72	5.756	0.2053	2.465	0.1418
20	41.79	5.757	0.2059	2.522	0.1496
21	43.76	5.757	0.2073	2.563	0.1575
22	45.75	5.757	0.2084	2.611	0.1654
23	47.50	5.759	0.2097	2.651	0.1733
24	49.59	5.759	0.211	2.697	0.1811
25	51.43	5.758	0.2118	2.737	0.189
26	53.61	5.758	0.2128	2.776	0.1969
27	55.44	5.759	0.2134	2.805	0.2048
28	57.33	5.759	0.2141	2.829	0.2126
29	59.33	5.758	0.215	2.856	0.2205
30	61.41	5.758	0.216	2.89	0.2284
31	63.37	5.759	0.2169	2.929	0.2362
32	65.33	5.759	0.2179	2.969	0.2441
33	67.37	5.758	0.2184	3.009	0.252
34	69.38	5.759	0.2192	3.047	0.2599
35	71.19	5.759	0.2197	3.075	0.2677
36	73.46	5.759	0.2205	3.1	0.2756
37	75.20	5.758	0.2211	3.128	0.2835
38	77.32	5.757	0.2218	3.156	0.2914
39	79.06	5.759	0.222	3.164	0.2992
40	81.22	5.759	0.2224	3.151	0.3071
41	83.02	5.759	0.2228	3.139	0.315
42	84.64	5.759	0.2231	3.118	0.3208

DIRECT SHEAR TEST by ASTM D3080

Terracon
Consulting Engineers & Scientists







Symbol		■	●	▲	
Test No.		20 PSI	40 PSI	80 PSI	
Sample No.		S-7	S-7	S-7	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.5748	2.576	2.5783	
	Area, in²	5.2069	5.2117	5.2212	
	Height, in	0.99449	0.99252	0.99488	
	Water Content, %	44.55	44.66	44.88	
	Dry Density, pcf	67.26	67.42	67.10	
	Saturation, %	80.27	80.78	80.53	
	Void Ratio	1.4873	1.4816	1.4935	
Consol. Height, in		0.99449	0.86625	0.81402	
Consol. Void Ratio		1.4873	1.1659	1.0402	
Final	Water Content, %	50.59	40.33	34.75	
	Dry Density, pcf	69.94	82.81	87.47	
	Saturation, %	97.38	105.92	102.03	
	Void Ratio	1.3922	1.0204	0.91268	
Normal Stress, tsf		1.3947	2.8789	5.7584	
Max. Shear Stress, tsf		1.0185	1.8642	3.695	
Ult. Shear Stress, tsf		1.0185	1.8642	3.695	
Time to Failure, min		79.017	81.05	81.167	
Disp. Rate, in/min		0.004	0.004	0.004	
Estimated Specific Gravity		2.68	2.68	2.68	
Liquid Limit		34	34	34	
Plastic Limit		28	28	26	
Plasticity Index		6	6	8	

Project: DYNEGY HENNEPIN

Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HEN-019 S-7

Sample Type: TRIMMED

Description: VERY DARK GRAY ORGANIC SILT WITH SAND OL SHELLS NOTED

Remarks: TEST PERFORMED AS PER ASTM D3080.

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-019 S-7
Sample No.: S-7
Test No.: 20 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/146/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

Soil Description: VERY DARK GRAY ORGANIC SILT WITH SAND OL SHELLS NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.40	0.0000	0.000	0.0000	0.0000
2	2.24	1.40	0.001009	0.150	0.008016	0.008016
3	4.21	1.39	0.003278	0.211	0.01589	0.01589
4	6.13	1.39	0.004728	0.264	0.02377	0.02377
5	8.15	1.39	0.006556	0.309	0.03164	0.03164
6	10.27	1.39	0.008132	0.356	0.03952	0.03952
7	12.08	1.39	0.009456	0.397	0.04740	0.04740
8	14.17	1.40	0.01122	0.442	0.05527	0.05527
9	16.22	1.39	0.01204	0.480	0.06315	0.06315
10	18.14	1.40	0.01292	0.512	0.07102	0.07102
11	20.08	1.39	0.01399	0.542	0.07890	0.07890
12	21.96	1.39	0.01488	0.567	0.08677	0.08677
13	24.13	1.39	0.01645	0.604	0.09465	0.09465
14	26.03	1.40	0.01734	0.632	0.1025	0.1025
15	27.97	1.40	0.01885	0.658	0.1104	0.1104
16	30.04	1.39	0.01992	0.683	0.1183	0.1183
17	32.00	1.39	0.02093	0.707	0.1262	0.1262
18	34.07	1.40	0.02169	0.730	0.1340	0.1340
19	35.81	1.39	0.02219	0.749	0.1419	0.1419
20	37.86	1.39	0.02307	0.767	0.1498	0.1498
21	39.69	1.39	0.02389	0.785	0.1577	0.1577
22	41.87	1.39	0.02465	0.806	0.1655	0.1655
23	43.68	1.39	0.02515	0.821	0.1734	0.1734
24	45.61	1.40	0.02622	0.838	0.1813	0.1813
25	47.58	1.39	0.02711	0.853	0.1892	0.1892
26	49.70	1.40	0.02774	0.869	0.1970	0.1970
27	51.63	1.39	0.02843	0.883	0.2049	0.2049
28	53.53	1.39	0.02912	0.898	0.2127	0.2127
29	55.49	1.39	0.03001	0.913	0.2206	0.2206
30	57.46	1.40	0.03076	0.927	0.2285	0.2285
31	59.32	1.40	0.03152	0.939	0.2364	0.2364
32	61.60	1.39	0.03221	0.952	0.2442	0.2442
33	63.33	1.40	0.03247	0.960	0.2521	0.2521
34	65.38	1.40	0.03322	0.970	0.2600	0.2600
35	67.15	1.40	0.03379	0.977	0.2679	0.2679
36	69.28	1.39	0.03486	0.983	0.2757	0.2757
37	71.08	1.40	0.03537	0.989	0.2836	0.2836
38	73.09	1.40	0.03587	0.994	0.2915	0.2915
39	75.11	1.39	0.03656	1.00	0.2994	0.2994
40	76.98	1.39	0.03713	1.01	0.3072	0.3072
41	79.02	1.39	0.03801	1.02	0.3151	0.3151

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-019 S-7
Sample No.: S-7
Test No.: 40 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/146/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

Soil Description: VERY DARK GRAY ORGANIC SILT WITH SAND OL SHELLS NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	2.88	0.1263	0.000	0.0000	0.0000
2	2.71	2.88	0.1295	0.442	0.007876	0.007876
3	4.72	2.87	0.1327	0.566	0.01575	0.01575
4	6.72	2.87	0.1353	0.662	0.02363	0.02363
5	8.56	2.88	0.1374	0.742	0.03150	0.03150
6	10.61	2.88	0.1401	0.819	0.03938	0.03938
7	12.63	2.88	0.1420	0.871	0.04730	0.04730
8	14.64	2.88	0.1440	0.936	0.05513	0.05513
9	16.63	2.87	0.1464	0.990	0.06301	0.06301
10	18.60	2.88	0.1484	1.05	0.07088	0.07088
11	20.62	2.88	0.1499	1.11	0.07876	0.07876
12	22.64	2.88	0.1518	1.16	0.08663	0.08663
13	24.58	2.88	0.1536	1.21	0.09451	0.09451
14	26.52	2.88	0.1553	1.25	0.1024	0.1024
15	28.53	2.88	0.1568	1.30	0.1103	0.1103
16	30.56	2.88	0.1579	1.34	0.1181	0.1181
17	32.49	2.88	0.1596	1.38	0.1260	0.1260
18	34.47	2.88	0.1611	1.41	0.1339	0.1339
19	36.51	2.88	0.1621	1.45	0.1418	0.1418
20	38.44	2.88	0.1633	1.48	0.1496	0.1496
21	40.29	2.88	0.1647	1.50	0.1575	0.1575
22	42.52	2.88	0.1661	1.53	0.1654	0.1654
23	44.32	2.88	0.1671	1.56	0.1733	0.1733
24	46.34	2.88	0.1679	1.58	0.1811	0.1811
25	48.43	2.88	0.1690	1.60	0.1890	0.1890
26	50.30	2.88	0.1701	1.63	0.1969	0.1969
27	52.25	2.88	0.1718	1.64	0.2048	0.2048
28	54.26	2.88	0.1727	1.67	0.2126	0.2126
29	56.18	2.88	0.1732	1.68	0.2205	0.2205
30	58.19	2.88	0.1742	1.71	0.2284	0.2284
31	60.23	2.88	0.1757	1.72	0.2362	0.2362
32	62.17	2.88	0.1765	1.74	0.2441	0.2441
33	63.89	2.88	0.1776	1.75	0.2520	0.2520
34	66.05	2.88	0.1787	1.77	0.2599	0.2599
35	68.20	2.88	0.1798	1.79	0.2677	0.2677
36	69.90	2.88	0.1802	1.80	0.2756	0.2756
37	71.94	2.88	0.1807	1.81	0.2835	0.2835
38	73.80	2.88	0.1814	1.82	0.2914	0.2914
39	76.05	2.88	0.1826	1.84	0.2992	0.2992
40	77.78	2.88	0.1836	1.85	0.3071	0.3071
41	79.97	2.88	0.1842	1.86	0.3150	0.3150
42	81.05	2.88	0.1845	1.86	0.3199	0.3199

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-019 S-7
Sample No.: S-7
Test No.: 80 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/146/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

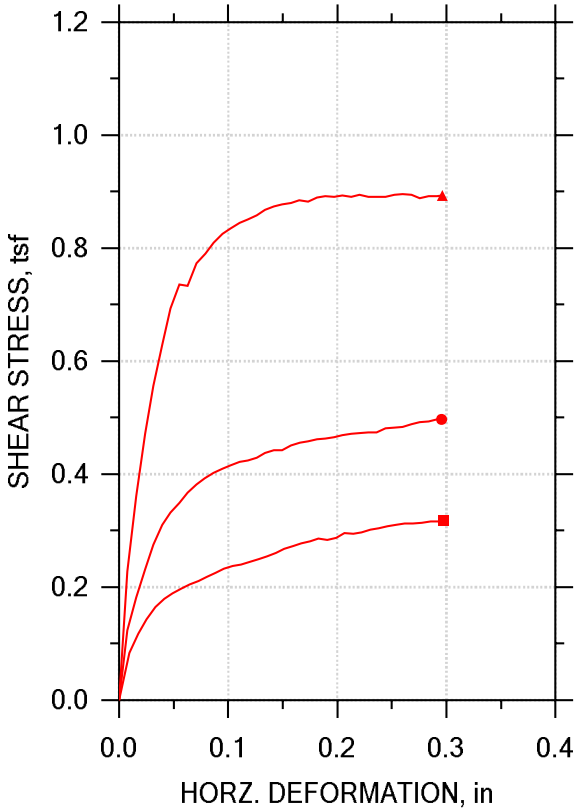
Soil Description: VERY DARK GRAY ORGANIC SILT WITH SAND OL SHELLS NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

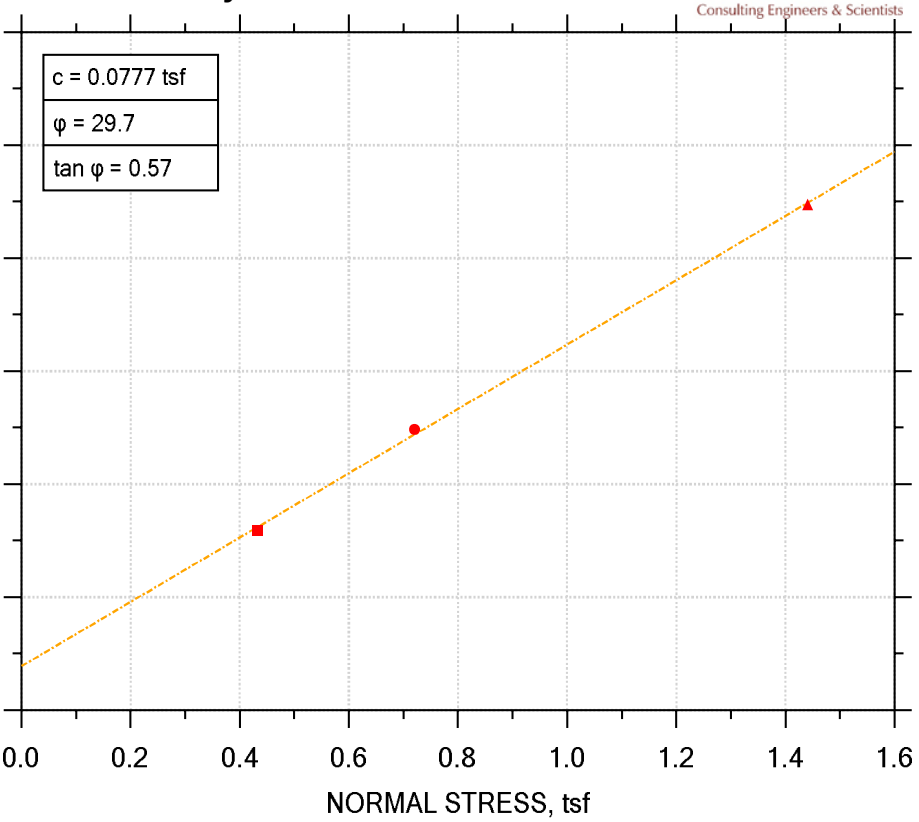
Step: 1 of 1

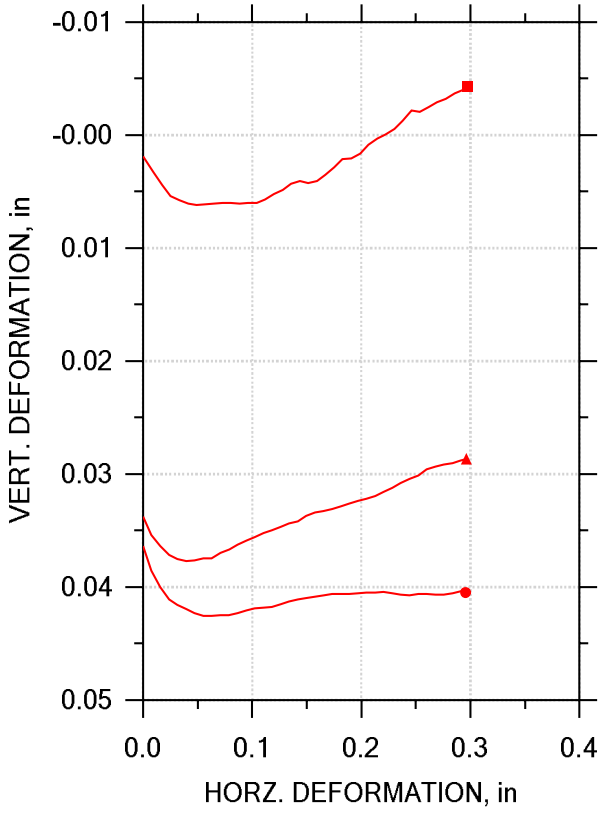
	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	5.76	0.1809	0.000	0.0000	0.0000
2	2.41	5.76	0.1838	0.693	0.007876	0.007876
3	4.56	5.76	0.1870	0.997	0.01575	0.01575
4	6.61	5.76	0.1899	1.23	0.02363	0.02363
5	8.66	5.76	0.1925	1.41	0.03150	0.03150
6	10.62	5.76	0.1954	1.55	0.03938	0.03938
7	12.67	5.75	0.1979	1.71	0.04725	0.04725
8	14.51	5.75	0.1999	1.84	0.05513	0.05513
9	16.84	5.76	0.2026	1.98	0.06301	0.06301
10	18.58	5.76	0.2041	2.08	0.07088	0.07088
11	20.61	5.76	0.2060	2.20	0.07876	0.07876
12	22.73	5.76	0.2080	2.30	0.08663	0.08663
13	24.64	5.76	0.2093	2.41	0.09451	0.09451
14	26.56	5.76	0.2116	2.50	0.1024	0.1024
15	28.75	5.76	0.2133	2.59	0.1103	0.1103
16	30.58	5.76	0.2143	2.67	0.1181	0.1181
17	32.68	5.76	0.2153	2.75	0.1260	0.1260
18	34.61	5.76	0.2171	2.83	0.1339	0.1339
19	36.73	5.76	0.2189	2.91	0.1418	0.1418
20	38.64	5.76	0.2196	2.98	0.1496	0.1496
21	40.62	5.76	0.2203	3.05	0.1575	0.1575
22	42.63	5.76	0.2213	3.11	0.1654	0.1654
23	44.66	5.76	0.2222	3.17	0.1733	0.1733
24	46.52	5.76	0.2229	3.21	0.1811	0.1811
25	48.51	5.76	0.2236	3.26	0.1890	0.1890
26	50.66	5.76	0.2246	3.32	0.1969	0.1969
27	52.51	5.76	0.2254	3.35	0.2048	0.2048
28	54.78	5.76	0.2261	3.41	0.2126	0.2126
29	56.49	5.76	0.2268	3.45	0.2205	0.2205
30	58.44	5.76	0.2273	3.50	0.2284	0.2284
31	60.62	5.76	0.2279	3.53	0.2362	0.2362
32	62.60	5.76	0.2283	3.55	0.2441	0.2441
33	64.58	5.76	0.2288	3.58	0.2520	0.2520
34	66.59	5.76	0.2295	3.59	0.2599	0.2599
35	68.47	5.76	0.2297	3.61	0.2677	0.2677
36	70.58	5.76	0.2298	3.62	0.2756	0.2756
37	72.44	5.76	0.2302	3.64	0.2835	0.2835
38	74.36	5.76	0.2306	3.65	0.2914	0.2914
39	76.49	5.76	0.2308	3.66	0.2992	0.2992
40	78.50	5.76	0.2312	3.67	0.3071	0.3071
41	80.37	5.76	0.2316	3.69	0.3150	0.3150
42	81.17	5.76	0.2317	3.70	0.3180	0.3180

DIRECT SHEAR TEST by ASTM D3080

Terracon
Consulting Engineers & Scientists







Symbol		■	●	▲	
Test No.		5.0 PSI	10.0 PSI	20.0 PSI	
Sample No.		S-5	S-5	S-5	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.4835	2.4835	2.4874	
	Area, in²	4.844	4.844	4.8594	
	Height, in	0.98504	0.98504	0.99016	
	Water Content, %	13.68	12.08	13.15	
	Dry Density, pcf	115.5	116.2	119.6	
	Saturation, %	79.15	71.31	85.21	
	Void Ratio	0.47011	0.46082	0.41964	
Consol. Height, in		0.98315	0.94868	0.95639	
Consol. Void Ratio		0.46729	0.4069	0.37123	
Final	Water Content, %	17.58	15.01	14.23	
	Dry Density, pcf	115.0	121.2	123.2	
	Saturation, %	100.38	101.90	102.21	
	Void Ratio	0.47651	0.40079	0.37856	
Normal Stress, tsf		0.4329	0.71995	1.4404	
Max. Shear Stress, tsf		0.31754	0.49691	0.89517	
Ult. Shear Stress, tsf		0.31754	0.49691	0.89342	
Time to Failure, min		70.449	70.931	63.315	
Disp. Rate, in/min		0.0041764	0.0041764	0.0041764	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		30	30	30	
Plastic Limit		17	17	17	
Plasticity Index		13	13	13	

Project: DYNERGY HENNEPIN	
Location: HENNEPIN, IL	
Project No.: MR155233	
Boring No.: HEN-020 S-5	
Sample Type: TRIMMED	
Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL	

Project: DYNERGY HENNEPIN
Boring No.: HEN-020 S-5
Sample No.: S-5
Test No.: 5.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 9.5'-11.5'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.432	0.001891	0.000	0.0000	0.0000
2	2.06	0.431	0.003260	0.0842	0.009677	0.009677
3	3.96	0.431	0.004430	0.118	0.01754	0.01754
4	5.72	0.430	0.005385	0.143	0.02541	0.02541
5	7.48	0.432	0.005763	0.164	0.03328	0.03328
6	9.24	0.432	0.006051	0.180	0.04118	0.04118
7	11.16	0.432	0.006177	0.189	0.04905	0.04905
8	13.18	0.432	0.006141	0.198	0.05691	0.05691
9	15.12	0.432	0.006069	0.204	0.06481	0.06481
10	17.19	0.432	0.006015	0.211	0.07265	0.07265
11	19.08	0.432	0.006015	0.218	0.08055	0.08055
12	20.84	0.432	0.006051	0.225	0.08845	0.08845
13	22.43	0.432	0.006015	0.232	0.09628	0.09628
14	24.24	0.432	0.005979	0.237	0.1041	0.1041
15	26.28	0.433	0.005691	0.240	0.1120	0.1120
16	28.23	0.433	0.005222	0.245	0.1199	0.1199
17	30.17	0.432	0.004880	0.249	0.1278	0.1278
18	32.38	0.432	0.004286	0.255	0.1357	0.1357
19	34.18	0.432	0.004034	0.261	0.1435	0.1435
20	35.99	0.432	0.004268	0.268	0.1514	0.1514
21	37.60	0.433	0.004070	0.273	0.1593	0.1593
22	39.35	0.432	0.003494	0.277	0.1672	0.1672
23	41.44	0.432	0.002827	0.281	0.1750	0.1750
24	43.46	0.432	0.002143	0.286	0.1829	0.1829
25	45.45	0.432	0.002035	0.284	0.1908	0.1908
26	47.34	0.432	0.001621	0.287	0.1987	0.1987
27	49.26	0.432	0.0008464	0.296	0.2065	0.2065
28	50.99	0.432	0.0002881	0.295	0.2145	0.2145
29	52.78	0.432	-7.203e-05	0.297	0.2223	0.2223
30	54.50	0.433	-0.0005403	0.301	0.2301	0.2301
31	56.44	0.433	-0.001261	0.305	0.2380	0.2380
32	58.49	0.431	-0.002197	0.307	0.2459	0.2459
33	60.44	0.432	-0.002089	0.310	0.2538	0.2538
34	62.35	0.433	-0.002467	0.313	0.2616	0.2616
35	64.33	0.433	-0.002935	0.313	0.2695	0.2695
36	65.99	0.432	-0.003206	0.314	0.2774	0.2774
37	67.90	0.433	-0.003692	0.316	0.2853	0.2853
38	69.45	0.433	-0.004016	0.317	0.2932	0.2932
39	70.45	0.433	-0.004286	0.318	0.2972	0.2972

Project: DYNERGY HENNEPIN
Boring No.: HEN-020 S-5
Sample No.: S-5
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 9.5'-11.5'
Elevation: ----

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.720	0.03636	0.000	0.0000	0.0000
2	2.62	0.719	0.03857	0.124	0.007902	0.007902
3	4.55	0.720	0.04001	0.181	0.01577	0.01577
4	6.74	0.719	0.04108	0.232	0.02364	0.02364
5	8.83	0.719	0.04156	0.275	0.03150	0.03150
6	10.79	0.720	0.04192	0.310	0.03940	0.03940
7	12.32	0.719	0.04232	0.332	0.04727	0.04727
8	14.21	0.720	0.04254	0.349	0.05514	0.05514
9	15.98	0.720	0.04257	0.367	0.06300	0.06300
10	18.03	0.720	0.04246	0.382	0.07091	0.07091
11	19.96	0.720	0.04248	0.392	0.07877	0.07877
12	21.84	0.720	0.04228	0.402	0.08664	0.08664
13	23.80	0.720	0.04207	0.410	0.09454	0.09454
14	25.80	0.720	0.04189	0.415	0.1024	0.1024
15	27.44	0.720	0.04183	0.421	0.1102	0.1102
16	29.16	0.720	0.04174	0.424	0.1181	0.1181
17	31.06	0.720	0.04155	0.428	0.1260	0.1260
18	33.15	0.721	0.04128	0.438	0.1339	0.1339
19	35.08	0.720	0.04110	0.442	0.1418	0.1418
20	37.03	0.720	0.04099	0.442	0.1496	0.1496
21	38.86	0.720	0.04086	0.451	0.1575	0.1575
22	40.95	0.720	0.04074	0.456	0.1654	0.1654
23	42.69	0.720	0.04061	0.458	0.1732	0.1732
24	44.32	0.720	0.04059	0.462	0.1811	0.1811
25	46.09	0.720	0.04063	0.463	0.1890	0.1890
26	48.19	0.720	0.04056	0.466	0.1969	0.1969
27	50.25	0.720	0.04047	0.469	0.2047	0.2047
28	52.21	0.720	0.04047	0.472	0.2126	0.2126
29	54.11	0.719	0.04045	0.473	0.2205	0.2205
30	55.96	0.720	0.04052	0.474	0.2283	0.2283
31	57.73	0.720	0.04066	0.474	0.2363	0.2363
32	59.49	0.720	0.04075	0.481	0.2441	0.2441
33	61.13	0.720	0.04063	0.483	0.2520	0.2520
34	63.17	0.720	0.04063	0.484	0.2599	0.2599
35	65.27	0.720	0.04068	0.489	0.2678	0.2678
36	67.26	0.720	0.04065	0.492	0.2756	0.2756
37	69.25	0.720	0.04054	0.494	0.2835	0.2835
38	70.93	0.720	0.04038	0.497	0.2914	0.2914
39	71.92	0.720	0.04048	0.497	0.2955	0.2955

Project: DYNERGY HENNEPIN
Boring No.: HEN=020 S-5
Sample No.: S-5
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 9.5'-11.5'
Elevation: ----

Terracon
Consulting Engineers & Scientists

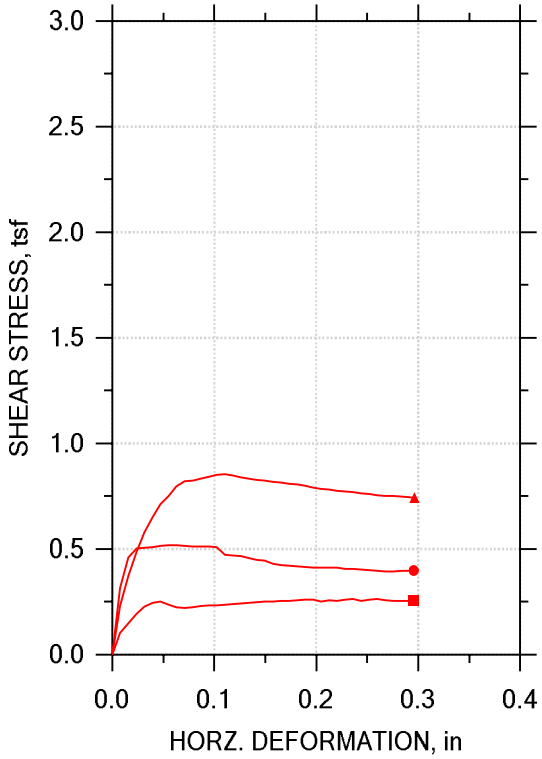
Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks:

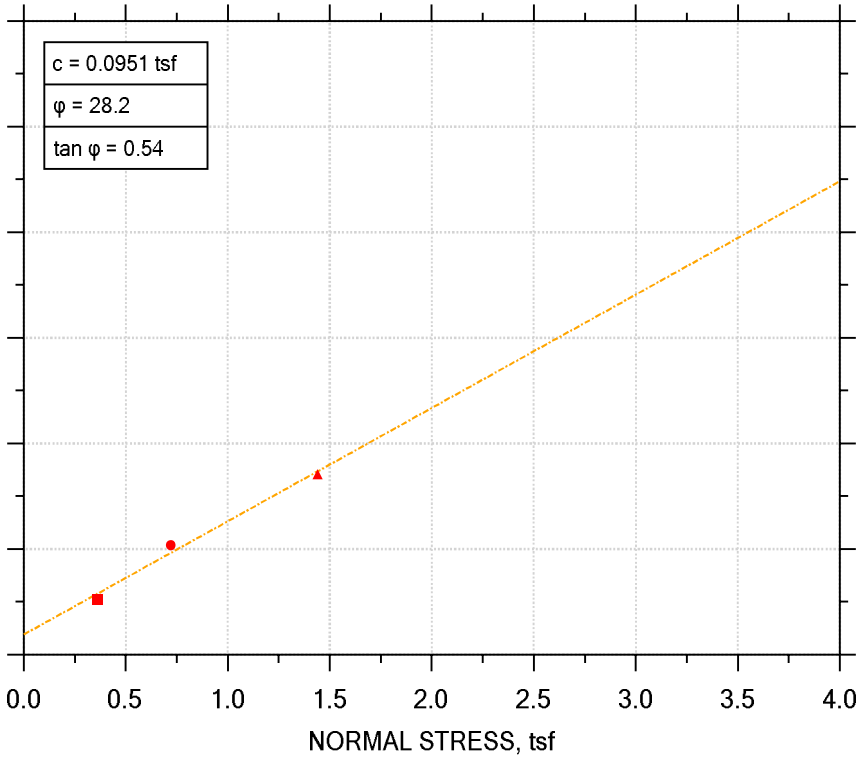
Step: 1 of 1

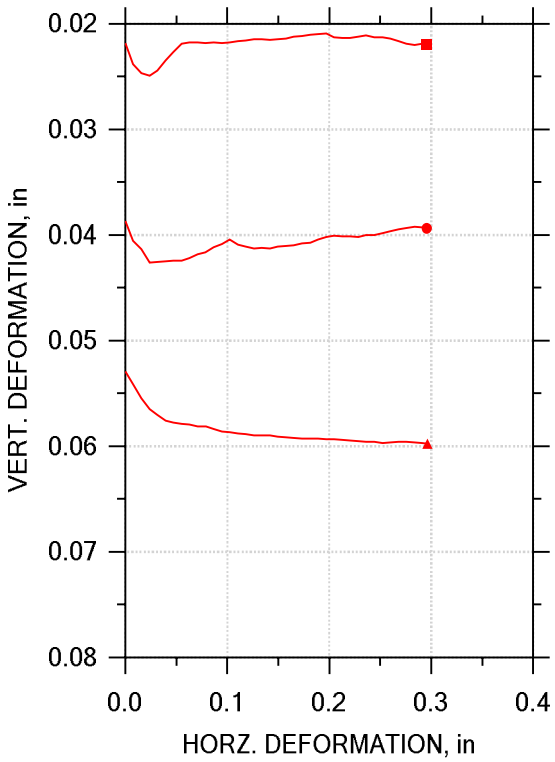
	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.44	0.03377	0.000	0.0000	0.0000
2	2.66	1.44	0.03542	0.228	0.007902	0.007902
3	4.70	1.44	0.03638	0.361	0.01577	0.01577
4	6.57	1.44	0.03717	0.472	0.02364	0.02364
5	8.27	1.44	0.03751	0.556	0.03154	0.03154
6	10.21	1.44	0.03773	0.628	0.03940	0.03940
7	12.14	1.44	0.03766	0.693	0.04731	0.04731
8	13.96	1.44	0.03746	0.736	0.05514	0.05514
9	15.73	1.44	0.03746	0.734	0.06300	0.06300
10	17.91	1.44	0.03695	0.774	0.07087	0.07087
11	19.88	1.44	0.03667	0.790	0.07881	0.07881
12	21.69	1.44	0.03625	0.810	0.08664	0.08664
13	23.58	1.44	0.03587	0.825	0.09454	0.09454
14	25.36	1.44	0.03555	0.835	0.1024	0.1024
15	27.29	1.44	0.03524	0.845	0.1102	0.1102
16	28.99	1.44	0.03497	0.851	0.1182	0.1182
17	31.07	1.44	0.03468	0.858	0.1260	0.1260
18	33.08	1.44	0.03438	0.868	0.1339	0.1339
19	34.88	1.44	0.03418	0.873	0.1417	0.1417
20	36.71	1.44	0.03369	0.877	0.1496	0.1496
21	38.55	1.44	0.03341	0.880	0.1575	0.1575
22	40.35	1.44	0.03326	0.885	0.1654	0.1654
23	42.34	1.44	0.03306	0.883	0.1732	0.1732
24	44.20	1.44	0.03285	0.890	0.1811	0.1811
25	46.28	1.44	0.03260	0.892	0.1890	0.1890
26	48.11	1.44	0.03236	0.891	0.1969	0.1969
27	50.08	1.44	0.03216	0.894	0.2047	0.2047
28	51.90	1.44	0.03191	0.891	0.2126	0.2126
29	53.75	1.44	0.03159	0.894	0.2205	0.2205
30	55.52	1.44	0.03123	0.891	0.2283	0.2283
31	57.38	1.44	0.03078	0.891	0.2362	0.2362
32	59.35	1.44	0.03045	0.891	0.2441	0.2441
33	61.35	1.44	0.03011	0.894	0.2520	0.2520
34	63.31	1.44	0.02955	0.895	0.2599	0.2599
35	65.06	1.44	0.02932	0.894	0.2678	0.2678
36	66.95	1.44	0.02917	0.889	0.2756	0.2756
37	68.86	1.44	0.02901	0.892	0.2835	0.2835
38	70.72	1.44	0.02880	0.892	0.2914	0.2914
39	71.60	1.44	0.02865	0.893	0.2960	0.2960

DIRECT SHEAR TEST by ASTM D3080

Terracon
Consulting Engineers & Scientists







Symbol		■	●	▲	
Test No.		5.0 PSI	10 PSI	20 PSI	
Sample No.		S-4	S-4	S-4	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.4878	2.4917	2.4929	
	Area, in²	4.8609	4.8763	4.8809	
	Height, in	0.99252	0.99409	0.99567	
	Water Content, %	34.29	34.23	32.70	
	Dry Density, pcf	74.65	74.24	73.55	
	Saturation, %	85.41	84.30	78.99	
	Void Ratio	0.92338	0.93397	0.95221	
Consol. Height, in		0.97073	0.95541	0.94274	
Consol. Void Ratio		0.88115	0.85871	0.84844	
Final	Water Content, %	37.77	37.64	36.21	
	Dry Density, pcf	76.34	77.30	78.25	
	Saturation, %	98.62	100.97	99.73	
	Void Ratio	0.88087	0.8574	0.83505	
Normal Stress, tsf		0.35988	0.72024	1.4391	
Max. Shear Stress, tsf		0.26345	0.51869	0.85481	
Ult. Shear Stress, tsf		0.25625	0.39908	0.74345	
Time to Failure, min		58.762	15.262	25.728	
Disp. Rate, in/min		0.0044283	0.0044283	0.0044283	
Estimated Specific Gravity		2.30	2.30	2.30	
Liquid Limit		NP	NP	NP	
Plastic Limit		NP	NP	NP	
Plasticity Index		NP	NP	NP	

Project: DYNEGY HENNEPIN	
Location: HENNEPIN, IL	
Project No.: MR155233	
Boring No.: HEN-022 S-4	
Sample Type: TRIMMED	
Description: VERY DARK GRAY VARVED FLY ASH WITH SAND - SAND SEAMS NOTED	
Remarks:	

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-022 S-4
Sample No.: S-4
Test No.: 5.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 7.5'-9.0'
Elevation: ----

Soil Description: VERY DARK GRAY VARVED FLY ASH WITH SAND - SAND SEAMS NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.360	0.02179	0.000	0.0000	0.0000
2	1.82	0.358	0.02383	0.102	0.007902	0.007902
3	3.38	0.360	0.02467	0.149	0.01577	0.01577
4	5.29	0.360	0.02492	0.195	0.02364	0.02364
5	6.98	0.361	0.02444	0.227	0.03150	0.03150
6	8.88	0.360	0.02348	0.245	0.03940	0.03940
7	10.59	0.360	0.02265	0.251	0.04727	0.04727
8	12.59	0.360	0.02186	0.237	0.05514	0.05514
9	14.44	0.359	0.02177	0.224	0.06300	0.06300
10	16.23	0.360	0.02177	0.222	0.07087	0.07087
11	17.90	0.360	0.02181	0.226	0.07877	0.07877
12	19.57	0.360	0.02177	0.229	0.08664	0.08664
13	21.32	0.360	0.02179	0.232	0.09454	0.09454
14	23.06	0.360	0.02175	0.234	0.1024	0.1024
15	24.91	0.360	0.02165	0.237	0.1102	0.1102
16	26.82	0.360	0.02159	0.239	0.1182	0.1182
17	28.76	0.360	0.02148	0.242	0.1260	0.1260
18	30.35	0.360	0.02145	0.244	0.1339	0.1339
19	31.96	0.361	0.02154	0.248	0.1417	0.1417
20	33.58	0.360	0.02145	0.250	0.1496	0.1496
21	35.60	0.360	0.02139	0.252	0.1575	0.1575
22	37.49	0.360	0.02121	0.253	0.1654	0.1654
23	39.23	0.360	0.02114	0.255	0.1732	0.1732
24	41.08	0.360	0.02105	0.258	0.1811	0.1811
25	42.93	0.360	0.02094	0.260	0.1890	0.1890
26	44.61	0.360	0.02093	0.261	0.1969	0.1969
27	46.36	0.360	0.02130	0.252	0.2047	0.2047
28	47.82	0.360	0.02136	0.257	0.2126	0.2126
29	49.66	0.360	0.02132	0.255	0.2205	0.2205
30	51.62	0.360	0.02120	0.259	0.2283	0.2283
31	53.54	0.360	0.02111	0.263	0.2362	0.2362
32	55.38	0.360	0.02129	0.255	0.2441	0.2441
33	57.05	0.360	0.02130	0.260	0.2520	0.2520
34	58.76	0.360	0.02139	0.263	0.2599	0.2599
35	60.45	0.360	0.02165	0.259	0.2678	0.2678
36	62.07	0.360	0.02188	0.256	0.2756	0.2756
37	63.81	0.360	0.02202	0.254	0.2835	0.2835
38	65.75	0.360	0.02190	0.255	0.2914	0.2914
39	66.77	0.359	0.02193	0.256	0.2956	0.2956

DIRECT SHEAR TEST DATA

Terracon Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN
Boring No.: HEN-022 S-4
Sample No.: S-4
Test No.: 10 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 7.5'-9.0'
Elevation: ----

Soil Description: VERY DARK GRAY VARVED FLY ASH WITH SAND - SAND SEAMS NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.719	0.03869	0.000	0.0000	0.0000
2	2.62	0.719	0.04054	0.316	0.007902	0.007902
3	4.32	0.719	0.04135	0.461	0.01577	0.01577
4	6.40	0.719	0.04260	0.502	0.02364	0.02364
5	8.11	0.720	0.04257	0.505	0.03150	0.03150
6	9.82	0.720	0.04247	0.510	0.03940	0.03940
7	11.45	0.720	0.04240	0.516	0.04727	0.04727
8	13.23	0.720	0.04243	0.518	0.05514	0.05514
9	15.26	0.720	0.04220	0.519	0.06300	0.06300
10	16.97	0.720	0.04182	0.515	0.07087	0.07087
11	18.82	0.720	0.04162	0.512	0.07877	0.07877
12	20.59	0.720	0.04118	0.513	0.08664	0.08664
13	22.44	0.720	0.04088	0.511	0.09451	0.09451
14	24.17	0.720	0.04044	0.509	0.1024	0.1024
15	25.70	0.719	0.04091	0.474	0.1102	0.1102
16	27.41	0.720	0.04112	0.471	0.1181	0.1181
17	29.20	0.720	0.04125	0.466	0.1260	0.1260
18	31.17	0.720	0.04122	0.457	0.1339	0.1339
19	32.93	0.720	0.04125	0.450	0.1417	0.1417
20	34.76	0.720	0.04108	0.446	0.1497	0.1497
21	36.49	0.720	0.04101	0.429	0.1575	0.1575
22	38.19	0.720	0.04098	0.425	0.1654	0.1654
23	39.89	0.720	0.04081	0.421	0.1732	0.1732
24	41.41	0.720	0.04071	0.418	0.1811	0.1811
25	43.24	0.720	0.04041	0.415	0.1890	0.1890
26	45.33	0.720	0.04020	0.413	0.1969	0.1969
27	47.18	0.720	0.04004	0.413	0.2047	0.2047
28	48.98	0.720	0.04014	0.413	0.2126	0.2126
29	50.59	0.720	0.04014	0.411	0.2205	0.2205
30	52.50	0.720	0.04017	0.406	0.2283	0.2283
31	54.10	0.720	0.04000	0.405	0.2362	0.2362
32	55.71	0.720	0.04000	0.404	0.2441	0.2441
33	57.50	0.720	0.03983	0.401	0.2520	0.2520
34	59.41	0.720	0.03966	0.398	0.2598	0.2598
35	61.36	0.720	0.03943	0.395	0.2678	0.2678
36	63.21	0.720	0.03933	0.394	0.2756	0.2756
37	64.91	0.719	0.03919	0.396	0.2835	0.2835
38	66.55	0.720	0.03929	0.398	0.2914	0.2914
39	67.46	0.720	0.03936	0.399	0.2955	0.2955

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-022 S-4
Sample No.: S-4
Test No.: 20 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 7.5'-9.0'
Elevation: ----

Soil Description: VERY DARK GRAY VARVED FLY ASH WITH SAND - SAND SEAMS NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.44	0.05293	0.000	0.0000	0.0000
2	2.34	1.44	0.05415	0.230	0.007902	0.007902
3	4.34	1.44	0.05548	0.372	0.01577	0.01577
4	6.32	1.44	0.05646	0.488	0.02364	0.02364
5	8.15	1.44	0.05703	0.579	0.03161	0.03161
6	9.79	1.44	0.05757	0.653	0.03940	0.03940
7	11.59	1.44	0.05779	0.712	0.04727	0.04727
8	13.24	1.44	0.05790	0.753	0.05524	0.05524
9	15.17	1.44	0.05797	0.798	0.06300	0.06300
10	17.06	1.44	0.05811	0.821	0.07087	0.07087
11	18.69	1.44	0.05811	0.824	0.07884	0.07884
12	20.66	1.44	0.05837	0.834	0.08664	0.08664
13	22.39	1.44	0.05858	0.842	0.09451	0.09451
14	24.07	1.44	0.05865	0.851	0.1024	0.1024
15	25.73	1.44	0.05880	0.855	0.1102	0.1102
16	27.50	1.44	0.05887	0.850	0.1181	0.1181
17	29.48	1.44	0.05896	0.838	0.1260	0.1260
18	31.22	1.44	0.05896	0.833	0.1339	0.1339
19	33.08	1.44	0.05900	0.829	0.1418	0.1418
20	34.82	1.44	0.05907	0.824	0.1496	0.1496
21	36.71	1.44	0.05914	0.818	0.1575	0.1575
22	38.43	1.44	0.05919	0.814	0.1654	0.1654
23	40.07	1.44	0.05925	0.809	0.1732	0.1732
24	41.68	1.44	0.05930	0.806	0.1811	0.1811
25	43.49	1.44	0.05928	0.800	0.1890	0.1890
26	45.57	1.44	0.05936	0.792	0.1969	0.1969
27	47.30	1.44	0.05936	0.786	0.2047	0.2047
28	49.13	1.44	0.05937	0.781	0.2126	0.2126
29	50.86	1.44	0.05945	0.777	0.2205	0.2205
30	52.57	1.44	0.05952	0.773	0.2283	0.2283
31	54.32	1.44	0.05955	0.769	0.2362	0.2362
32	55.87	1.44	0.05955	0.765	0.2441	0.2441
33	57.62	1.44	0.05968	0.761	0.2520	0.2520
34	59.71	1.44	0.05961	0.755	0.2598	0.2598
35	61.58	1.44	0.05959	0.752	0.2678	0.2678
36	63.36	1.44	0.05959	0.750	0.2757	0.2757
37	64.97	1.44	0.05961	0.748	0.2835	0.2835
38	66.90	1.44	0.05972	0.746	0.2914	0.2914
39	67.87	1.44	0.05975	0.743	0.2961	0.2961

DIRECT SHEAR TEST by ASTM D3080

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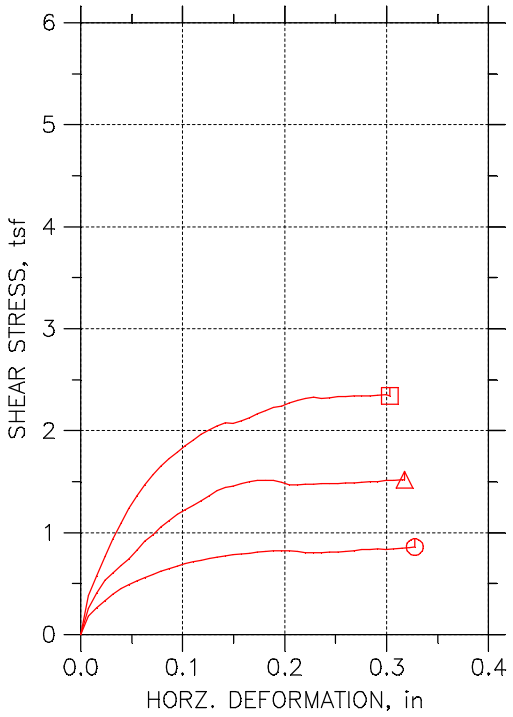

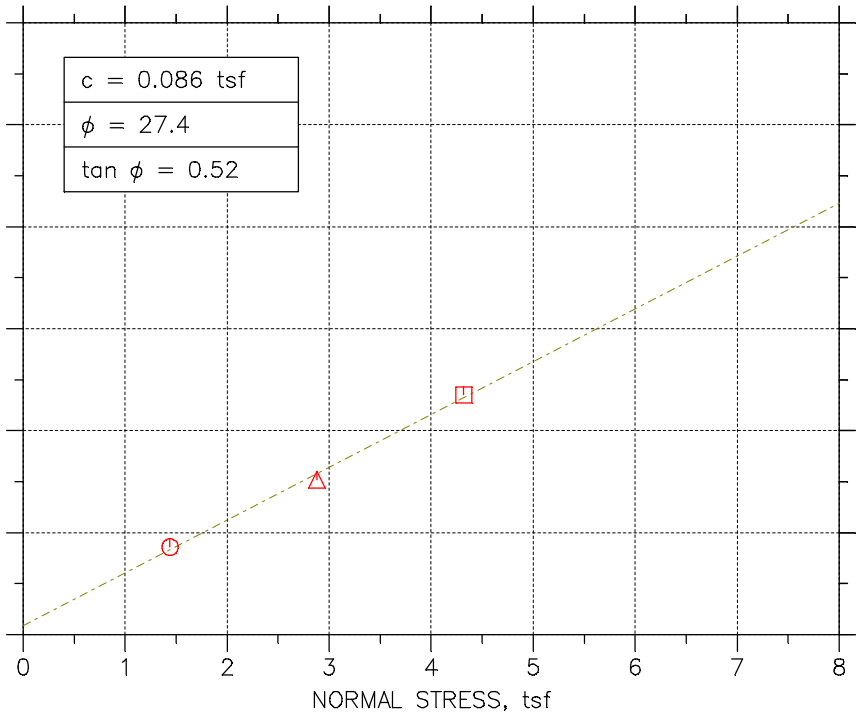

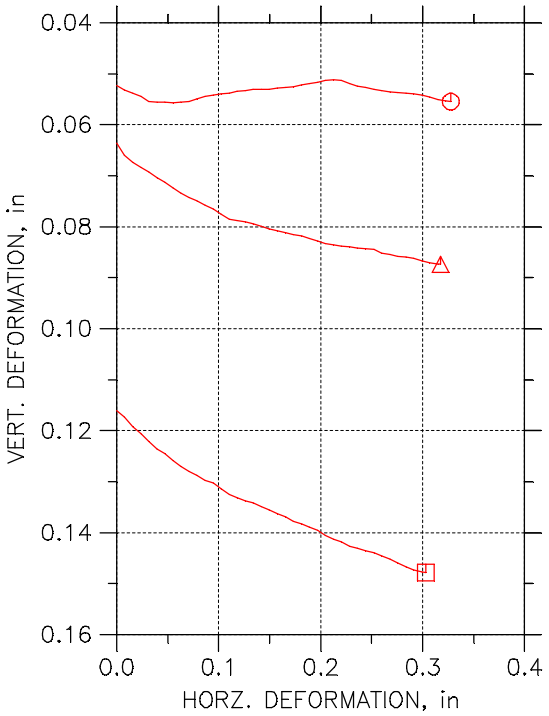

Symbol		⏲	△	⊡	
Test No.		20 PSI	40 PSI	60 PSI	
Sample No.		S-9	S-9	S-9	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.5803	2.5787	2.578	
	Area, in^2	5.2292	5.2228	5.2196	
	Height, in	0.99646	0.99882	1.0004	
	Water Content, %	27.10	27.49	27.75	
	Dry Density, pcf	82.685	82.862	81.487	
	Saturation, %	84.62	86.28	83.76	
	Void Ratio	0.73653	0.73281	0.76205	
Consol. Height, in		0.9488	0.93496	0.88478	
Consol. Void Ratio		0.65348	0.62203	0.55841	
Final	Water Content, %	27.69	24.38	21.54	
	Dry Density, pcf	87.559	90.805	95.616	
	Saturation, %	99.53	96.47	98.75	
	Void Ratio	0.63985	0.58123	0.50167	
Normal Stress, tsf		1.4387	2.8787	4.3188	
Max. Shear Stress, tsf		0.85913	1.5203	2.3505	
Ult. Shear Stress, tsf		0.85913	1.5203	2.3401	
Time to Failure, min		82.679	84.196	80.075	
Disp. Rate, in/min		0.004	0.004	0.004	
Estimated Specific Gravity		2.30	2.30	2.30	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: DYNEGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN-023 S1
Sample Type: 3.0" ST

Description: VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL

Remarks: TEST PERFORMED AS PER ASTM D3080.

Wed, 23-DEC-2015 12:06:11

DIRECT SHEAR TEST DATA

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Project: DYNEGY HENNEPIN
Boring No.: HEN-023 S1
Sample No.: S-9
Test No.: 20 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/146/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 27.0'-29.0'
Elevation: ----

Soil Description: VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL
Remarks: TEST PERFORMED AS PER ASTM D3080.

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	1.437	0.05232	0	0
2	2.57	1.439	0.05321	0.1845	0.007876
3	4.37	1.439	0.05384	0.262	0.01575
4	6.49	1.438	0.05447	0.3348	0.02363
5	8.64	1.439	0.05541	0.3987	0.0315
6	10.60	1.439	0.05554	0.4493	0.03938
7	12.60	1.439	0.0556	0.4929	0.04725
8	14.66	1.44	0.05566	0.5295	0.05513
9	16.62	1.44	0.05554	0.5601	0.06301
10	18.58	1.441	0.05541	0.5898	0.07088
11	20.52	1.44	0.05497	0.6213	0.07876
12	22.48	1.44	0.0544	0.6477	0.08663
13	24.33	1.44	0.05415	0.6723	0.09451
14	26.65	1.44	0.0539	0.6982	0.1024
15	28.33	1.44	0.05377	0.7149	0.1103
16	30.29	1.44	0.05346	0.7312	0.1181
17	32.44	1.44	0.05327	0.7446	0.126
18	34.34	1.44	0.05308	0.7604	0.1339
19	36.25	1.44	0.05302	0.7747	0.1418
20	38.33	1.44	0.05302	0.7854	0.1496
21	40.21	1.44	0.05276	0.7919	0.1576
22	42.27	1.44	0.05264	0.7998	0.1654
23	44.18	1.44	0.05251	0.81	0.1733
24	46.26	1.44	0.0522	0.8174	0.1811
25	48.13	1.44	0.05195	0.8211	0.189
26	50.09	1.439	0.05169	0.823	0.1969
27	52.06	1.439	0.05138	0.8202	0.2048
28	54.03	1.439	0.05125	0.8179	0.2126
29	55.86	1.439	0.05131	0.8049	0.2205
30	57.76	1.438	0.05195	0.8021	0.2284
31	59.91	1.438	0.05239	0.8021	0.2362
32	61.73	1.439	0.05264	0.81	0.2441
33	63.96	1.439	0.05302	0.8086	0.252
34	65.73	1.439	0.05327	0.8174	0.2599
35	67.59	1.439	0.05352	0.8225	0.2677
36	69.70	1.439	0.05371	0.8327	0.2756
37	71.64	1.439	0.05384	0.8364	0.2835
38	73.60	1.439	0.05396	0.8392	0.2914
39	75.59	1.439	0.05415	0.8373	0.2992
40	77.45	1.439	0.05453	0.8383	0.3071
41	79.47	1.439	0.05503	0.8462	0.315
42	81.41	1.439	0.05529	0.8526	0.3229
43	82.68	1.439	0.05548	0.8591	0.3275

DIRECT SHEAR TEST DATA

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Project: DYNEGY HENNEPIN
Boring No.: HEN-023 S1
Sample No.: S-9
Test No.: 40 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/146/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 27.0'-29.0'
Elevation: ----

Soil Description: VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL
Remarks: TEST PERFORMED AS PER ASTM D3080.

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	2.879	0.06367	0	0
2	5.50	2.879	0.066	0.2558	0.007876
3	7.58	2.876	0.06739	0.4071	0.01575
4	9.71	2.879	0.0684	0.5366	0.02363
5	11.73	2.878	0.06928	0.6049	0.0315
6	13.68	2.878	0.07042	0.6796	0.03938
7	15.64	2.877	0.0713	0.7404	0.04725
8	17.61	2.877	0.07243	0.8268	0.05513
9	19.78	2.878	0.07344	0.914	0.06301
10	21.88	2.878	0.07432	0.9795	0.07088
11	23.89	2.878	0.07496	1.051	0.07876
12	25.89	2.879	0.07584	1.118	0.08663
13	27.97	2.876	0.07659	1.179	0.09451
14	29.98	2.879	0.0776	1.222	0.1024
15	31.97	2.878	0.07855	1.269	0.1103
16	34.06	2.878	0.0788	1.313	0.1181
17	36.03	2.878	0.07905	1.361	0.126
18	38.01	2.879	0.07943	1.411	0.1339
19	40.08	2.878	0.07987	1.443	0.1418
20	42.02	2.878	0.08038	1.453	0.1496
21	43.98	2.878	0.08082	1.483	0.1575
22	45.99	2.879	0.08113	1.499	0.1654
23	48.06	2.879	0.08157	1.516	0.1733
24	49.93	2.879	0.08183	1.51	0.1811
25	51.88	2.879	0.08233	1.512	0.189
26	54.00	2.879	0.08284	1.492	0.1969
27	55.79	2.879	0.08328	1.472	0.2048
28	57.64	2.879	0.08353	1.466	0.2126
29	59.87	2.879	0.08378	1.473	0.2205
30	61.83	2.878	0.08397	1.477	0.2284
31	63.72	2.879	0.08416	1.481	0.2362
32	65.75	2.879	0.08429	1.479	0.2441
33	67.56	2.879	0.08441	1.482	0.252
34	69.63	2.879	0.08523	1.486	0.2599
35	71.57	2.879	0.08548	1.49	0.2677
36	73.66	2.879	0.0858	1.494	0.2756
37	75.62	2.879	0.08599	1.499	0.2835
38	77.53	2.879	0.08624	1.502	0.2914
39	79.64	2.879	0.08668	1.51	0.2992
40	81.55	2.879	0.08712	1.514	0.3072
41	83.43	2.879	0.08737	1.518	0.315
42	84.20	2.879	0.08737	1.52	0.3176

DIRECT SHEAR TEST DATA

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Project: DYNEGY HENNEPIN
Boring No.: HEN-023 S1
Sample No.: S-9
Test No.: 60 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/146/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 27.0'-29.0'
Elevation: ----

Soil Description: VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL
Remarks: TEST PERFORMED AS PER ASTM D3080.

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in
1	0.00	4.319	0.1161	0	0
2	6.63	4.317	0.1173	0.3858	0.007876
3	8.64	4.317	0.1192	0.5763	0.01575
4	10.67	4.319	0.1206	0.7651	0.02363
5	12.61	4.319	0.1221	0.938	0.0315
6	14.65	4.316	0.1236	1.092	0.03938
7	16.80	4.318	0.1244	1.238	0.04725
8	18.85	4.319	0.1259	1.362	0.05513
9	20.70	4.319	0.127	1.466	0.06301
10	22.72	4.317	0.128	1.566	0.07088
11	24.69	4.318	0.1288	1.652	0.07876
12	26.74	4.319	0.1297	1.728	0.08663
13	28.73	4.318	0.1303	1.792	0.09451
14	30.64	4.318	0.1314	1.849	0.1024
15	32.69	4.318	0.1325	1.908	0.1103
16	34.81	4.318	0.1331	1.962	0.1181
17	36.79	4.319	0.1337	2.006	0.126
18	38.68	4.317	0.1342	2.046	0.1339
19	40.54	4.318	0.1348	2.078	0.1418
20	42.61	4.319	0.1355	2.073	0.1496
21	44.59	4.317	0.1363	2.095	0.1575
22	46.53	4.318	0.1369	2.126	0.1654
23	48.62	4.318	0.1377	2.162	0.1733
24	50.61	4.318	0.1382	2.198	0.1811
25	52.53	4.319	0.1389	2.227	0.189
26	54.34	4.318	0.1395	2.24	0.1969
27	56.45	4.319	0.1406	2.273	0.2048
28	58.39	4.318	0.1413	2.297	0.2126
29	60.26	4.318	0.1418	2.315	0.2205
30	62.40	4.318	0.1427	2.325	0.2284
31	64.27	4.318	0.1431	2.315	0.2362
32	66.19	4.318	0.1435	2.324	0.2441
33	68.09	4.319	0.1439	2.334	0.252
34	70.02	4.319	0.1446	2.335	0.2599
35	72.17	4.318	0.1452	2.338	0.2677
36	74.03	4.318	0.1459	2.342	0.2756
37	76.23	4.318	0.1466	2.343	0.2835
38	78.15	4.319	0.1473	2.348	0.2914
39	80.07	4.319	0.1476	2.35	0.2992
40	81.07	4.318	0.1478	2.34	0.3032

DIRECT SHEAR TEST by ASTM D3080

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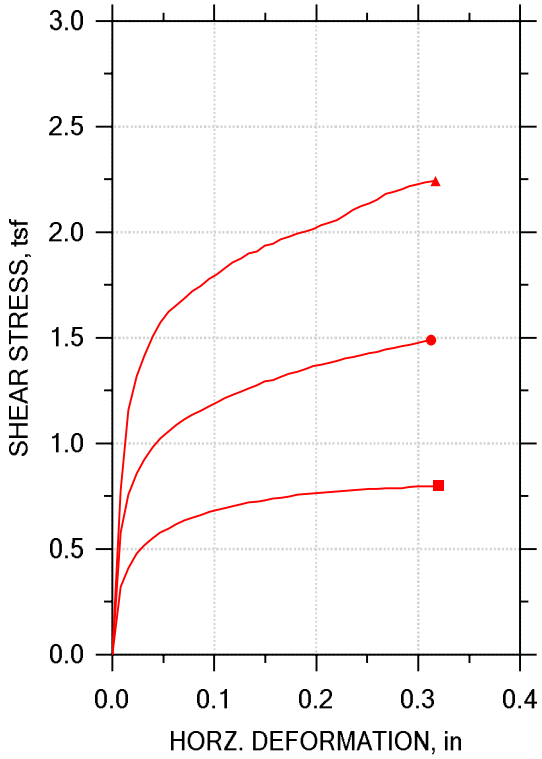

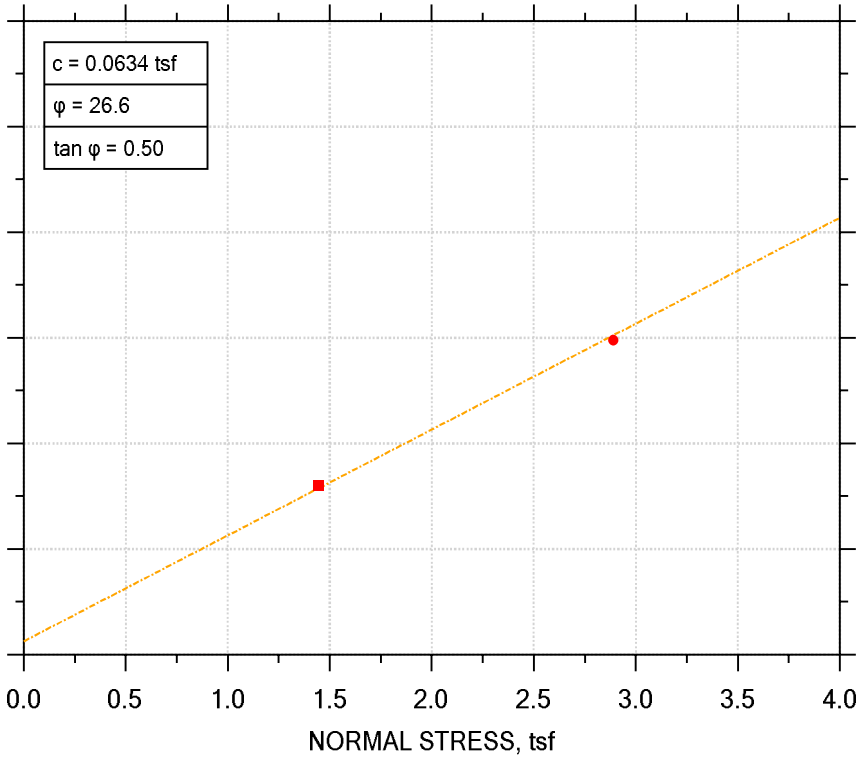

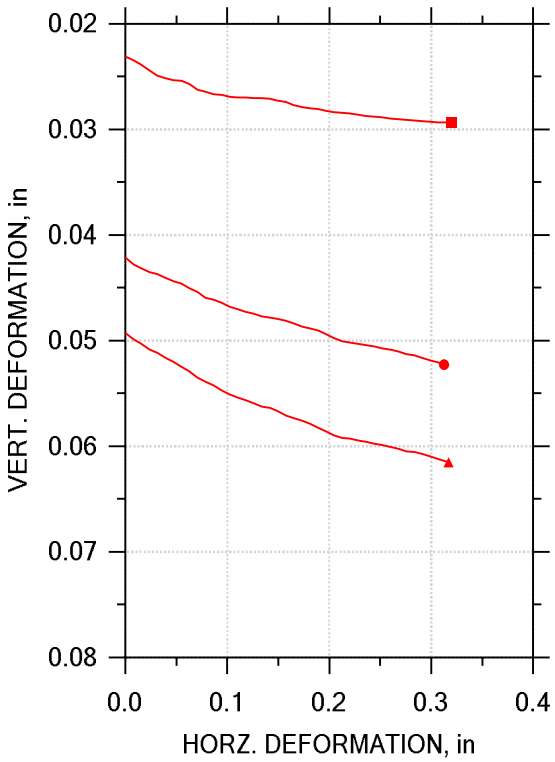

Symbol		■	●	▲	
Test No.		20.0 PSI	40.0 PSI	60.0 PSI	
Sample No.		S-9	S-9	S-9	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.4996	2.4996	2.5035	
	Area, in²	4.9072	4.9072	4.9227	
	Height, in	1.0012	1.0043	1.0063	
	Water Content, %	48.30	48.74	48.73	
	Dry Density, pcf	73.27	74.93	74.29	
	Saturation, %	103.35	108.66	106.94	
	Void Ratio	1.2152	1.1662	1.1848	
Consol. Height, in		0.97808	0.96221	0.95704	
Consol. Void Ratio		1.1641	1.0754	1.0779	
Final	Water Content, %	43.69	39.99	40.37	
	Dry Density, pcf	75.49	79.04	79.13	
	Saturation, %	98.76	98.70	99.84	
	Void Ratio	1.1502	1.0534	1.0513	
Normal Stress, tsf		1.4455	2.8899	4.3244	
Max. Shear Stress, tsf		0.7992	1.4892	2.2422	
Ult. Shear Stress, tsf		0.7992	1.4892	2.2422	
Time to Failure, min		78.896	78.246	79.775	
Disp. Rate, in/min		0.004	0.004	0.004	
Estimated Specific Gravity		2.60	2.60	2.60	
Liquid Limit		58	58	58	
Plastic Limit		23	23	23	
Plasticity Index		35	35	35	

Project: DYNEGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN-024 S-9
Sample Type: 3" ST
Description: DARK GRAY ORGANIC CLAY WITH SAND OH
Remarks: TEST PERFORMED AS PER ASTM D3080

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-024 S-9
Sample No.: S-9
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: WPQ
Test Date: 12/16/15
Sample Type: 3" ST

Project No.: MR155233
Checked By: BCM
Depth: 26.5'-28.5'
Elevation: ----

Soil Description: DARK GRAY ORGANIC CLAY WITH SAND OH
Remarks: TEST PERFORMED AS PER ASTM D3080

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.45	0.02310	0.000	0.0000	0.0000
2	2.83	1.44	0.02346	0.322	0.007916	0.007916
3	4.68	1.44	0.02391	0.410	0.01578	0.01578
4	6.60	1.44	0.02445	0.478	0.02365	0.02365
5	8.62	1.44	0.02490	0.519	0.03152	0.03152
6	10.54	1.44	0.02516	0.550	0.03939	0.03939
7	12.47	1.44	0.02535	0.577	0.04726	0.04726
8	14.35	1.44	0.02542	0.598	0.05512	0.05512
9	16.24	1.44	0.02568	0.617	0.06299	0.06299
10	18.42	1.44	0.02622	0.636	0.07091	0.07091
11	20.09	1.44	0.02645	0.648	0.07878	0.07878
12	21.99	1.44	0.02667	0.661	0.08665	0.08665
13	24.07	1.44	0.02674	0.674	0.09451	0.09451
14	25.98	1.44	0.02690	0.685	0.1024	0.1024
15	27.86	1.44	0.02696	0.695	0.1102	0.1102
16	29.65	1.44	0.02699	0.703	0.1181	0.1181
17	31.66	1.44	0.02703	0.712	0.1260	0.1260
18	33.60	1.44	0.02706	0.720	0.1339	0.1339
19	35.46	1.44	0.02709	0.725	0.1418	0.1418
20	37.49	1.44	0.02728	0.732	0.1496	0.1496
21	39.55	1.44	0.02741	0.738	0.1575	0.1575
22	41.43	1.44	0.02770	0.744	0.1654	0.1654
23	43.16	1.44	0.02790	0.750	0.1732	0.1732
24	45.07	1.45	0.02799	0.756	0.1811	0.1811
25	47.14	1.44	0.02809	0.761	0.1890	0.1890
26	48.89	1.44	0.02825	0.765	0.1969	0.1969
27	50.73	1.44	0.02835	0.767	0.2048	0.2048
28	52.81	1.45	0.02844	0.770	0.2126	0.2126
29	54.81	1.44	0.02847	0.774	0.2205	0.2205
30	56.58	1.44	0.02864	0.775	0.2284	0.2284
31	58.54	1.45	0.02870	0.779	0.2362	0.2362
32	60.26	1.45	0.02876	0.782	0.2441	0.2441
33	62.26	1.45	0.02886	0.784	0.2520	0.2520
34	64.13	1.45	0.02896	0.786	0.2599	0.2599
35	66.07	1.45	0.02905	0.787	0.2678	0.2678
36	68.20	1.44	0.02912	0.788	0.2756	0.2756
37	69.92	1.45	0.02918	0.787	0.2835	0.2835
38	71.92	1.45	0.02921	0.792	0.2914	0.2914
39	73.61	1.44	0.02928	0.796	0.2992	0.2992
40	75.77	1.44	0.02931	0.798	0.3071	0.3071
41	77.51	1.44	0.02934	0.797	0.3150	0.3150
42	78.90	1.45	0.02938	0.799	0.3202	0.3202

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-024 S-9
Sample No.: S-9
Test No.: 40.0 PSI

Location: HENNEPIN, IL
Tested By: WPQ
Test Date: 12/16/15
Sample Type: 3" ST

Project No.: MR155233
Checked By: BCM
Depth: 26.5'-28.5'
Elevation: ----

Soil Description: DARK GRAY ORGANIC CLAY WITH SAND OH
Remarks: TEST PERFORMED AS PER ASTM D3080

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	2.89	0.04212	0.000	0.0000	0.0000
2	4.33	2.89	0.04276	0.579	0.007916	0.007916
3	6.24	2.89	0.04315	0.759	0.01578	0.01578
4	8.26	2.89	0.04350	0.856	0.02365	0.02365
5	10.18	2.89	0.04373	0.923	0.03152	0.03152
6	12.02	2.89	0.04405	0.981	0.03939	0.03939
7	13.99	2.89	0.04434	1.02	0.04726	0.04726
8	15.82	2.89	0.04463	1.06	0.05512	0.05512
9	17.65	2.89	0.04504	1.09	0.06299	0.06299
10	19.62	2.89	0.04540	1.11	0.07091	0.07091
11	21.62	2.89	0.04591	1.14	0.07878	0.07878
12	23.51	2.89	0.04614	1.15	0.08665	0.08665
13	25.43	2.89	0.04640	1.18	0.09451	0.09451
14	27.27	2.89	0.04678	1.20	0.1024	0.1024
15	29.24	2.89	0.04704	1.22	0.1102	0.1102
16	31.09	2.89	0.04730	1.23	0.1181	0.1181
17	33.03	2.89	0.04746	1.25	0.1260	0.1260
18	35.12	2.89	0.04768	1.26	0.1339	0.1339
19	36.86	2.89	0.04784	1.28	0.1418	0.1418
20	38.90	2.89	0.04794	1.30	0.1496	0.1496
21	40.73	2.89	0.04813	1.30	0.1575	0.1575
22	42.66	2.89	0.04839	1.32	0.1654	0.1654
23	44.59	2.89	0.04868	1.33	0.1732	0.1732
24	46.52	2.89	0.04887	1.34	0.1811	0.1811
25	48.24	2.89	0.04903	1.35	0.1890	0.1890
26	50.32	2.89	0.04942	1.37	0.1969	0.1969
27	52.25	2.89	0.04974	1.37	0.2048	0.2048
28	54.15	2.89	0.05006	1.38	0.2126	0.2126
29	56.03	2.89	0.05019	1.39	0.2205	0.2205
30	58.01	2.89	0.05029	1.40	0.2284	0.2284
31	59.88	2.89	0.05042	1.41	0.2362	0.2362
32	61.69	2.89	0.05055	1.42	0.2441	0.2441
33	63.69	2.89	0.05071	1.43	0.2520	0.2520
34	65.33	2.89	0.05087	1.43	0.2599	0.2599
35	67.31	2.89	0.05106	1.44	0.2678	0.2678
36	69.14	2.89	0.05129	1.45	0.2756	0.2756
37	71.13	2.89	0.05138	1.46	0.2835	0.2835
38	73.21	2.89	0.05164	1.47	0.2914	0.2914
39	75.04	2.89	0.05187	1.48	0.2992	0.2992
40	76.93	2.89	0.05209	1.49	0.3071	0.3071
41	78.25	2.89	0.05228	1.49	0.3125	0.3125

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-024 S-9
Sample No.: S-9
Test No.: 60.0 PSI

Location: HENNEPIN, IL
Tested By: WPQ
Test Date: 12/16/15
Sample Type: 3" ST

Project No.: MR155233
Checked By: BCM
Depth: 26.5'-28.5'
Elevation: ----

Soil Description: DARK GRAY ORGANIC CLAY WITH SAND OH
Remarks: TEST PERFORMED AS PER ASTM D3080

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	4.32	0.04926	0.000	0.0000	0.0000
2	4.54	4.32	0.04986	0.778	0.007916	0.007916
3	6.59	4.32	0.05030	1.16	0.01578	0.01578
4	8.54	4.32	0.05082	1.32	0.02365	0.02365
5	10.51	4.32	0.05114	1.42	0.03152	0.03152
6	12.34	4.32	0.05162	1.51	0.03939	0.03939
7	14.31	4.32	0.05202	1.57	0.04726	0.04726
8	16.21	4.32	0.05250	1.62	0.05512	0.05512
9	17.95	4.32	0.05290	1.66	0.06299	0.06299
10	19.92	4.32	0.05351	1.69	0.07091	0.07091
11	22.00	4.32	0.05391	1.72	0.07878	0.07878
12	23.87	4.32	0.05423	1.74	0.08665	0.08665
13	25.83	4.32	0.05471	1.78	0.09451	0.09451
14	27.73	4.32	0.05511	1.80	0.1024	0.1024
15	29.76	4.32	0.05539	1.83	0.1102	0.1102
16	31.70	4.32	0.05567	1.86	0.1181	0.1181
17	33.58	4.32	0.05595	1.88	0.1260	0.1260
18	35.51	4.32	0.05623	1.90	0.1339	0.1339
19	37.34	4.32	0.05639	1.91	0.1418	0.1418
20	39.30	4.32	0.05667	1.94	0.1496	0.1496
21	41.16	4.32	0.05707	1.95	0.1575	0.1575
22	43.16	4.32	0.05735	1.97	0.1654	0.1654
23	44.97	4.32	0.05755	1.98	0.1732	0.1732
24	46.86	4.32	0.05787	2.00	0.1811	0.1811
25	48.65	4.32	0.05827	2.00	0.1890	0.1890
26	50.79	4.32	0.05863	2.02	0.1969	0.1969
27	52.65	4.32	0.05899	2.03	0.2048	0.2048
28	54.53	4.32	0.05919	2.04	0.2126	0.2126
29	56.53	4.32	0.05927	2.06	0.2205	0.2205
30	58.38	4.32	0.05943	2.08	0.2284	0.2284
31	60.24	4.32	0.05959	2.11	0.2362	0.2362
32	62.16	4.32	0.05975	2.12	0.2441	0.2441
33	64.08	4.32	0.05987	2.14	0.2520	0.2520
34	65.85	4.32	0.06007	2.16	0.2599	0.2599
35	67.89	4.32	0.06023	2.18	0.2678	0.2678
36	69.71	4.32	0.06047	2.19	0.2756	0.2756
37	71.73	4.32	0.06055	2.20	0.2835	0.2835
38	73.61	4.32	0.06071	2.22	0.2914	0.2914
39	75.62	4.32	0.06095	2.23	0.2992	0.2992
40	77.34	4.32	0.06119	2.24	0.3071	0.3071
41	79.25	4.32	0.06148	2.24	0.3150	0.3150
42	79.77	4.32	0.06152	2.24	0.3167	0.3167

DIRECT SHEAR TEST by ASTM D3080

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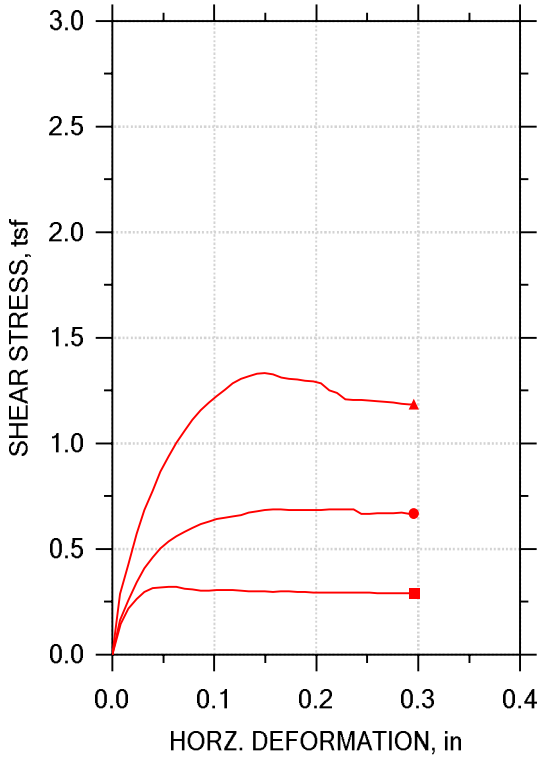

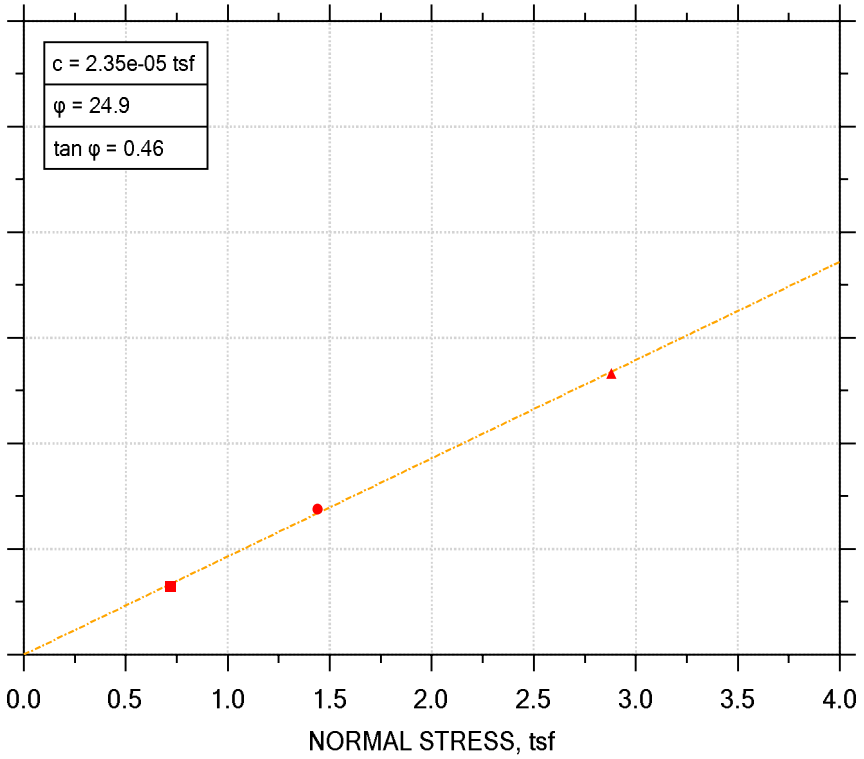

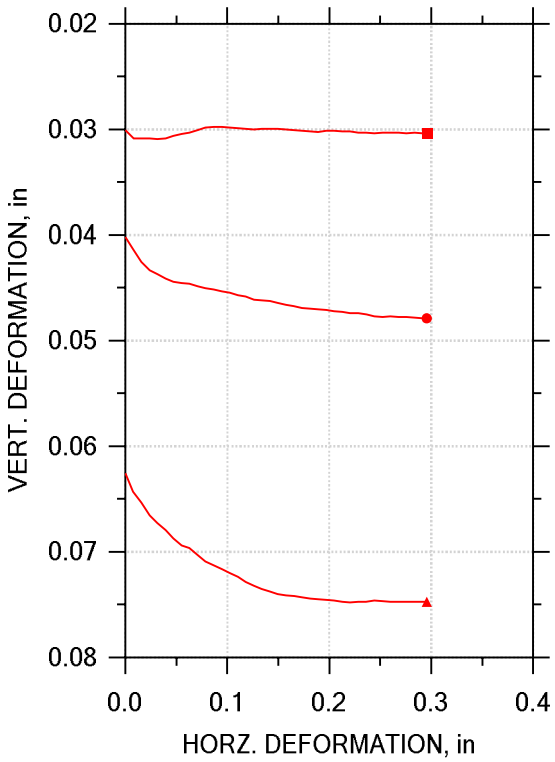

Symbol		■	●	▲	
Test No.		10 PSI	20 PSI	40 PSI	
Sample No.		S-6	S-6	S-6	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.4969	2.4957	2.502	
	Area, in²	4.8964	4.8917	4.9165	
	Height, in	1.0035	0.99685	0.99685	
	Water Content, %	31.49	31.84	31.90	
	Dry Density, pcf	74.23	74.44	73.95	
	Saturation, %	77.52	78.85	77.93	
	Void Ratio	0.93443	0.92878	0.94155	
Consol. Height, in		0.97345	0.95666	0.93431	
Consol. Void Ratio		0.87642	0.851	0.81974	
Final	Water Content, %	37.75	35.63	34.57	
	Dry Density, pcf	76.55	78.20	79.95	
	Saturation, %	99.14	98.01	99.89	
	Void Ratio	0.87576	0.83613	0.79599	
Normal Stress, tsf		0.72004	1.4392	2.8793	
Max. Shear Stress, tsf		0.32137	0.68923	1.332	
Ult. Shear Stress, tsf		0.28956	0.66847	1.1862	
Time to Failure, min		13.317	52.872	34.55	
Disp. Rate, in/min		0.0044283	0.0044283	0.0044283	
Estimated Specific Gravity		2.30	2.30	2.30	
Liquid Limit		NP	NP	NP	
Plastic Limit		NP	NP	NP	
Plasticity Index		NP	NP	NP	

Project: DYNEGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN-025 S-6
Sample Type: TRIMMED
Description: VERY DARK GRAY FLY ASH WITH SAND
Remarks:

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-025 S-6
Sample No.: S-6
Test No.: 10 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 11.5'-13.5'
Elevation: ----

Soil Description: VERY DARK GRAY FLY ASH WITH SAND
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.719	0.03009	0.000	0.0000	0.0000
2	2.49	0.719	0.03083	0.147	0.007971	0.007971
3	4.56	0.720	0.03083	0.219	0.01577	0.01577
4	6.40	0.720	0.03083	0.264	0.02364	0.02364
5	8.22	0.720	0.03090	0.298	0.03154	0.03154
6	9.89	0.720	0.03087	0.314	0.03944	0.03944
7	11.62	0.720	0.03061	0.319	0.04727	0.04727
8	13.32	0.720	0.03045	0.321	0.05514	0.05514
9	15.05	0.720	0.03029	0.320	0.06300	0.06300
10	16.89	0.720	0.03007	0.312	0.07087	0.07087
11	18.73	0.720	0.02984	0.310	0.07877	0.07877
12	20.76	0.719	0.02975	0.303	0.08664	0.08664
13	22.51	0.719	0.02979	0.304	0.09451	0.09451
14	24.15	0.720	0.02982	0.306	0.1024	0.1024
15	25.71	0.720	0.02986	0.306	0.1102	0.1102
16	27.59	0.720	0.02993	0.305	0.1181	0.1181
17	29.28	0.720	0.02998	0.302	0.1260	0.1260
18	31.01	0.720	0.02993	0.300	0.1339	0.1339
19	32.97	0.719	0.02995	0.300	0.1417	0.1417
20	34.86	0.720	0.02995	0.298	0.1496	0.1496
21	36.70	0.720	0.03000	0.298	0.1575	0.1575
22	38.37	0.720	0.03007	0.298	0.1654	0.1654
23	40.03	0.720	0.03011	0.298	0.1732	0.1732
24	41.67	0.720	0.03018	0.298	0.1811	0.1811
25	43.57	0.720	0.03022	0.296	0.1890	0.1890
26	45.47	0.720	0.03015	0.294	0.1969	0.1969
27	47.27	0.720	0.03015	0.294	0.2047	0.2047
28	49.05	0.720	0.03016	0.294	0.2126	0.2126
29	50.95	0.720	0.03018	0.294	0.2205	0.2205
30	52.72	0.720	0.03029	0.293	0.2283	0.2283
31	54.18	0.719	0.03033	0.294	0.2362	0.2362
32	55.82	0.720	0.03034	0.294	0.2441	0.2441
33	57.83	0.720	0.03029	0.294	0.2520	0.2520
34	59.65	0.720	0.03031	0.291	0.2598	0.2598
35	61.60	0.720	0.03031	0.291	0.2678	0.2678
36	63.38	0.720	0.03036	0.290	0.2756	0.2756
37	65.11	0.720	0.03031	0.290	0.2835	0.2835
38	66.87	0.720	0.03038	0.290	0.2914	0.2914
39	67.77	0.720	0.03043	0.290	0.2959	0.2959

DIRECT SHEAR TEST DATA

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Project: DYNEGY HENNEPIN
Boring No.: HEN-025 S-6
Sample No.: S-6
Test No.: 20 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 11.5'-13.5'
Elevation: ----

Soil Description: VERY DARK GRAY FLY ASH WITH SAND
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.44	0.04020	0.000	0.0000	0.0000
2	2.45	1.44	0.04135	0.162	0.007902	0.007902
3	4.38	1.44	0.04254	0.259	0.01577	0.01577
4	6.37	1.44	0.04333	0.343	0.02364	0.02364
5	8.17	1.44	0.04372	0.410	0.03154	0.03154
6	9.94	1.44	0.04414	0.461	0.03940	0.03940
7	11.65	1.44	0.04441	0.502	0.04731	0.04731
8	13.41	1.44	0.04452	0.537	0.05517	0.05517
9	15.14	1.44	0.04459	0.560	0.06300	0.06300
10	16.90	1.44	0.04482	0.582	0.07087	0.07087
11	18.84	1.44	0.04502	0.600	0.07877	0.07877
12	20.84	1.44	0.04513	0.618	0.08664	0.08664
13	22.56	1.44	0.04531	0.632	0.09451	0.09451
14	24.41	1.44	0.04544	0.643	0.1024	0.1024
15	26.03	1.44	0.04572	0.649	0.1102	0.1102
16	27.61	1.44	0.04585	0.654	0.1182	0.1182
17	29.43	1.44	0.04612	0.662	0.1260	0.1260
18	31.34	1.44	0.04617	0.671	0.1339	0.1339
19	33.28	1.44	0.04623	0.679	0.1417	0.1417
20	35.06	1.44	0.04643	0.684	0.1496	0.1496
21	36.88	1.44	0.04661	0.687	0.1575	0.1575
22	38.57	1.44	0.04675	0.687	0.1654	0.1654
23	40.34	1.44	0.04691	0.685	0.1732	0.1732
24	41.97	1.44	0.04697	0.684	0.1811	0.1811
25	43.74	1.44	0.04704	0.683	0.1890	0.1890
26	45.60	1.44	0.04711	0.684	0.1969	0.1969
27	47.52	1.44	0.04720	0.686	0.2048	0.2048
28	49.31	1.44	0.04725	0.687	0.2126	0.2126
29	51.07	1.44	0.04738	0.688	0.2205	0.2205
30	52.87	1.44	0.04738	0.689	0.2283	0.2283
31	54.66	1.44	0.04749	0.689	0.2363	0.2363
32	56.02	1.44	0.04772	0.667	0.2441	0.2441
33	57.82	1.44	0.04774	0.668	0.2520	0.2520
34	59.66	1.44	0.04770	0.669	0.2598	0.2598
35	61.64	1.44	0.04774	0.669	0.2678	0.2678
36	63.57	1.44	0.04776	0.669	0.2756	0.2756
37	65.29	1.44	0.04781	0.671	0.2835	0.2835
38	67.10	1.44	0.04787	0.666	0.2914	0.2914
39	67.98	1.44	0.04788	0.668	0.2953	0.2953

DIRECT SHEAR TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-025 S-6
Sample No.: S-6
Test No.: 40 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 11.5'-13.5'
Elevation: ----

Soil Description: VERY DARK GRAY FLY ASH WITH SAND
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	2.88	0.06254	0.000	0.0000	0.0000
2	2.06	2.88	0.06431	0.288	0.007902	0.007902
3	3.73	2.88	0.06535	0.427	0.01577	0.01577
4	5.68	2.88	0.06656	0.572	0.02364	0.02364
5	7.41	2.88	0.06726	0.683	0.03150	0.03150
6	9.18	2.88	0.06796	0.775	0.03940	0.03940
7	11.28	2.88	0.06874	0.867	0.04731	0.04731
8	13.15	2.88	0.06937	0.941	0.05514	0.05514
9	14.96	2.88	0.06966	1.00	0.06300	0.06300
10	16.75	2.88	0.07029	1.06	0.07087	0.07087
11	18.48	2.88	0.07094	1.11	0.07877	0.07877
12	20.21	2.88	0.07126	1.16	0.08664	0.08664
13	22.02	2.88	0.07162	1.19	0.09451	0.09451
14	23.89	2.88	0.07200	1.22	0.1024	0.1024
15	25.71	2.88	0.07238	1.26	0.1103	0.1103
16	27.46	2.88	0.07284	1.28	0.1182	0.1182
17	29.34	2.88	0.07322	1.31	0.1260	0.1260
18	31.19	2.88	0.07355	1.32	0.1339	0.1339
19	32.76	2.88	0.07378	1.33	0.1417	0.1417
20	34.55	2.88	0.07400	1.33	0.1496	0.1496
21	36.46	2.88	0.07414	1.33	0.1575	0.1575
22	38.17	2.88	0.07421	1.31	0.1654	0.1654
23	40.09	2.88	0.07432	1.31	0.1732	0.1732
24	41.83	2.88	0.07443	1.30	0.1811	0.1811
25	43.52	2.88	0.07448	1.30	0.1890	0.1890
26	45.41	2.88	0.07454	1.29	0.1969	0.1969
27	47.13	2.88	0.07463	1.29	0.2047	0.2047
28	48.78	2.88	0.07475	1.25	0.2126	0.2126
29	50.52	2.88	0.07479	1.24	0.2205	0.2205
30	52.37	2.88	0.07472	1.21	0.2283	0.2283
31	54.21	2.88	0.07472	1.21	0.2363	0.2363
32	56.04	2.88	0.07463	1.21	0.2441	0.2441
33	57.71	2.88	0.07466	1.20	0.2520	0.2520
34	59.65	2.88	0.07472	1.20	0.2599	0.2599
35	61.38	2.88	0.07472	1.20	0.2678	0.2678
36	63.12	2.88	0.07470	1.19	0.2756	0.2756
37	64.78	2.88	0.07470	1.19	0.2835	0.2835
38	66.67	2.88	0.07472	1.19	0.2914	0.2914
39	67.75	2.88	0.07474	1.19	0.2958	0.2958

DIRECT SHEAR TEST by ASTM D3080

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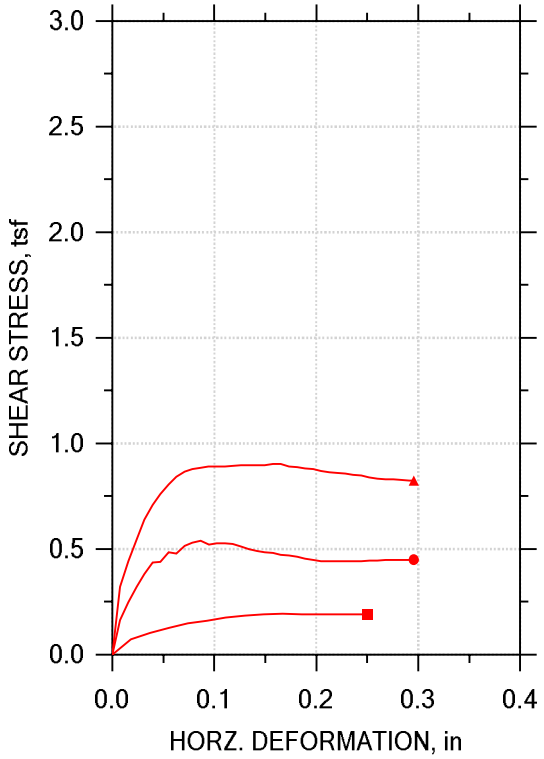

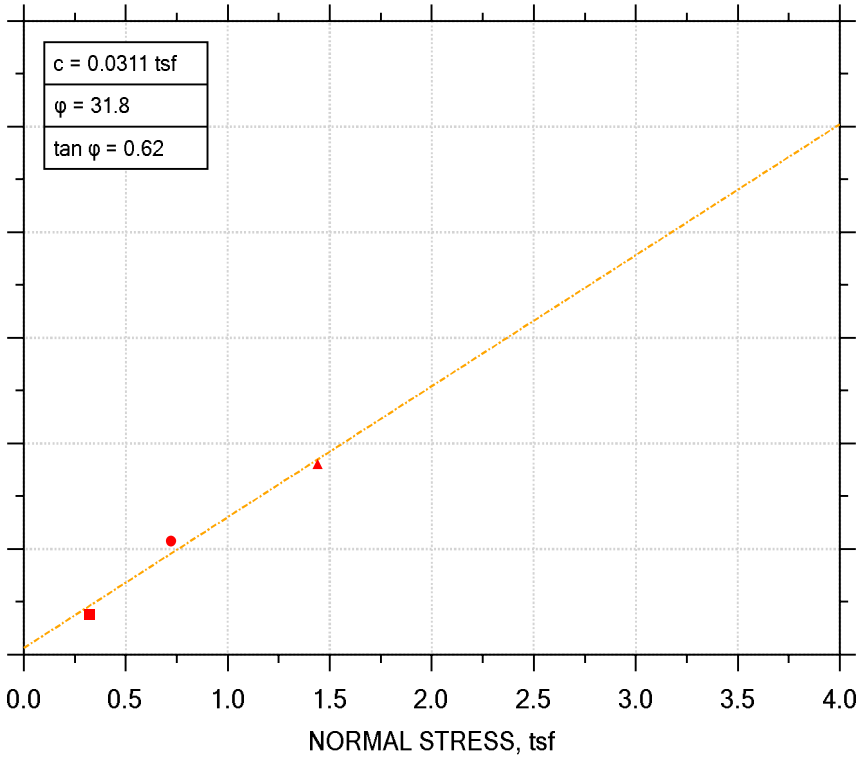

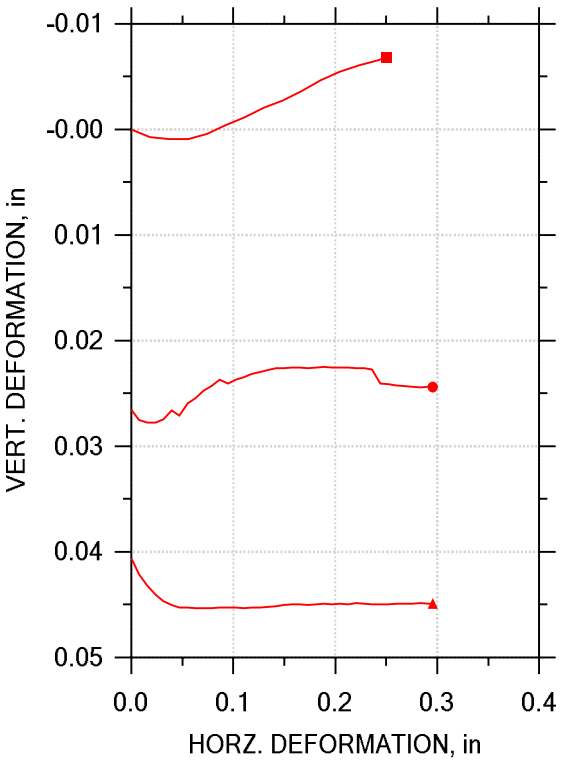

Symbol		■	●	▲	
Test No.		5.0 PSI	10.0 PSI	20.0 PSI	
Sample No.		S-5	S-5	S-5	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.4913	2.4941	2.4976	
	Area, in²	4.8748	4.8856	4.8995	
	Height, in	0.9878	0.99094	0.99252	
	Water Content, %	16.30	16.70	16.83	
	Dry Density, pcf	112.2	111.3	110.7	
	Saturation, %	86.28	86.36	85.72	
	Void Ratio	0.51397	0.52594	0.53408	
Consol. Height, in		0.9878	0.9644	0.95193	
Consol. Void Ratio		0.51397	0.48506	0.47134	
Final	Water Content, %	19.67	18.05	17.75	
	Dry Density, pcf	111.4	114.1	115.9	
	Saturation, %	102.01	100.52	103.90	
	Void Ratio	0.52446	0.48839	0.46469	
Normal Stress, tsf		0.32343	0.72072	1.4396	
Max. Shear Stress, tsf		0.19271	0.53843	0.90226	
Ult. Shear Stress, tsf		0.19231	0.44946	0.82371	
Time to Failure, min		39.855	23.081	41.061	
Disp. Rate, in/min		0.047244	0.004	0.004	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		31	31	31	
Plastic Limit		17	17	17	
Plasticity Index		14	14	14	

Project: DYNEGY HENNEPIN	
Location: HENNEPIN, IL	
Project No.: MR155233	
Boring No.: HEN-029 S-5	
Sample Type: TRIMMED	
Description: DARK BROWN AND GRAY SLIGHTLY ORGANIC CLAY CL SAND POCKETS NOTED	
Remarks:	

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-5
Sample No.: S-5
Test No.: 5.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

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Soil Description: DARK BROWN AND GRAY SLIGHTLY ORGANIC CLAY CL SAND POCKETS NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.323	0.0000	0.000202	0.0000	0.0000
2	5.49	0.322	0.0007383	0.0717	0.01854	0.01854
3	10.36	0.323	0.0009004	0.104	0.03709	0.03709
4	15.03	0.323	0.0009004	0.128	0.05563	0.05563
5	19.38	0.323	0.0004142	0.147	0.07418	0.07418
6	23.15	0.323	-0.0003962	0.161	0.09280	0.09280
7	27.26	0.323	-0.001135	0.175	0.1113	0.1113
8	31.47	0.323	-0.002053	0.186	0.1299	0.1299
9	35.85	0.324	-0.002755	0.191	0.1484	0.1484
10	39.85	0.323	-0.003638	0.193	0.1670	0.1670
11	44.32	0.323	-0.004646	0.192	0.1856	0.1856
12	48.69	0.323	-0.005475	0.192	0.2041	0.2041
13	53.17	0.323	-0.006051	0.192	0.2228	0.2228
14	57.05	0.323	-0.006537	0.192	0.2413	0.2413
15	60.08	0.322	-0.006843	0.192	0.2506	0.2506

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-5
Sample No.: S-5
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

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Soil Description: DARK BROWN AND GRAY SLIGHTLY ORGANIC CLAY CL SAND POCKETS NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.719	0.02654	0.000	0.0000	0.0000
2	2.71	0.719	0.02752	0.165	0.007902	0.007902
3	4.89	0.719	0.02777	0.248	0.01580	0.01580
4	7.16	0.720	0.02779	0.321	0.02364	0.02364
5	9.14	0.721	0.02746	0.382	0.03150	0.03150
6	11.21	0.721	0.02662	0.436	0.03940	0.03940
7	12.99	0.722	0.02710	0.441	0.04727	0.04727
8	14.76	0.722	0.02597	0.484	0.05517	0.05517
9	16.83	0.722	0.02543	0.479	0.06300	0.06300
10	18.94	0.722	0.02471	0.516	0.07087	0.07087
11	21.09	0.721	0.02433	0.529	0.07877	0.07877
12	23.08	0.721	0.02372	0.538	0.08664	0.08664
13	25.09	0.720	0.02404	0.521	0.09451	0.09451
14	26.95	0.721	0.02370	0.527	0.1024	0.1024
15	28.84	0.720	0.02343	0.528	0.1102	0.1102
16	30.60	0.720	0.02318	0.523	0.1182	0.1182
17	32.68	0.720	0.02294	0.512	0.1260	0.1260
18	34.69	0.720	0.02280	0.499	0.1339	0.1339
19	36.76	0.720	0.02262	0.491	0.1417	0.1417
20	38.80	0.720	0.02258	0.485	0.1496	0.1496
21	40.72	0.720	0.02256	0.482	0.1575	0.1575
22	42.71	0.720	0.02253	0.474	0.1654	0.1654
23	44.65	0.720	0.02258	0.468	0.1732	0.1732
24	46.29	0.720	0.02255	0.463	0.1811	0.1811
25	48.27	0.720	0.02249	0.455	0.1890	0.1890
26	50.29	0.720	0.02255	0.448	0.1969	0.1969
27	52.42	0.720	0.02253	0.444	0.2047	0.2047
28	54.59	0.720	0.02253	0.441	0.2126	0.2126
29	56.45	0.720	0.02260	0.441	0.2205	0.2205
30	58.41	0.720	0.02264	0.441	0.2283	0.2283
31	60.25	0.720	0.02271	0.443	0.2362	0.2362
32	62.14	0.719	0.02408	0.443	0.2441	0.2441
33	64.05	0.720	0.02410	0.444	0.2520	0.2520
34	66.14	0.720	0.02424	0.447	0.2598	0.2598
35	68.26	0.719	0.02431	0.448	0.2678	0.2678
36	70.36	0.719	0.02438	0.449	0.2756	0.2756
37	72.12	0.719	0.02442	0.449	0.2835	0.2835
38	74.01	0.719	0.02437	0.449	0.2914	0.2914
39	75.01	0.719	0.02438	0.449	0.2953	0.2953

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-5
Sample No.: S-5
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

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Soil Description: DARK BROWN AND GRAY SLIGHTLY ORGANIC CLAY CL SAND POCKETS NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.44	0.04059	0.000	0.0000	0.0000
2	2.82	1.44	0.04214	0.321	0.007867	0.007867
3	4.83	1.44	0.04324	0.444	0.01573	0.01573
4	7.10	1.44	0.04405	0.546	0.02360	0.02360
5	9.38	1.44	0.04470	0.641	0.03147	0.03147
6	11.33	1.44	0.04504	0.710	0.03937	0.03937
7	13.35	1.44	0.04526	0.759	0.04724	0.04724
8	15.20	1.44	0.04529	0.807	0.05510	0.05510
9	17.03	1.44	0.04533	0.841	0.06297	0.06297
10	19.00	1.44	0.04531	0.865	0.07087	0.07087
11	21.09	1.44	0.04531	0.877	0.07877	0.07877
12	23.26	1.44	0.04527	0.883	0.08660	0.08660
13	25.19	1.44	0.04529	0.890	0.09447	0.09447
14	27.24	1.44	0.04527	0.891	0.1023	0.1023
15	29.09	1.44	0.04533	0.890	0.1102	0.1102
16	30.98	1.44	0.04529	0.893	0.1181	0.1181
17	32.82	1.44	0.04526	0.896	0.1260	0.1260
18	34.93	1.44	0.04524	0.896	0.1338	0.1338
19	36.84	1.44	0.04513	0.895	0.1417	0.1417
20	39.05	1.44	0.04500	0.896	0.1496	0.1496
21	41.06	1.44	0.04499	0.902	0.1575	0.1575
22	42.87	1.44	0.04495	0.902	0.1653	0.1653
23	44.87	1.44	0.04502	0.889	0.1732	0.1732
24	46.86	1.44	0.04497	0.888	0.1811	0.1811
25	48.59	1.44	0.04493	0.883	0.1889	0.1889
26	50.54	1.44	0.04499	0.877	0.1968	0.1968
27	52.49	1.44	0.04493	0.869	0.2047	0.2047
28	54.68	1.44	0.04497	0.865	0.2126	0.2126
29	56.76	1.44	0.04488	0.862	0.2204	0.2204
30	58.63	1.44	0.04493	0.858	0.2283	0.2283
31	60.64	1.44	0.04497	0.850	0.2362	0.2362
32	62.54	1.44	0.04497	0.847	0.2441	0.2441
33	64.42	1.44	0.04499	0.840	0.2519	0.2519
34	66.26	1.44	0.04493	0.834	0.2598	0.2598
35	68.32	1.44	0.04493	0.831	0.2677	0.2677
36	70.44	1.44	0.04493	0.830	0.2756	0.2756
37	72.48	1.44	0.04488	0.828	0.2834	0.2834
38	74.27	1.44	0.04490	0.825	0.2913	0.2913
39	75.29	1.44	0.04490	0.824	0.2955	0.2955

Hydraulic Conductivity Tests
ASTM D 5084

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Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(847) 793-0306 Fax:(847) 793-0309

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

TERRACON PROJECT NO.: **MR155233** **12/21/2015**
PROJECT NAME: **DYNERGY - HENNEPIN SITE**
CLIENT: **AECOM**
LOCATION : **HENNEPIN, IL**

SUMMARY OF TEST RESULTS

BORING NO. HEN-B010

SAMPLE NO. S-5

DEPTH: 10.0'-11.5'

CLASSIFICATION VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	86.6	93.3
WATER CONTENT (%)	26.5	23.2
DIAMETER (cm)	7.215	6.956
LENGTH (cm)	4.527	4.521

SAMPLE PHOTO

HYDRAULIC GRADIENT (MAXIMUM) 20.83

PERCENT SATURATION 99.5 (Percent saturation calculation is based on final measurements and an estimated specific gravity.)

HYDRAULIC CONDUCTIVITY k (cm/sec) 1.16E-05

Deaired water was used as the liquid permeant.

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HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

TERRACON PROJECT NO.: **MR155233** **12/21/2015**
PROJECT NAME: **DYNERGY - HENNEPIN SITE**
CLIENT: **AECOM**
LOCATION : **HENNEPIN, IL**

SUMMARY OF TEST RESULTS

BORING NO. HEN-B017

SAMPLE NO. S-3

DEPTH: 5.0'-7.0'

CLASSIFICATION VERY DARK GRAY LEAN CLAY WITH SAND

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	76.0	82.8
WATER CONTENT (%)	36.7	38.2
DIAMETER (cm)	6.929	6.692
LENGTH (cm)	7.541	7.425
HYDRAULIC GRADIENT (MAXIMUM)	26.49	
PERCENT SATURATION	99.3	
HYDRAULIC CONDUCTIVITY k (cm/sec)	6.79E-07	

SAMPLE PHOTO

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

Deaired water was used as the liquid permeant.

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Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(847) 793-0306 Fax:(847) 793-0309

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

TERRACON PROJECT NO.: **MR155233** **12/21/2015**
PROJECT NAME: **DYNERGY - HENNEPIN SITE**
CLIENT: **AECOM**
LOCATION : **HENNEPIN, IL**

SUMMARY OF TEST RESULTS

BORING NO. HEN-B023

SAMPLE NO. S-9

DEPTH: 27.0'-29.0'

CLASSIFICATION VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	81.8	83.2
WATER CONTENT (%)	28.3	31.5
DIAMETER (cm)	7.154	7.063
LENGTH (cm)	5.432	5.479

SAMPLE PHOTO

HYDRAULIC GRADIENT (MAXIMUM) 17.36

PERCENT SATURATION 100.4 (Percent saturation calculation is based on final measurements and an estimated specific gravity.)

HYDRAULIC CONDUCTIVITY k (cm/sec) 1.00E-05

Deaired water was used as the liquid permeant.

Unconfined Compression Tests
ASTM D 2166

UNCONFINED COMPRESSION TEST
ASTM D2166

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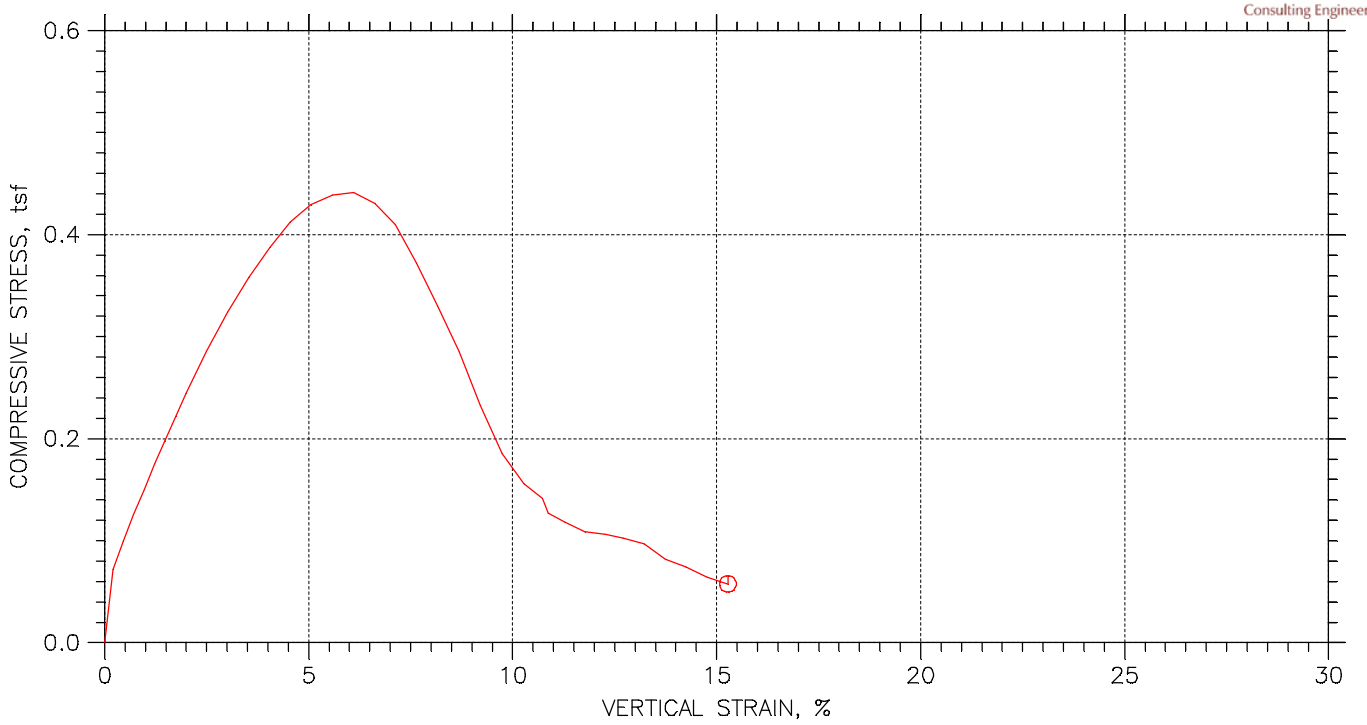

Symbol		⏲			
Test No.		HENB001S4			
Initial	Diameter, in	2.865			
	Height, in	6.0992			
	Water Content, %	17.60			
	Dry Density, pcf	108.4			
	Saturation, %	84.55			
	Void Ratio	0.56618			
Unconfined Compressive Strength, tsf		0.44114			
Undrained Shear Strength, tsf		0.22057			
Time to Failure, min		6.0041			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		21			
Plastic Limit		14			
Plasticity Index		7			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HENB001 S-4
Sample Type: 3.0" ST
Description: BROWN AND GRAY LEAN CLAY WITH SAND CL SAND SEAMS NOTED
Remarks: TEST PERFORMED AS PER ASTM D2166. 408

Tue, 22-DEC-2015 14:04:16

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HENB001 S-4
Sample No.: ST-4
Test No.: HENB001S4

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 7.5'-9.5'
Elevation: -----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN AND GRAY LEAN CLAY WITH SAND CL SAND SEAMS NOTED
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.10 in
Specimen Area: 6.45 in^2
Specimen Volume: 39.32 in^3

Liquid Limit: 21
Plastic Limit: 14
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.4465	0	0
2	0.25412	0.012269	0.20115	6.4512	6.4595	0.071907	0.035954
3	0.50388	0.027674	0.45373	8.9163	6.4759	0.099133	0.049566
4	0.75412	0.043356	0.71085	11.329	6.4927	0.12563	0.062816
5	1.0041	0.05913	0.96947	13.584	6.5097	0.15025	0.075125
6	1.2541	0.074997	1.2296	15.892	6.5268	0.17531	0.087656
7	1.5041	0.090402	1.4822	17.99	6.5435	0.19795	0.098974
8	1.7541	0.1059	1.7363	20.193	6.5605	0.22161	0.11081
9	2.0041	0.1214	1.9904	22.291	6.5775	0.24401	0.122
10	2.5041	0.15221	2.4955	26.225	6.6115	0.28559	0.14279
11	3.0041	0.18348	3.0082	29.896	6.6465	0.32386	0.16193
12	3.5041	0.2153	3.53	33.2	6.6824	0.35772	0.17886
13	4.0041	0.24667	4.0443	36.137	6.7183	0.38729	0.19364
14	4.5041	0.27739	4.5479	38.707	6.7537	0.41265	0.20633
15	5.0041	0.30847	5.0576	40.491	6.79	0.42936	0.21468
16	5.5041	0.3403	5.5794	41.592	6.8275	0.43861	0.21931
17	6.0041	0.37212	6.1012	42.064	6.8654	0.44114	0.22057
18	6.5042	0.40349	6.6154	41.277	6.9032	0.43052	0.21526
19	7.0042	0.43439	7.1221	39.547	6.9409	0.41023	0.20511
20	7.5042	0.46603	7.6409	36.085	6.9799	0.37223	0.18612
21	8.0042	0.49776	8.1611	32.204	7.0194	0.33032	0.16516
22	8.5042	0.52996	8.689	27.955	7.06	0.2851	0.14255
23	9.0042	0.5616	9.2077	22.92	7.1003	0.23242	0.11621
24	9.5042	0.59398	9.7386	18.357	7.1421	0.18506	0.09253
25	10.004	0.62673	10.276	15.577	7.1848	0.1561	0.078051
26	10.504	0.65486	10.737	14.161	7.222	0.14118	0.070591
27	11.004	0.66279	10.867	12.745	7.2325	0.12688	0.063439
28	11.5	0.6877	11.275	11.906	7.2658	0.11798	0.058991
29	12	0.71722	11.759	11.014	7.3056	0.10855	0.054275
30	12.5	0.74775	12.26	10.857	7.3473	0.10639	0.053196
31	13	0.77515	12.709	10.542	7.3851	0.10278	0.05139
32	13.5	0.80652	13.223	9.9653	7.4289	0.096583	0.048291
33	14	0.83816	13.742	8.4968	7.4736	0.081857	0.040929
34	14.5	0.86897	14.247	7.7625	7.5176	0.074345	0.037173
35	15	0.89996	14.755	6.7659	7.5624	0.064417	0.032208
36	15.5	0.93169	15.276	6.0841	7.6088	0.057572	0.028786

UNCONFINED COMPRESSION TEST
ASTM D2166

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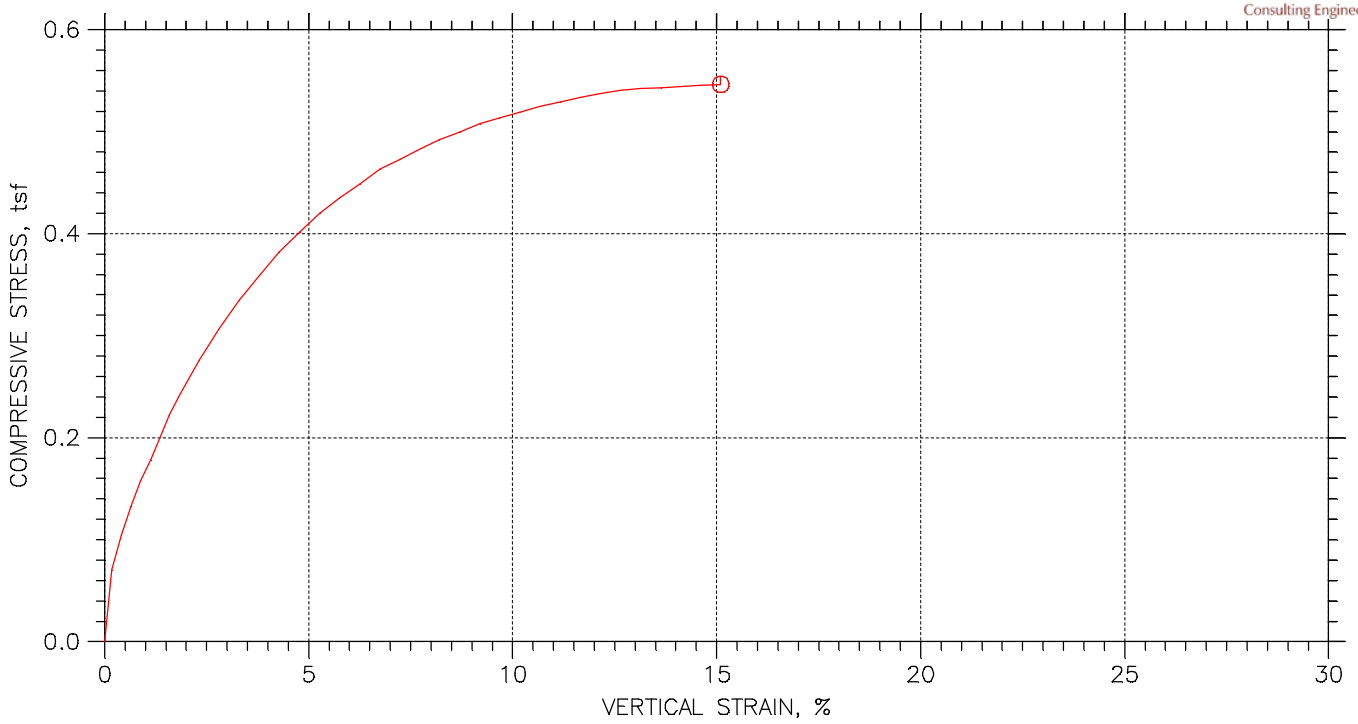

Symbol		⏲			
Test No.		HEN001S7			
Initial	Diameter, in	2.8047			
	Height, in	6.0043			
	Water Content, %	37.23			
	Dry Density, pcf	81.96			
	Saturation, %	94.48			
	Void Ratio	1.0718			
Unconfined Compressive Strength, tsf		0.54628			
Undrained Shear Strength, tsf		0.27314			
Time to Failure, min		15.5			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		38			
Plastic Limit		22			
Plasticity Index		16			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN001 S7
Sample Type: 3.0" ST
Description: DARK GRAY ORGANIC LEAN CLAY OL SHELL NOTED
Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 14:21:51

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN001 S7
Sample No.: ST-7
Test No.: HEN001S7

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 20.0'-22.0'
Elevation: ----

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Soil Description: DARK GRAY ORGANIC LEAN CLAY OL SHELL NOTED
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.00 in
Specimen Area: 6.18 in^2
Specimen Volume: 37.10 in^3

Liquid Limit: 38
Plastic Limit: 22
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.1783	0	0
2	0.25003	0.010322	0.1719	6.0347	6.189	0.070205	0.035102
3	0.50003	0.024571	0.40922	8.9991	6.2037	0.10444	0.052221
4	0.75003	0.038638	0.6435	11.434	6.2183	0.13239	0.066196
5	1	0.05307	0.88386	13.657	6.2334	0.15775	0.078876
6	1.25	0.067593	1.1257	15.51	6.2487	0.17871	0.089357
7	1.5	0.082299	1.3707	17.469	6.2642	0.20078	0.10039
8	1.75	0.095361	1.5882	19.374	6.278	0.2222	0.1111
9	2.0001	0.11007	1.8331	21.121	6.2937	0.24163	0.12081
10	2.5	0.13957	2.3245	24.297	6.3254	0.27657	0.13829
11	3	0.16862	2.8083	27.103	6.3568	0.30698	0.15349
12	3.5	0.19803	3.2981	29.697	6.389	0.33466	0.16733
13	4.0001	0.22781	3.7941	32.026	6.422	0.35906	0.17953
14	4.5	0.25759	4.29	34.302	6.4552	0.3826	0.1913
15	5.0001	0.28709	4.7814	36.208	6.4886	0.40178	0.20089
16	5.5001	0.31623	5.2666	38.061	6.5218	0.42019	0.21009
17	6.0001	0.34582	5.7595	39.596	6.5559	0.43486	0.21743
18	6.5001	0.3756	6.2555	41.078	6.5906	0.44876	0.22438
19	7.0001	0.40519	6.7484	42.613	6.6254	0.46309	0.23154
20	7.5001	0.43415	7.2306	43.725	6.6599	0.47271	0.23636
21	8.0001	0.46329	7.7159	44.889	6.6949	0.48276	0.24138
22	8.5001	0.49288	8.2088	46.001	6.7308	0.49207	0.24604
23	9.0001	0.52266	8.7047	46.954	6.7674	0.49955	0.24978
24	9.5001	0.55226	9.1976	48.013	6.8041	0.50806	0.25403
25	10	0.5813	9.6814	48.807	6.8406	0.51371	0.25686
26	10.5	0.6109	10.174	49.601	6.8781	0.51922	0.25961
27	11	0.64067	10.67	50.395	6.9163	0.52462	0.26231
28	11.5	0.67054	11.168	51.136	6.955	0.52937	0.26468
29	12	0.69996	11.658	51.824	6.9936	0.53353	0.26677
30	12.5	0.729	12.141	52.459	7.0321	0.53712	0.26856
31	13	0.7586	12.634	53.094	7.0718	0.54057	0.27029
32	13.5	0.78856	13.133	53.571	7.1124	0.54231	0.27115
33	14	0.81824	13.628	53.941	7.1531	0.54295	0.27147
34	14.5	0.84766	14.117	54.365	7.1939	0.54411	0.27205
35	15	0.8767	14.601	54.841	7.2347	0.54579	0.27289
36	15.5	0.90648	15.097	55.212	7.2769	0.54628	0.27314

UNCONFINED COMPRESSION TEST
ASTM D2166

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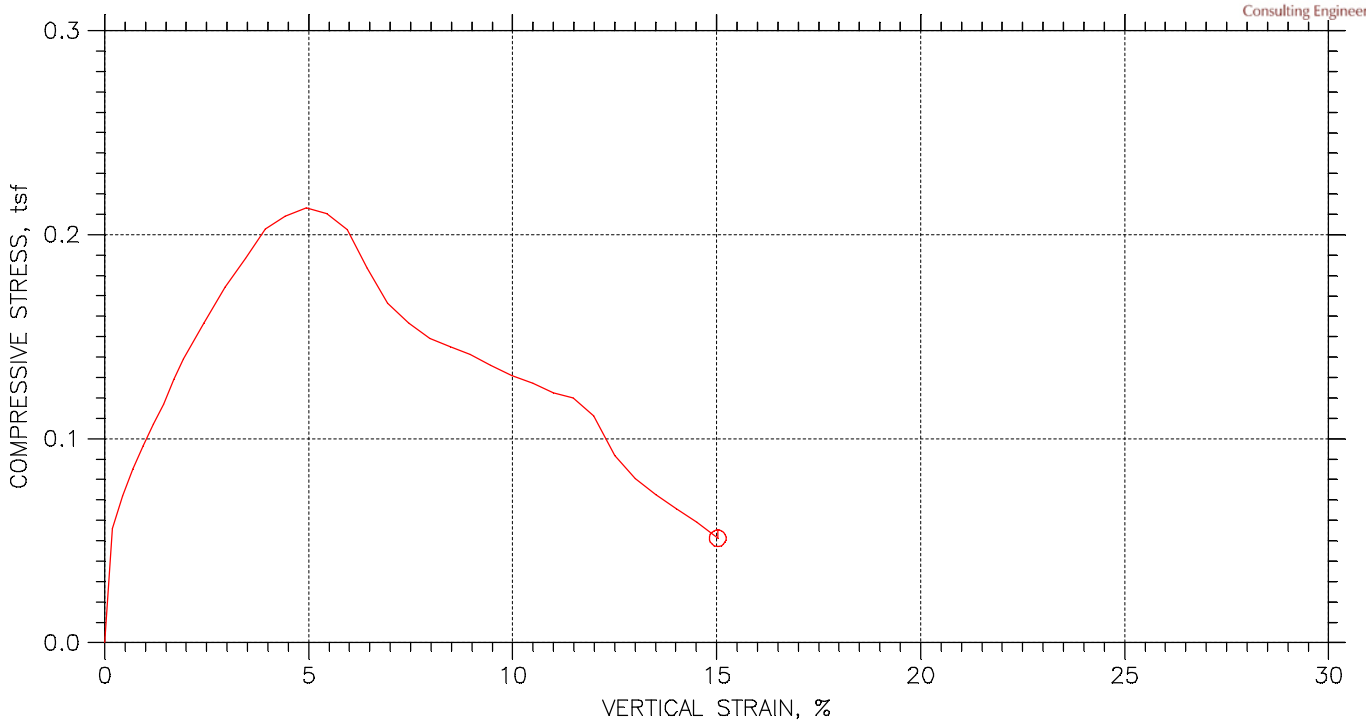

Symbol		⏲			
Test No.		HENB003S5			
Initial	Diameter, in	2.8394			
	Height, in	6.2583			
	Water Content, %	38.47			
	Dry Density, pcf	68.88			
	Saturation, %	72.73			
	Void Ratio	1.4017			
Unconfined Compressive Strength, tsf		0.21317			
Undrained Shear Strength, tsf		0.10659			
Time to Failure, min		5.0039			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.65			
Liquid Limit		---			
Plastic Limit		---			
Plasticity Index		---			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HENB003 S-5
Sample Type: 3.0" ST
Description: BLACK ORGANIC CLAY WITH SAND OL WOOD NOTED
Remarks: TEST PERFORMED AS PER ASTM D2166. 412

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HENB003 S-5
Sample No.: ST-5
Test No.: HENB003S5

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: -----

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Soil Description: BLACK ORGANIC CLAY WITH SAND OL WOOD NOTED
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.26 in
Specimen Area: 6.33 in^2
Specimen Volume: 39.63 in^3

Liquid Limit: ---
Plastic Limit: ---
Estimated Specific Gravity: 2.65

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.3319	0	0
2	0.25412	0.011992	0.19162	4.9302	6.3441	0.055954	0.027977
3	0.50387	0.027951	0.44662	6.3463	6.3603	0.071842	0.035921
4	0.75387	0.043725	0.69868	7.5527	6.3764	0.085281	0.042641
5	1.0039	0.059407	0.94926	8.5492	6.3926	0.09629	0.048145
6	1.2539	0.074812	1.1954	9.5457	6.4085	0.10725	0.053623
7	1.5039	0.090125	1.4401	10.437	6.4244	0.11697	0.058487
8	1.7539	0.10562	1.6877	11.539	6.4406	0.12899	0.064497
9	2.0039	0.12121	1.9368	12.483	6.457	0.13919	0.069597
10	2.5039	0.15258	2.438	14.109	6.4901	0.15652	0.07826
11	3.0039	0.1844	2.9465	15.787	6.5241	0.17423	0.087113
12	3.5039	0.21567	3.4462	17.151	6.5579	0.1883	0.094151
13	4.0039	0.24621	3.9341	18.567	6.5912	0.20282	0.10141
14	4.5039	0.27729	4.4309	19.249	6.6255	0.20918	0.10459
15	5.0039	0.30903	4.9379	19.721	6.6608	0.21317	0.10659
16	5.5039	0.34085	5.4464	19.564	6.6966	0.21034	0.10517
17	6.0039	0.37194	5.9432	18.934	6.732	0.2025	0.10125
18	6.5039	0.40284	6.437	17.256	6.7675	0.18358	0.091792
19	7.0039	0.4343	6.9396	15.735	6.8041	0.1665	0.083252
20	7.5039	0.46659	7.4555	14.896	6.842	0.15675	0.078375
21	8.0039	0.49887	7.9714	14.266	6.8804	0.14929	0.074645
22	8.5039	0.52987	8.4667	13.951	6.9176	0.14521	0.072605
23	9.0039	0.56068	8.959	13.637	6.955	0.14117	0.070586
24	9.5039	0.59223	9.4631	13.217	6.9937	0.13607	0.068035
25	10.004	0.62451	9.979	12.798	7.0338	0.131	0.0655
26	10.504	0.65661	10.492	12.483	7.0741	0.12705	0.063525
27	11.004	0.68779	10.99	12.116	7.1137	0.12263	0.061314
28	11.504	0.71879	11.485	11.906	7.1535	0.11983	0.059917
29	12.004	0.75034	11.99	11.119	7.1945	0.11128	0.055639
30	12.504	0.78244	12.502	9.231	7.2367	0.091843	0.045921
31	13.004	0.81417	13.01	8.1296	7.2788	0.080416	0.040208
32	13.504	0.84517	13.505	7.3953	7.3205	0.072736	0.036368
33	14.004	0.87635	14.003	6.7135	7.3629	0.065649	0.032825
34	14.504	0.90817	14.512	6.0841	7.4067	0.059143	0.029571
35	15.004	0.94037	15.026	5.2974	7.4516	0.051185	0.025593

UNCONFINED COMPRESSION TEST
ASTM D2166

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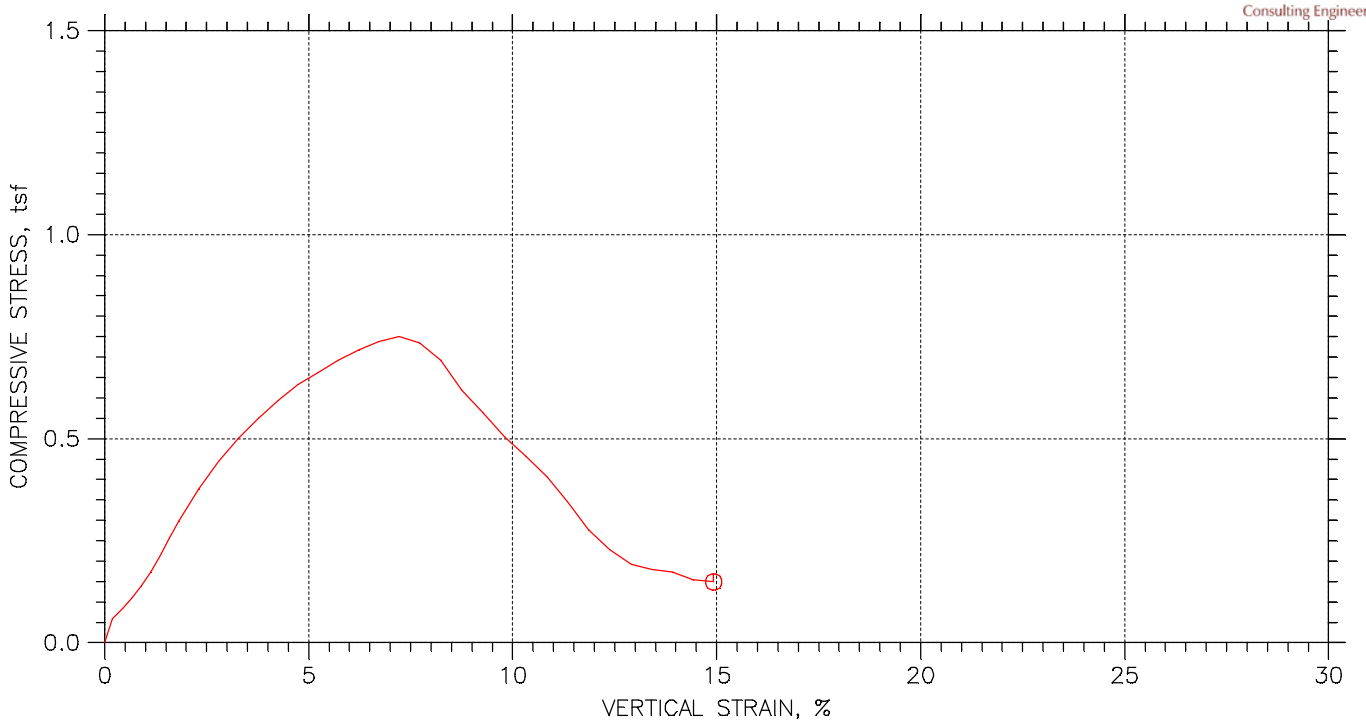

Symbol		⏲			
Test No.		HEN004S5			
Initial	Diameter, in	2.8673			
	Height, in	6.2728			
	Water Content, %	36.84			
	Dry Density, pcf	84.04			
	Saturation, %	98.19			
	Void Ratio	1.0205			
Unconfined Compressive Strength, tsf		0.75034			
Undrained Shear Strength, tsf		0.37517			
Time to Failure, min		7.5002			
Strain Rate, %/min		1.52			
Estimated Specific Gravity		2.72			
Liquid Limit		NP			
Plastic Limit		NP			
Plasticity Index		NP			
Failure Sketch					

Project: DYNERGY HENNEPIN,
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN-004 S5
Sample Type: 3" ST
Description: BROWN BLACK AND GRAY SANDY SILT WITH GRAVEL
Remarks: TEST PERFORMED AS PER ASTM D 2166. 414

Tue, 22-DEC-2015 15:34:58

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN,
Boring No.: HEN-004 S5
Sample No.: S-5
Test No.: HEN004S5

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/16/15
Sample Type: 3" ST

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: -----

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Soil Description: BROWN BLACK AND GRAY SANDY SILT WITH GRAVEL
Remarks: TEST PERFORMED AS PER ASTM D 2166.

Specimen Height: 6.27 in
Specimen Area: 6.46 in^2
Specimen Volume: 40.50 in^3

Liquid Limit: NP
Plastic Limit: NP
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.4572	0	0
2	0.25028	0.012177	0.19412	5.2238	6.4697	0.058134	0.029067
3	0.50028	0.027213	0.43382	7.5583	6.4853	0.083913	0.041956
4	0.75028	0.042065	0.67058	9.9187	6.5008	0.10986	0.054928
5	1.0003	0.05664	0.90294	12.595	6.516	0.13917	0.069586
6	1.2503	0.07103	1.1323	15.755	6.5311	0.17369	0.086843
7	1.5003	0.085328	1.3603	19.418	6.5462	0.21358	0.10679
8	1.7503	0.099811	1.5912	23.365	6.5616	0.25638	0.12819
9	2.0003	0.11439	1.8235	27.325	6.5771	0.29913	0.14956
10	2.5002	0.14446	2.3029	34.567	6.6094	0.37656	0.18828
11	3.0002	0.17527	2.7941	40.945	6.6428	0.4438	0.2219
12	3.5002	0.2059	3.2823	46.44	6.6763	0.50083	0.25041
13	4.0002	0.23634	3.7676	51.238	6.71	0.5498	0.2749
14	4.5002	0.26669	4.2514	55.585	6.7439	0.59344	0.29672
15	5.0002	0.29768	4.7456	59.525	6.7789	0.63223	0.31612
16	5.5002	0.32877	5.2411	62.756	6.8143	0.66308	0.33154
17	6.0002	0.35967	5.7338	65.903	6.8499	0.69271	0.34636
18	6.5002	0.39048	6.225	68.625	6.8858	0.71756	0.35878
19	7.0002	0.4212	6.7147	70.966	6.922	0.73816	0.36908
20	7.5002	0.45266	7.2161	72.527	6.9594	0.75034	0.37517
21	8.0002	0.48439	7.722	71.456	6.9975	0.73524	0.36762
22	8.5002	0.5164	8.2323	67.599	7.0364	0.69171	0.34585
23	9.0002	0.54878	8.7485	60.738	7.0762	0.618	0.309
24	9.5002	0.58153	9.2705	55.746	7.117	0.56396	0.28198
25	10	0.61492	9.8029	50.193	7.159	0.50481	0.25241
26	10.5	0.64785	10.328	45.66	7.2009	0.45654	0.22827
27	11	0.67986	10.838	40.855	7.2421	0.40618	0.20309
28	11.5	0.71141	11.341	34.915	7.2832	0.34517	0.17258
29	12	0.7437	11.856	28.086	7.3257	0.27604	0.13802
30	12.5	0.77681	12.384	23.378	7.3698	0.22839	0.1142
31	13	0.81021	12.916	19.773	7.4149	0.192	0.095999
32	13.5	0.84139	13.413	18.548	7.4575	0.17907	0.089536
33	14	0.87256	13.91	17.974	7.5005	0.17253	0.086267
34	14.5	0.9043	14.416	16.213	7.5449	0.15472	0.07736
35	15	0.93612	14.923	15.704	7.5898	0.14897	0.074485

UNCONFINED COMPRESSION TEST
ASTM D2166

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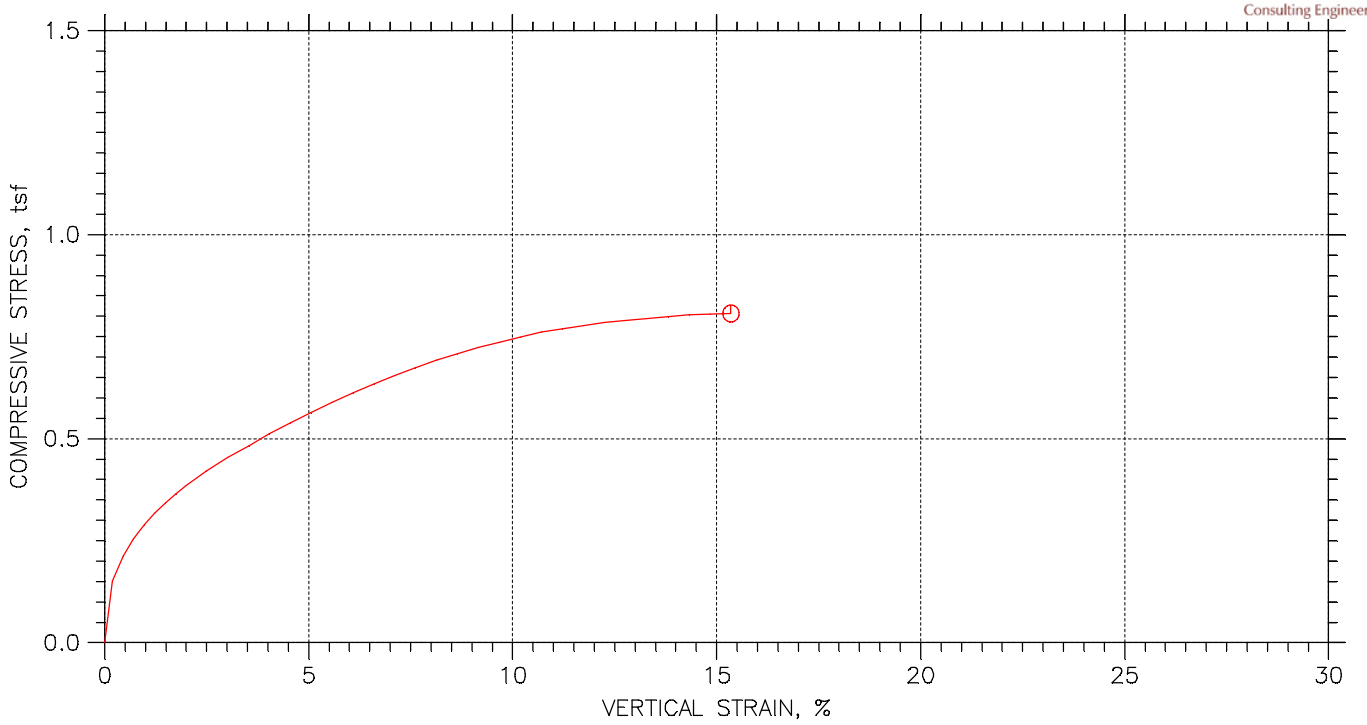

Symbol		⏲			
Test No.		HEN004S9			
Initial	Diameter, in	2.7551			
	Height, in	6.0059			
	Water Content, %	33.62			
	Dry Density, pcf	85.2			
	Saturation, %	92.10			
	Void Ratio	0.99292			
Unconfined Compressive Strength, tsf		0.80682			
Undrained Shear Strength, tsf		0.40341			
Time to Failure, min		15.004			
Strain Rate, %/min		1.14			
Estimated Specific Gravity		2.72			
Liquid Limit		43			
Plastic Limit		22			
Plasticity Index		21			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN004 S-9
Sample Type: 3.0" ST
Description: BROWN AND GRAY LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 14:31:30

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN004 S-9
Sample No.: ST-9
Test No.: HEN004S9

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

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Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.01 in
Specimen Area: 5.96 in^2
Specimen Volume: 35.81 in^3

Liquid Limit: 43
Plastic Limit: 22
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	5.9617	0	0
2	0.25398	0.01157	0.19265	12.53	5.9732	0.15103	0.075517
3	0.50398	0.027058	0.45052	17.637	5.9887	0.21204	0.10602
4	0.75398	0.04291	0.71446	21.269	6.0046	0.25504	0.12752
5	1.004	0.058397	0.97233	24.165	6.0202	0.289	0.1445
6	1.254	0.073885	1.2302	26.639	6.036	0.31777	0.15888
7	1.504	0.089281	1.4866	28.798	6.0517	0.34262	0.17131
8	1.754	0.10477	1.7444	30.746	6.0675	0.36484	0.18242
9	2.004	0.11989	1.9962	32.483	6.0831	0.38447	0.19224
10	2.504	0.15005	2.4983	35.695	6.1145	0.42032	0.21016
11	3.004	0.18093	3.0126	38.696	6.1469	0.45325	0.22663
12	3.504	0.21163	3.5238	41.433	6.1795	0.48276	0.24138
13	4.004	0.24252	4.038	44.118	6.2126	0.5113	0.25565
14	4.504	0.27322	4.5492	46.698	6.2458	0.53832	0.26916
15	5.004	0.30374	5.0573	49.172	6.2793	0.56382	0.28191
16	5.504	0.33453	5.57	51.647	6.3134	0.589	0.2945
17	6.004	0.36542	6.0843	53.963	6.3479	0.61207	0.30603
18	6.504	0.3963	6.5985	56.174	6.3829	0.63366	0.31683
19	7.004	0.42691	7.1082	58.333	6.4179	0.65441	0.32721
20	7.504	0.45734	7.6148	60.386	6.4531	0.67375	0.33688
21	8.004	0.48831	8.1306	62.334	6.4893	0.69161	0.3458
22	8.504	0.51938	8.6478	64.124	6.5261	0.70746	0.35373
23	9.004	0.55045	9.1651	65.914	6.5632	0.72309	0.36155
24	9.504	0.58088	9.6717	67.546	6.6	0.73686	0.36843
25	10.004	0.6114	10.18	69.02	6.6374	0.74871	0.37435
26	10.504	0.64246	10.697	70.547	6.6758	0.76086	0.38043
27	11.004	0.67362	11.216	71.758	6.7148	0.76943	0.38471
28	11.504	0.70478	11.735	72.969	6.7543	0.77784	0.38892
29	12.004	0.73557	12.247	74.022	6.7938	0.78448	0.39224
30	12.504	0.76636	12.76	74.917	6.8337	0.78932	0.39466
31	13.004	0.79761	13.28	75.917	6.8747	0.79509	0.39755
32	13.504	0.82886	13.801	76.707	6.9162	0.79854	0.39927
33	14.004	0.86002	14.32	77.602	6.9581	0.803	0.4015
34	14.504	0.8909	14.834	78.339	7.0001	0.80576	0.40288
35	15.004	0.92178	15.348	78.918	7.0426	0.80682	0.40341

UNCONFINED COMPRESSION TEST
ASTM D2166

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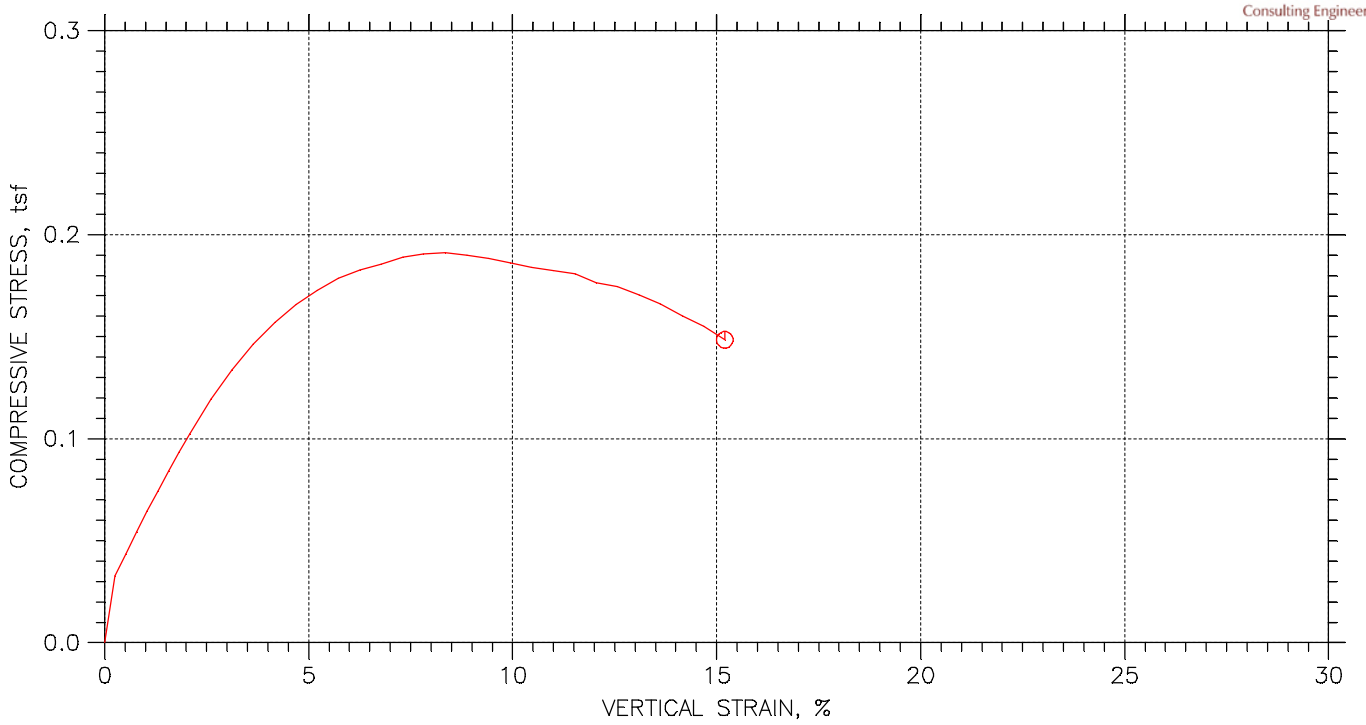

Symbol		⏲			
Test No.		HENB005S2			
Initial	Diameter, in	2.8366			
	Height, in	6.0217			
	Water Content, %	59.63			
	Dry Density, pcf	60.38			
	Saturation, %	91.85			
	Void Ratio	1.688			
Unconfined Compressive Strength, tsf		0.19114			
Undrained Shear Strength, tsf		0.095571			
Time to Failure, min		8.0034			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.60			
Liquid Limit		---			
Plastic Limit		---			
Plasticity Index		---			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HENB005 S-2
Sample Type: 3.0" ST
Description: BLACK TO VERY DARK GRAY ORGANIC CLAY OL
Remarks: TEST PERFORMED AS PER ASTM D2166. 418

Tue, 22-DEC-2015 14:34:51

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HENB005 S-2
Sample No.: ST-2
Test No.: HENB005S2

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 7.5'-9.5'
Elevation: -----

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Soil Description: BLACK TO VERY DARK GRAY ORGANIC CLAY OL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.02 in
Specimen Area: 6.32 in^2
Specimen Volume: 38.05 in^3

Liquid Limit: ---
Plastic Limit: ---
Estimated Specific Gravity: 2.60

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.3196	0	0
2	0.25025	0.015497	0.25736	2.8847	6.3359	0.032781	0.016391
3	0.50417	0.031272	0.51932	3.8288	6.3526	0.043395	0.021698
4	0.75417	0.046861	0.77822	4.8253	6.3692	0.054548	0.027274
5	1	0.062267	1.034	5.717	6.3856	0.06446	0.03223
6	1.2539	0.078318	1.3006	6.6086	6.4029	0.074313	0.037157
7	1.5037	0.094092	1.5626	7.5002	6.4199	0.084116	0.042058
8	1.7534	0.10977	1.823	8.3394	6.437	0.09328	0.04664
9	2.0034	0.12555	2.0849	9.1786	6.4542	0.10239	0.051196
10	2.5034	0.15673	2.6027	10.752	6.4885	0.11931	0.059656
11	3.0034	0.18791	3.1205	12.116	6.5232	0.13373	0.066864
12	3.5034	0.21946	3.6444	13.322	6.5586	0.14625	0.073124
13	4.0034	0.25119	4.1714	14.371	6.5947	0.1569	0.078451
14	4.5034	0.28264	4.6938	15.263	6.6309	0.16573	0.082864
15	5.0034	0.31373	5.2101	15.997	6.667	0.17276	0.08638
16	5.5034	0.3451	5.7309	16.626	6.7038	0.17857	0.089285
17	6.0034	0.37674	6.2564	17.098	6.7414	0.18262	0.091308
18	6.5034	0.40847	6.7833	17.466	6.7795	0.18549	0.092744
19	7.0034	0.43983	7.3042	17.885	6.8176	0.18888	0.094442
20	7.5034	0.47092	7.8205	18.147	6.8558	0.19059	0.095293
21	8.0034	0.50256	8.3459	18.305	6.8951	0.19114	0.095571
22	8.5034	0.53494	8.8836	18.305	6.9358	0.19002	0.095011
23	9.0034	0.56713	9.4183	18.252	6.9767	0.18836	0.094182
24	9.5034	0.59878	9.9437	18.147	7.0174	0.1862	0.093098
25	10.003	0.63023	10.466	18.042	7.0583	0.18405	0.092023
26	10.503	0.66187	10.992	17.99	7.1	0.18243	0.091217
27	11.003	0.69416	11.528	17.938	7.143	0.18081	0.090403
28	11.503	0.7258	12.053	17.623	7.1857	0.17658	0.08829
29	12.003	0.75707	12.572	17.518	7.2284	0.17449	0.087246
30	12.503	0.78853	13.095	17.203	7.2719	0.17033	0.085167
31	13.003	0.82035	13.623	16.889	7.3163	0.1662	0.0831
32	13.503	0.85255	14.158	16.364	7.3619	0.16004	0.080021
33	14.003	0.8841	14.682	15.945	7.4071	0.15499	0.077493
34	14.503	0.91518	15.198	15.368	7.4522	0.14847	0.074237

UNCONFINED COMPRESSION TEST
ASTM D2166

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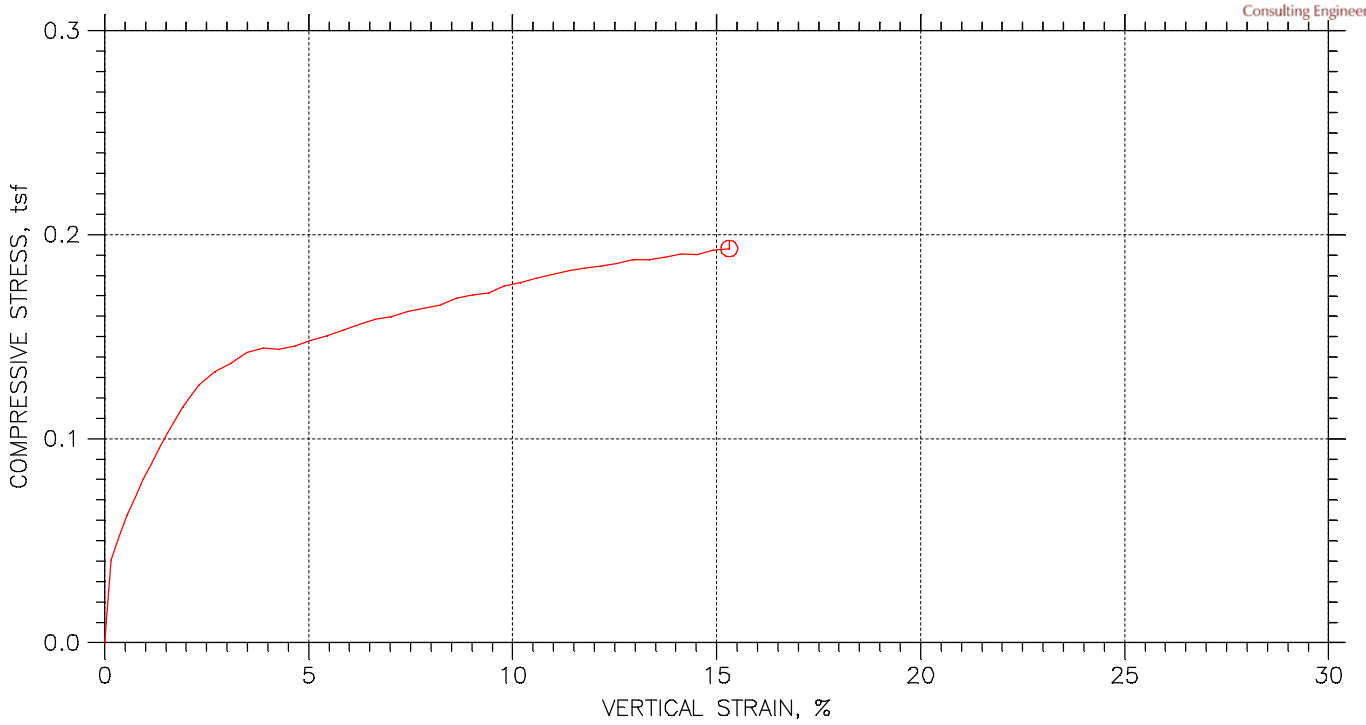

Symbol		⏲			
Test No.		HENB012S7			
Initial	Diameter, in	2.8343			
	Height, in	6.0142			
	Water Content, %	38.30			
	Dry Density, pcf	73.56			
	Saturation, %	79.62			
	Void Ratio	1.3083			
Unconfined Compressive Strength, tsf		0.19314			
Undrained Shear Strength, tsf		0.09657			
Time to Failure, min		19.5			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		---			
Plastic Limit		---			
Plasticity Index		---			
Failure Sketch					

Project: DYNERGY HENNEPIN

Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HENB012 S-7

Sample Type: 3.0" ST

Description: VERY DARK GRAY LEAN CLAY CL ORGANICS NOTED

Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 14:45:08

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HENB012 S-7
Sample No.: S-7
Test No.: HENB012S7

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 20.0'-22.0'
Elevation: -----

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Soil Description: VERY DARK GRAY LEAN CLAY CL ORGANICS NOTED
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.01 in
Specimen Area: 6.31 in^2
Specimen Volume: 37.94 in^3

Liquid Limit: ---
Plastic Limit: ---
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.3091	0	0
2	0.25005	0.0095937	0.15952	3.5665	6.3192	0.040637	0.020318
3	0.50007	0.021309	0.35431	4.6155	6.3315	0.052486	0.026243
4	0.75007	0.033117	0.55064	5.5072	6.344	0.062502	0.031251
5	1.0001	0.045017	0.74851	6.2939	6.3567	0.071289	0.035644
6	1.2501	0.056824	0.94484	7.0806	6.3693	0.080041	0.040021
7	1.5001	0.068724	1.1427	7.7625	6.382	0.087574	0.043787
8	1.7501	0.080532	1.339	8.4443	6.3947	0.095077	0.047538
9	2.0001	0.092247	1.5338	9.1261	6.4074	0.10255	0.051276
10	2.5001	0.1154	1.9188	10.332	6.4325	0.11565	0.057826
11	3.0001	0.13865	2.3053	11.329	6.458	0.12631	0.063154
12	3.5001	0.16208	2.6949	11.958	6.4838	0.13279	0.066396
13	4.0001	0.18579	3.0891	12.378	6.5102	0.1369	0.068448
14	4.5001	0.20977	3.4879	12.902	6.5371	0.14211	0.071054
15	5.0001	0.23366	3.8852	13.165	6.5641	0.1444	0.0722
16	5.5001	0.257	4.2732	13.165	6.5907	0.14382	0.071909
17	6.0001	0.28025	4.6598	13.375	6.6174	0.14552	0.07276
18	6.5001	0.30377	5.0509	13.689	6.6447	0.14833	0.074166
19	7.0001	0.32748	5.4451	13.951	6.6724	0.15055	0.075273
20	7.5001	0.35165	5.8469	14.266	6.7009	0.15329	0.076644
21	8.0001	0.37591	6.2503	14.581	6.7297	0.156	0.077999
22	8.5001	0.39952	6.643	14.896	6.758	0.1587	0.079349
23	9.0001	0.42277	7.0295	15.053	6.7861	0.15971	0.079855
24	9.5001	0.44611	7.4176	15.368	6.8146	0.16237	0.081184
25	10	0.46991	7.8133	15.577	6.8438	0.16388	0.08194
26	10.5	0.49417	8.2167	15.787	6.8739	0.16536	0.082681
27	11	0.51861	8.6232	16.207	6.9045	0.169	0.084502
28	11.5	0.54278	9.025	16.417	6.935	0.17044	0.08522
29	12	0.56594	9.41	16.574	6.9644	0.17134	0.085672
30	12.5	0.589	9.7935	16.994	6.9941	0.17494	0.08747
31	13	0.61252	10.185	17.203	7.0245	0.17633	0.088165
32	13.5	0.63632	10.58	17.518	7.0556	0.17877	0.089383
33	14	0.66058	10.984	17.78	7.0876	0.18062	0.090311
34	14.5	0.68466	11.384	18.042	7.1196	0.18246	0.091231
35	15	0.70827	11.777	18.252	7.1513	0.18377	0.091883
36	15.5	0.73133	12.16	18.41	7.1825	0.18455	0.092273
37	16	0.75467	12.548	18.619	7.2144	0.18582	0.092912
38	16.5	0.77847	12.944	18.882	7.2472	0.18759	0.093794
39	17	0.80264	13.346	18.987	7.2808	0.18776	0.09388
40	17.5	0.82681	13.748	19.196	7.3147	0.18895	0.094477
41	18	0.85043	14.14	19.459	7.3481	0.19066	0.095332
42	18.5	0.87367	14.527	19.511	7.3814	0.19032	0.095158
43	19	0.89701	14.915	19.826	7.415	0.19251	0.096254
44	19.5	0.92063	15.308	19.983	7.4494	0.19314	0.09657

UNCONFINED COMPRESSION TEST
ASTM D2166

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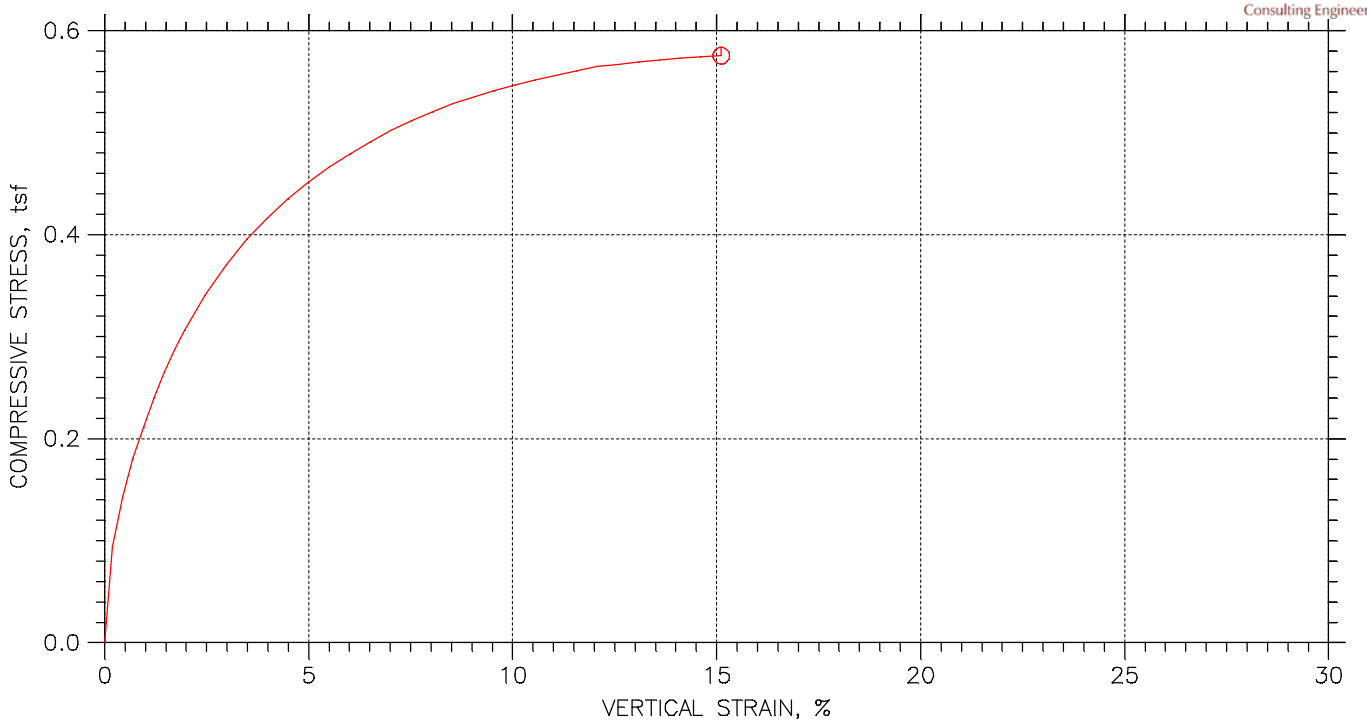

Symbol		⏲			
Test No.		HEN014S8			
Initial	Diameter, in	2.8339			
	Height, in	6.0764			
	Water Content, %	32.54			
	Dry Density, pcf	89.48			
	Saturation, %	98.61			
	Void Ratio	0.89757			
Unconfined Compressive Strength, tsf		0.57547			
Undrained Shear Strength, tsf		0.28774			
Time to Failure, min		15			
Strain Rate, %/min		1.14			
Estimated Specific Gravity		2.72			
Liquid Limit		43			
Plastic Limit		20			
Plasticity Index		23			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN014 S-8
Sample Type: 3.0" ST
Description: BROWN AND GRAY LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 14:47:46

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN014 S-8
Sample No.: ST-8
Test No.: HEN014S8

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

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Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.08 in
Specimen Area: 6.31 in^2
Specimen Volume: 38.33 in^3

Liquid Limit: 43
Plastic Limit: 20
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.3073	0	0
2	0.25018	0.011388	0.18741	8.2129	6.3192	0.093577	0.046789
3	0.50018	0.026876	0.44229	12.53	6.3354	0.1424	0.0712
4	0.75018	0.042363	0.69718	15.952	6.3516	0.18083	0.090414
5	1.0002	0.057942	0.95356	18.742	6.3681	0.21191	0.10595
6	1.2502	0.073429	1.2084	21.269	6.3845	0.23986	0.11993
7	1.5002	0.088644	1.4588	23.533	6.4007	0.26472	0.13236
8	1.7502	0.10395	1.7107	25.586	6.4171	0.28708	0.14354
9	2.0002	0.11925	1.9626	27.376	6.4336	0.30638	0.15319
10	2.5002	0.15014	2.4709	30.641	6.4671	0.34113	0.17056
11	3.0002	0.18102	2.9791	33.431	6.501	0.37025	0.18513
12	3.5002	0.21209	3.4904	35.905	6.5355	0.39556	0.19778
13	4.0002	0.24243	3.9897	37.958	6.5694	0.41602	0.20801
14	4.5002	0.27285	4.4904	39.906	6.6039	0.43509	0.21754
15	5.0002	0.30347	4.9942	41.644	6.6389	0.45163	0.22582
16	5.5002	0.33417	5.4995	43.223	6.6744	0.46627	0.23314
17	6.0002	0.36487	6.0047	44.645	6.7103	0.47903	0.23951
18	6.5002	0.39566	6.5115	46.013	6.7466	0.49105	0.24553
19	7.0002	0.42627	7.0152	47.33	6.7832	0.50238	0.25119
20	7.5002	0.45707	7.522	48.435	6.8204	0.51131	0.25566
21	8.0002	0.48786	8.0288	49.541	6.8579	0.52012	0.26006
22	8.5002	0.51865	8.5355	50.594	6.8959	0.52825	0.26412
23	9.0002	0.54935	9.0408	51.489	6.9343	0.53462	0.26731
24	9.5002	0.57969	9.5401	52.384	6.9725	0.54093	0.27046
25	10	0.61058	10.048	53.226	7.0119	0.54654	0.27327
26	10.5	0.64128	10.554	54.068	7.0515	0.55207	0.27603
27	11	0.67189	11.057	54.806	7.0915	0.55644	0.27822
28	11.5	0.7025	11.561	55.543	7.1319	0.56073	0.28037
29	12	0.73311	12.065	56.28	7.1727	0.56494	0.28247
30	12.5	0.76408	12.575	56.806	7.2145	0.56692	0.28346
31	13	0.79506	13.084	57.385	7.2569	0.56936	0.28468
32	13.5	0.82603	13.594	57.912	7.2997	0.57121	0.2856
33	14	0.85665	14.098	58.438	7.3425	0.57304	0.28652
34	14.5	0.88717	14.6	58.912	7.3857	0.57431	0.28716
35	15	0.91814	15.11	59.386	7.43	0.57547	0.28774

UNCONFINED COMPRESSION TEST
ASTM D2166

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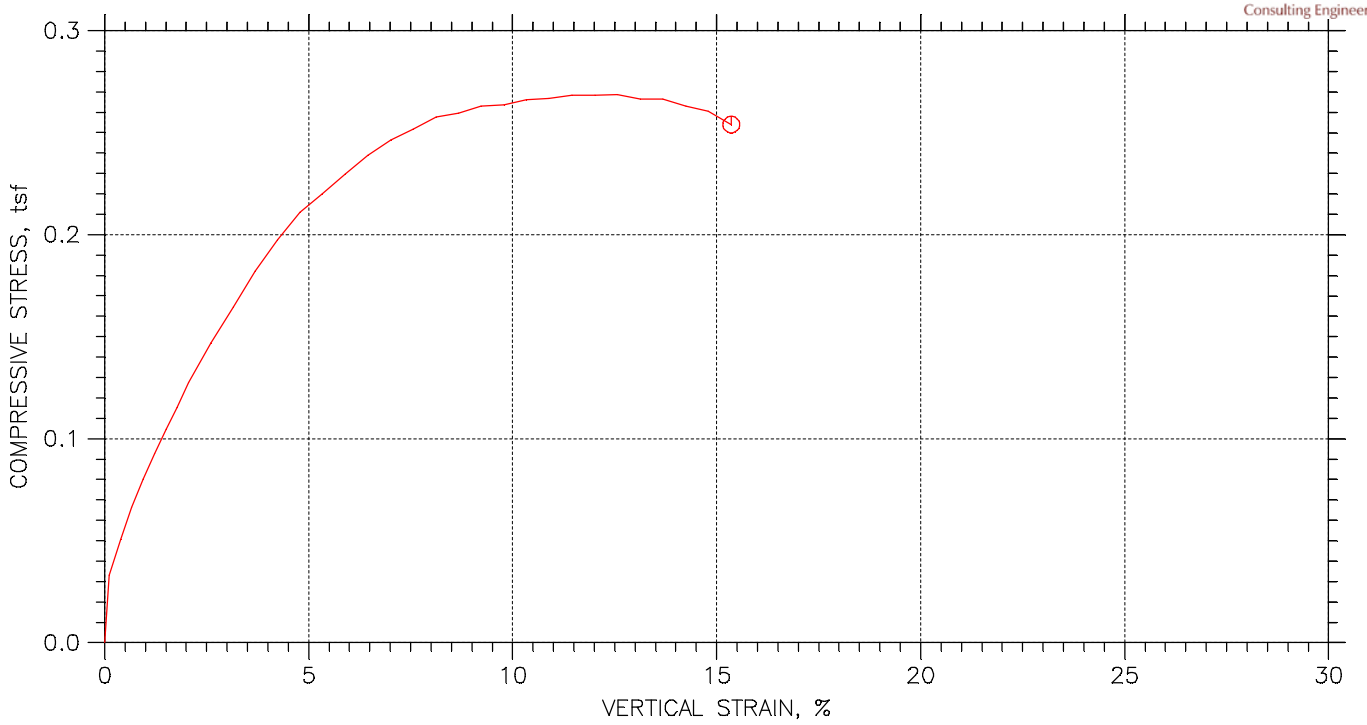

Symbol		⏲			
Test No.		HENB015S4			
Initial	Diameter, in	2.7992			
	Height, in	5.6701			
	Water Content, %	131.90			
	Dry Density, pcf	50.83			
	Saturation, %	155.02			
	Void Ratio	2.2547			
Unconfined Compressive Strength, tsf		0.26878			
Undrained Shear Strength, tsf		0.13439			
Time to Failure, min		11.5			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.65			
Liquid Limit		48			
Plastic Limit		25			
Plasticity Index		23			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HENB015 S-4
Sample Type: 3.0" ST
Description: BLACK AND DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL OL
Remarks: TEST PERFORMED AS PER ASTM D2166. 424

Tue, 22-DEC-2015 14:50:01

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HENB015 S-4
Sample No.: ST-4
Test No.: HENB015S4

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 7.5'-9.5'
Elevation: -----

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Soil Description: BLACK AND DARK GRAY ORGANIC CLAY WITH SAND AND GRAVEL OL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 5.67 in
Specimen Area: 6.15 in^2
Specimen Volume: 34.89 in^3

Liquid Limit: 48
Plastic Limit: 25
Estimated Specific Gravity: 2.65

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.1541	0	0
2	0.25005	0.006365	0.11226	2.8323	6.161	0.033099	0.016549
3	0.50005	0.022047	0.38883	4.3533	6.1781	0.050734	0.025367
4	0.75005	0.037821	0.66703	5.717	6.1954	0.06644	0.03322
5	1.0001	0.053503	0.94361	6.9233	6.2127	0.080235	0.040118
6	1.2501	0.069278	1.2218	8.0247	6.2302	0.092739	0.046369
7	1.5001	0.085144	1.5016	9.0737	6.2479	0.10456	0.052282
8	1.7501	0.10073	1.7766	10.018	6.2654	0.11512	0.057561
9	2.0001	0.11623	2.0499	11.119	6.2829	0.12742	0.063712
10	2.5001	0.14741	2.5998	12.902	6.3183	0.14703	0.073515
11	3.0001	0.17841	3.1464	14.528	6.354	0.16463	0.082314
12	3.5001	0.20912	3.6882	16.154	6.3897	0.18203	0.091014
13	4.0001	0.2404	4.2397	17.623	6.4265	0.19744	0.09872
14	4.5001	0.27158	4.7896	18.934	6.4636	0.21091	0.10546
15	5.0001	0.30285	5.3411	19.878	6.5013	0.22015	0.11007
16	5.5001	0.3343	5.8959	20.875	6.5396	0.22983	0.11491
17	6.0001	0.36567	6.4491	21.819	6.5783	0.23881	0.1194
18	6.5001	0.39722	7.0055	22.658	6.6177	0.24652	0.12326
19	7.0001	0.42886	7.5635	23.287	6.6576	0.25185	0.12592
20	7.5001	0.4604	8.1199	23.969	6.6979	0.25766	0.12883
21	8.0001	0.49186	8.6747	24.284	6.7386	0.25947	0.12973
22	8.5001	0.52323	9.2278	24.756	6.7797	0.26291	0.13145
23	9.0001	0.55468	9.7826	24.966	6.8214	0.26352	0.13176
24	9.5001	0.58605	10.336	25.385	6.8634	0.2663	0.13315
25	10	0.61769	10.894	25.595	6.9064	0.26683	0.13342
26	10.5	0.64942	11.453	25.91	6.9501	0.26842	0.13421
27	11	0.68124	12.015	26.067	6.9944	0.26833	0.13417
28	11.5	0.71279	12.571	26.277	7.0389	0.26878	0.13439
29	12	0.74416	13.124	26.225	7.0837	0.26655	0.13327
30	12.5	0.7758	13.682	26.382	7.1295	0.26643	0.13321
31	13	0.80744	14.24	26.225	7.1759	0.26312	0.13156
32	13.5	0.83917	14.8	26.12	7.2231	0.26036	0.13018
33	14	0.87081	15.358	25.648	7.2707	0.25398	0.12699

UNCONFINED COMPRESSION TEST
ASTM D2166

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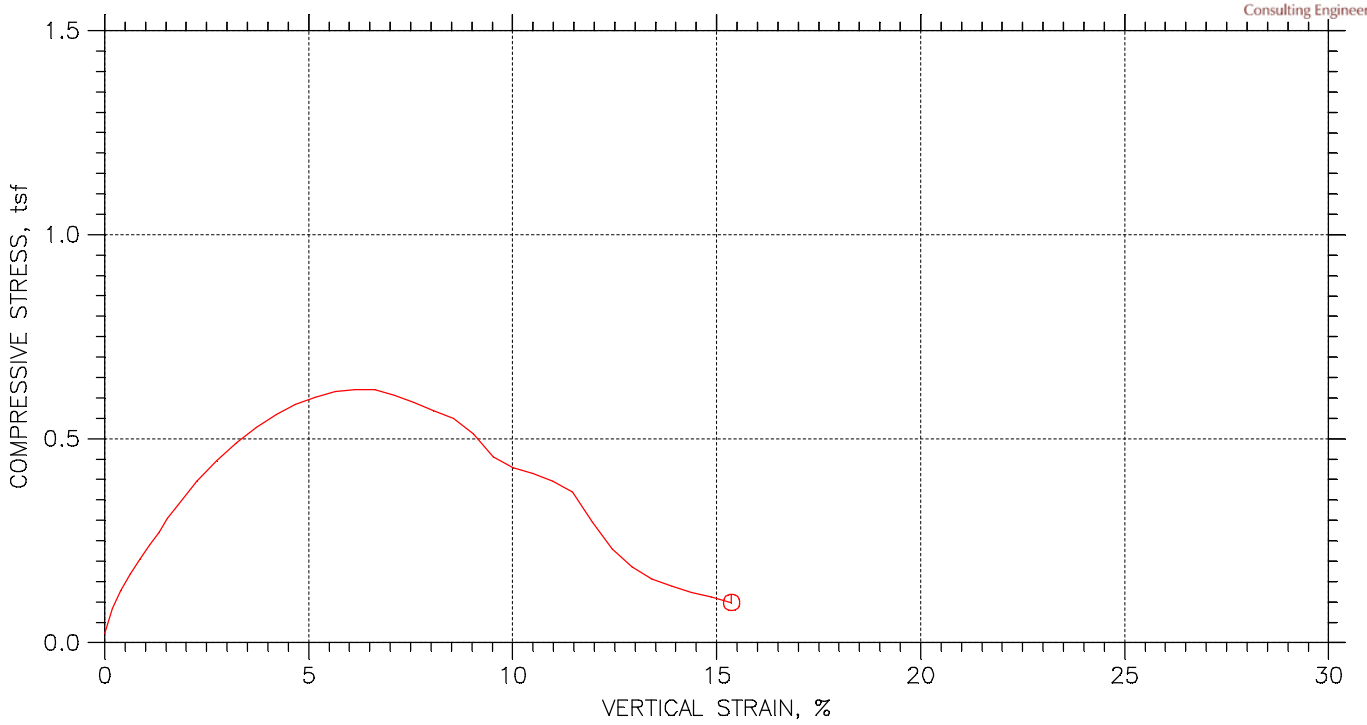

Symbol		⏲			
Test No.		HEN015S8			
Initial	Diameter, in	2.8402			
	Height, in	6.0898			
	Water Content, %	148.86			
	Dry Density, pcf	39.26			
	Saturation, %	121.79			
	Void Ratio	3.3248			
Unconfined Compressive Strength, tsf		0.62021			
Undrained Shear Strength, tsf		0.31011			
Time to Failure, min		7.0003			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		74			
Plastic Limit		37			
Plasticity Index		37			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN015 S8
Sample Type: 3.0" ST
Description: BLACK ORGANIC SILT WITH SAND OH
Remarks: TEST PERFORMED AS PER ASTM D2166. 426

Tue, 22-DEC-2015 14:52:19

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN015 S8
Sample No.: S-8
Test No.: HEN015S8

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

Soil Description: BLACK ORGANIC SILT WITH SAND OH
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.09 in
Specimen Area: 6.34 in^2
Specimen Volume: 38.58 in^3

Liquid Limit: 74
Plastic Limit: 37
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	1.9586	6.3354	0.022259	0.01113
2	0.25022	0.011144	0.18299	7.358	6.347	0.083469	0.041734
3	0.50022	0.024023	0.39448	11.328	6.3605	0.12823	0.064117
4	0.75023	0.037907	0.62247	14.928	6.3751	0.16859	0.084297
5	1.0002	0.052156	0.85646	18.21	6.3901	0.20518	0.10259
6	1.2502	0.06668	1.0949	21.227	6.4055	0.2386	0.1193
7	1.5002	0.081021	1.3304	24.139	6.4208	0.27068	0.13534
8	1.7502	0.093991	1.5434	27.262	6.4347	0.30504	0.15252
9	2.0002	0.1087	1.7849	30.173	6.4505	0.33679	0.16839
10	2.5002	0.13793	2.2649	35.679	6.4822	0.39629	0.19815
11	3.0002	0.16725	2.7464	40.337	6.5143	0.44583	0.22291
12	3.5002	0.19684	3.2324	44.625	6.547	0.49075	0.24538
13	4.0002	0.22625	3.7153	48.224	6.5799	0.52769	0.26385
14	4.5002	0.25585	4.2013	51.295	6.6133	0.55846	0.27923
15	5.0002	0.28517	4.6828	53.941	6.6467	0.58432	0.29216
16	5.5002	0.31467	5.1673	55.847	6.6806	0.60189	0.30094
17	6.0002	0.34409	5.6502	57.329	6.7148	0.61472	0.30736
18	6.5003	0.37359	6.1347	58.123	6.7495	0.62003	0.31002
19	7.0003	0.403	6.6177	58.441	6.7844	0.62021	0.31011
20	7.5003	0.43241	7.1007	57.382	6.8197	0.60583	0.30291
21	8.0003	0.46183	7.5836	56.112	6.8553	0.58933	0.29467
22	8.5003	0.49115	8.0651	54.471	6.8912	0.56912	0.28456
23	9.0003	0.52065	8.5496	52.883	6.9277	0.54961	0.27481
24	9.5003	0.55025	9.0356	49.548	6.9647	0.51222	0.25611
25	10	0.57993	9.5231	44.36	7.0022	0.45613	0.22806
26	10.5	0.60953	10.009	41.925	7.0401	0.42878	0.21439
27	11	0.63885	10.491	40.707	7.0779	0.4141	0.20705
28	11.5	0.66863	10.979	39.066	7.1168	0.39523	0.19762
29	12	0.69804	11.462	36.631	7.1556	0.36859	0.18429
30	12.5	0.72763	11.948	29.538	7.1951	0.29558	0.14779
31	13	0.75741	12.437	23.08	7.2353	0.22967	0.11484
32	13.5	0.78728	12.928	18.686	7.2761	0.18491	0.092455
33	14	0.81706	13.417	15.828	7.3171	0.15574	0.077872
34	14.5	0.84656	13.901	14.134	7.3583	0.1383	0.069149
35	15	0.87634	14.39	12.705	7.4003	0.12361	0.061803
36	15.5	0.90602	14.878	11.646	7.4427	0.11266	0.05633
37	16	0.93562	15.364	10.217	7.4855	0.09827	0.049135

UNCONFINED COMPRESSION TEST
ASTM D2166

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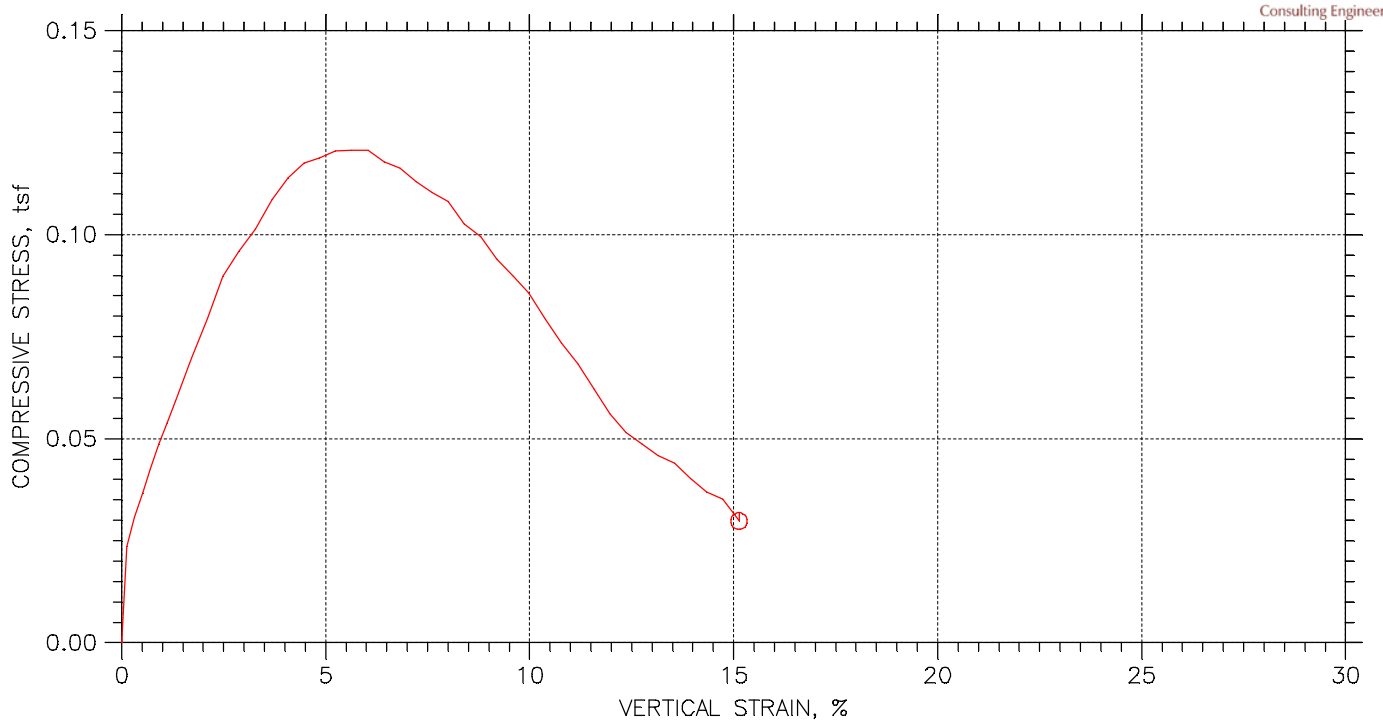

Symbol		⏲			
Test No.		HENB017S3			
Initial	Diameter, in	2.8169			
	Height, in	5.9768			
	Water Content, %	36.89			
	Dry Density, pcf	81.7			
	Saturation, %	93.06			
	Void Ratio	1.0783			
Unconfined Compressive Strength, tsf		0.1207			
Undrained Shear Strength, tsf		0.060351			
Time to Failure, min		8.004			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		39			
Plastic Limit		21			
Plasticity Index		18			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HENB017 S-3
Sample Type: 3.0" ST
Description: VERY DARK GRAY LEAN CLAY WITH SAND
Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 14:55:26

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HENB017 S-3
Sample No.: ST-3
Test No.: HENB017S3

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: -----

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Soil Description: VERY DARK GRAY LEAN CLAY WITH SAND
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 5.98 in
Specimen Area: 6.23 in^2
Specimen Volume: 37.25 in^3

Liquid Limit: 39
Plastic Limit: 21
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.2322	0	0
2	0.50395	0.0072875	0.12193	2.0455	6.2398	0.023603	0.011801
3	0.75395	0.019095	0.31949	2.6749	6.2522	0.030804	0.015402
4	1.004	0.030903	0.51705	3.1994	6.2646	0.036771	0.018386
5	1.254	0.04271	0.71461	3.7239	6.2771	0.042714	0.021357
6	1.504	0.054702	0.91525	4.2484	6.2898	0.048632	0.024316
7	1.754	0.066695	1.1159	4.7204	6.3025	0.053926	0.026963
8	2.004	0.078687	1.3165	5.1925	6.3153	0.059198	0.029599
9	2.504	0.10221	1.7101	6.1365	6.3406	0.069682	0.034841
10	3.004	0.12546	2.0991	7.0282	6.3658	0.079491	0.039746
11	3.504	0.14861	2.4865	7.9723	6.3911	0.089813	0.044906
12	4.004	0.17204	2.8785	8.5492	6.4169	0.095925	0.047963
13	4.504	0.19584	3.2767	9.0737	6.4433	0.10139	0.050696
14	5.004	0.22001	3.6811	9.7555	6.4704	0.10856	0.054278
15	5.504	0.24399	4.0824	10.28	6.4975	0.11392	0.056958
16	6.004	0.26724	4.4713	10.647	6.5239	0.11751	0.058753
17	6.504	0.29021	4.8556	10.805	6.5503	0.11876	0.059381
18	7.004	0.31336	5.243	11.014	6.577	0.12058	0.060288
19	7.504	0.33689	5.6366	11.067	6.6045	0.12065	0.060323
20	8.004	0.36087	6.0379	11.119	6.6327	0.1207	0.060351
21	8.504	0.38476	6.4376	10.909	6.661	0.11792	0.058961
22	9.004	0.40819	6.8297	10.805	6.689	0.1163	0.058149
23	9.504	0.43135	7.2171	10.542	6.717	0.113	0.056502
24	10.004	0.45459	7.606	10.332	6.7452	0.11029	0.055145
25	10.504	0.47802	7.998	10.175	6.774	0.10815	0.054075
26	11.004	0.50192	8.3978	9.7031	6.8036	0.10268	0.051342
27	11.504	0.5259	8.7991	9.4408	6.8335	0.099472	0.049736
28	12.004	0.54979	9.1988	8.9688	6.8636	0.094084	0.047042
29	12.504	0.57341	9.5939	8.6017	6.8936	0.08984	0.04492
30	13.004	0.59675	9.9844	8.2345	6.9235	0.085634	0.042817
31	13.504	0.62036	10.38	7.6576	6.954	0.079285	0.039642
32	14.004	0.64416	10.778	7.1331	6.985	0.073526	0.036763
33	14.504	0.66805	11.177	6.661	7.0165	0.068353	0.034176
34	15.004	0.69194	11.577	6.0841	7.0482	0.062151	0.031076
35	15.504	0.71547	11.971	5.5072	7.0797	0.056007	0.028004
36	16.004	0.73871	12.36	5.0876	7.1111	0.051511	0.025756
37	16.504	0.76224	12.753	4.8253	7.1432	0.048637	0.024318
38	17.004	0.78594	13.15	4.5631	7.1758	0.045784	0.022892
39	17.504	0.80984	13.55	4.4057	7.209	0.044002	0.022001
40	18.004	0.83373	13.949	4.0386	7.2425	0.040149	0.020074
41	18.504	0.85734	14.345	3.7239	7.2759	0.03685	0.018425
42	19.004	0.88077	14.737	3.5665	7.3094	0.035132	0.017566
43	19.504	0.90448	15.133	3.042	7.3435	0.029826	0.014913

UNCONFINED COMPRESSION TEST
ASTM D2166

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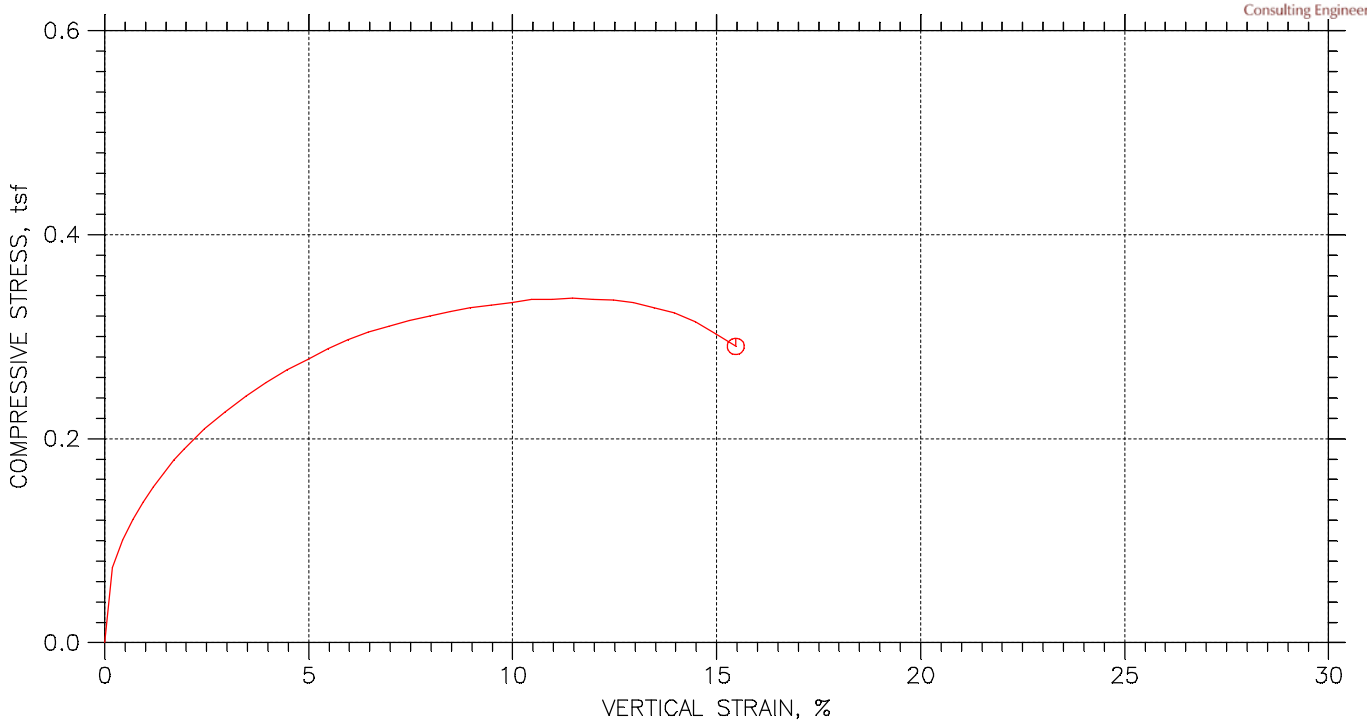

Symbol		⏲			
Test No.		HEN017S6			
Initial	Diameter, in	2.7764			
	Height, in	6.1713			
	Water Content, %	34.15			
	Dry Density, pcf	88.			
	Saturation, %	99.92			
	Void Ratio	0.9296			
Unconfined Compressive Strength, tsf		0.33759			
Undrained Shear Strength, tsf		0.16879			
Time to Failure, min		11.504			
Strain Rate, %/min		1.14			
Estimated Specific Gravity		2.72			
Liquid Limit		45			
Plastic Limit		24			
Plasticity Index		21			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN017 S-6
Sample Type: 3.0" ST
Description: BROWN AND GRAY LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 14:58:59

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN017 S-6
Sample No.: ST-6
Test No.: HEN017S6

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 15.0'-17.0'
Elevation: ----

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Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.17 in
Specimen Area: 6.05 in^2
Specimen Volume: 37.36 in^3

Liquid Limit: 45
Plastic Limit: 24
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.0541	0	0
2	0.25403	0.011661	0.18896	6.2123	6.0655	0.073743	0.036871
3	0.50403	0.02724	0.4414	8.4762	6.0809	0.10036	0.05018
4	0.75403	0.042636	0.69089	10.214	6.0962	0.12063	0.060314
5	1.004	0.057942	0.9389	11.688	6.1114	0.13769	0.068847
6	1.254	0.073429	1.1899	13.004	6.127	0.15281	0.076406
7	1.504	0.088735	1.4379	14.162	6.1424	0.16601	0.083003
8	1.754	0.10431	1.6903	15.32	6.1582	0.17912	0.089561
9	2.004	0.11998	1.9442	16.268	6.1741	0.18971	0.094855
10	2.504	0.15123	2.4506	18.058	6.2062	0.2095	0.10475
11	3.004	0.18248	2.9569	19.585	6.2385	0.22603	0.11302
12	3.504	0.21355	3.4603	21.059	6.2711	0.24178	0.12089
13	4.004	0.24443	3.9608	22.322	6.3037	0.25496	0.12748
14	4.5041	0.27559	4.4657	23.533	6.3371	0.26738	0.13369
15	5.0041	0.30665	4.9691	24.534	6.3706	0.27727	0.13864
16	5.5041	0.33754	5.4695	25.639	6.4044	0.28824	0.14412
17	6.0041	0.36815	5.9655	26.534	6.4381	0.29674	0.14837
18	6.5041	0.39903	6.466	27.376	6.4726	0.30453	0.15227
19	7.0041	0.43019	6.9709	28.061	6.5077	0.31046	0.15523
20	7.5041	0.46107	7.4713	28.693	6.5429	0.31574	0.15787
21	8.0041	0.49187	7.9703	29.272	6.5784	0.32038	0.16019
22	8.5041	0.52248	8.4663	29.798	6.614	0.32438	0.16219
23	9.0041	0.55327	8.9653	30.325	6.6503	0.32831	0.16416
24	9.5041	0.58443	9.4702	30.746	6.6874	0.33103	0.16551
25	10.004	0.6154	9.9721	31.167	6.7247	0.3337	0.16685
26	10.504	0.64592	10.467	31.588	6.7618	0.33635	0.16818
27	11.004	0.67663	10.964	31.799	6.7996	0.33671	0.16836
28	11.504	0.7076	11.466	32.062	6.8381	0.33759	0.16879
29	12.004	0.73876	11.971	32.167	6.8773	0.33676	0.16838
30	12.504	0.76955	12.47	32.273	6.9166	0.33595	0.16798
31	13.004	0.79998	12.963	32.22	6.9557	0.33351	0.16676
32	13.504	0.83086	13.463	31.904	6.996	0.32835	0.16417
33	14.004	0.86202	13.968	31.588	7.037	0.3232	0.1616
34	14.504	0.89336	14.476	30.956	7.0788	0.31486	0.15743
35	15.004	0.92406	14.974	29.956	7.1202	0.30292	0.15146
36	15.504	0.95449	15.467	28.903	7.1618	0.29058	0.14529

UNCONFINED COMPRESSION TEST
ASTM D2166

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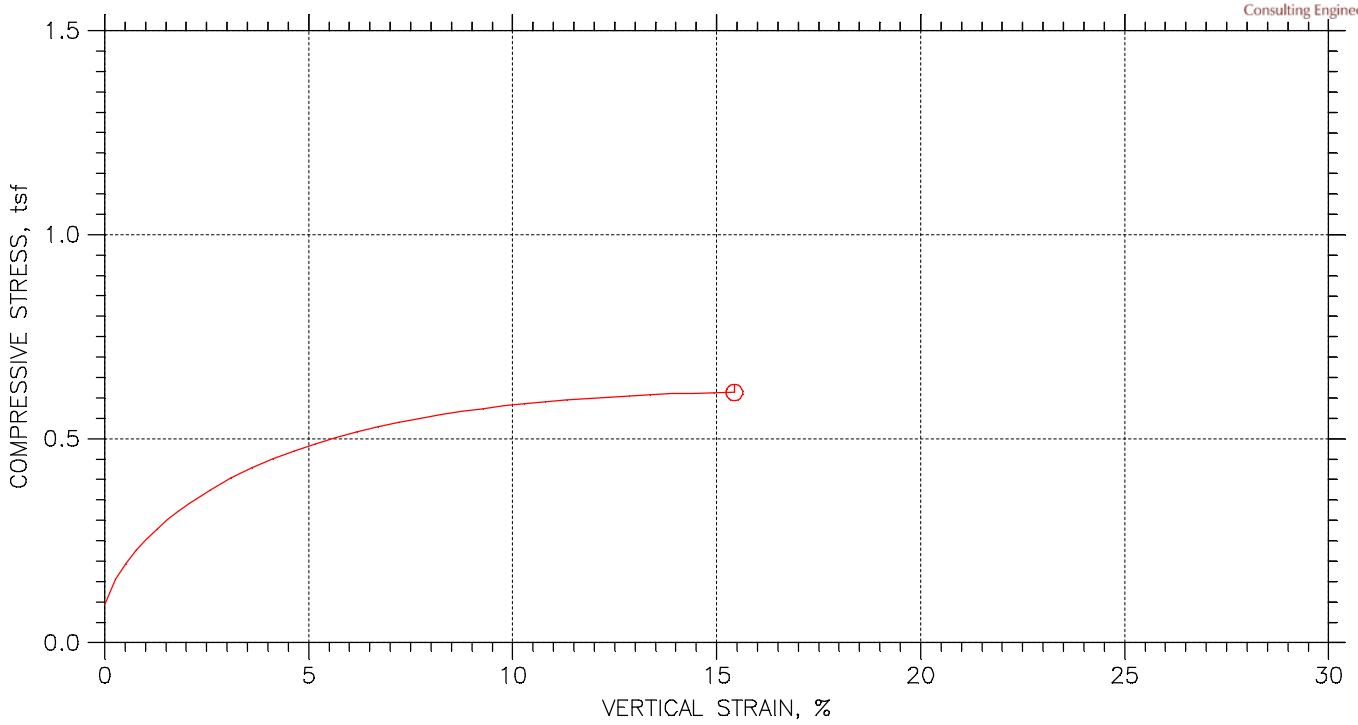

Symbol		⏲			
Test No.		HEN018S8			
Initial	Diameter, in	2.8083			
	Height, in	6.0094			
	Water Content, %	31.88			
	Dry Density, pcf	90.04			
	Saturation, %	97.88			
	Void Ratio	0.8859			
Unconfined Compressive Strength, tsf		0.61328			
Undrained Shear Strength, tsf		0.30664			
Time to Failure, min		15.004			
Strain Rate, %/min		1.14			
Estimated Specific Gravity		2.72			
Liquid Limit		43			
Plastic Limit		22			
Plasticity Index		21			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN018 S-8
Sample Type: 3.0" ST
Description: DARK BROWNISH GRAY LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 15:00:59

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN018 S-8
Sample No.: ST-8
Test No.: HEN018S8

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

Terracon
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Soil Description: DARK BROWNISH GRAY LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.01 in
Specimen Area: 6.19 in^2
Specimen Volume: 37.22 in^3

Liquid Limit: 43
Plastic Limit: 22
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	7.9497	6.1939	0.092409	0.046205
2	0.25402	0.015943	0.2653	13.478	6.2104	0.15625	0.078126
3	0.50403	0.031431	0.52302	16.794	6.2265	0.1942	0.097101
4	0.75403	0.046554	0.77468	19.585	6.2423	0.22589	0.11295
5	1.004	0.061768	1.0279	22.059	6.2583	0.25379	0.12689
6	1.254	0.077165	1.2841	24.27	6.2745	0.2785	0.13925
7	1.504	0.092743	1.5433	26.376	6.291	0.30187	0.15094
8	1.754	0.10841	1.804	28.219	6.3077	0.32211	0.16105
9	2.004	0.12408	2.0648	30.009	6.3245	0.34163	0.17081
10	2.504	0.15524	2.5833	33.062	6.3582	0.3744	0.1872
11	3.004	0.18594	3.0942	35.8	6.3917	0.40327	0.20164
12	3.504	0.21664	3.6051	38.274	6.4256	0.42887	0.21444
13	4.004	0.24807	4.1281	40.38	6.4606	0.45001	0.22501
14	4.504	0.27923	4.6465	42.328	6.4958	0.46917	0.23459
15	5.004	0.30993	5.1574	44.171	6.5308	0.48697	0.24349
16	5.5041	0.34027	5.6623	45.803	6.5657	0.50228	0.25114
17	6.0041	0.37116	6.1762	47.33	6.6017	0.51619	0.2581
18	6.5041	0.40268	6.7007	48.751	6.6388	0.52872	0.26436
19	7.0041	0.43402	7.2222	50.067	6.6761	0.53996	0.26998
20	7.5041	0.46435	7.7271	51.278	6.7126	0.55001	0.27501
21	8.0041	0.4946	8.2304	52.436	6.7494	0.55937	0.27968
22	8.5041	0.52539	8.7428	53.489	6.7873	0.56741	0.28371
23	9.0041	0.55701	9.2688	54.384	6.8267	0.57358	0.28679
24	9.5041	0.58825	9.7888	55.332	6.866	0.58023	0.29012
25	10.004	0.61887	10.298	56.122	6.905	0.58519	0.2926
26	10.504	0.64939	10.806	56.964	6.9443	0.59061	0.29531
27	11.004	0.68063	11.326	57.701	6.9851	0.59477	0.29738
28	11.504	0.71206	11.849	58.333	7.0265	0.59773	0.29887
29	12.004	0.74286	12.361	59.07	7.0676	0.60177	0.30088
30	12.504	0.77301	12.863	59.702	7.1083	0.60472	0.30236
31	13.004	0.80362	13.373	60.333	7.1501	0.60755	0.30377
32	13.504	0.83496	13.894	60.965	7.1934	0.61021	0.30511
33	14.004	0.86658	14.42	61.439	7.2376	0.6112	0.3056
34	14.504	0.89719	14.93	61.966	7.281	0.61277	0.30638
35	15.004	0.92743	15.433	62.387	7.3243	0.61328	0.30664

UNCONFINED COMPRESSION TEST
ASTM D2166

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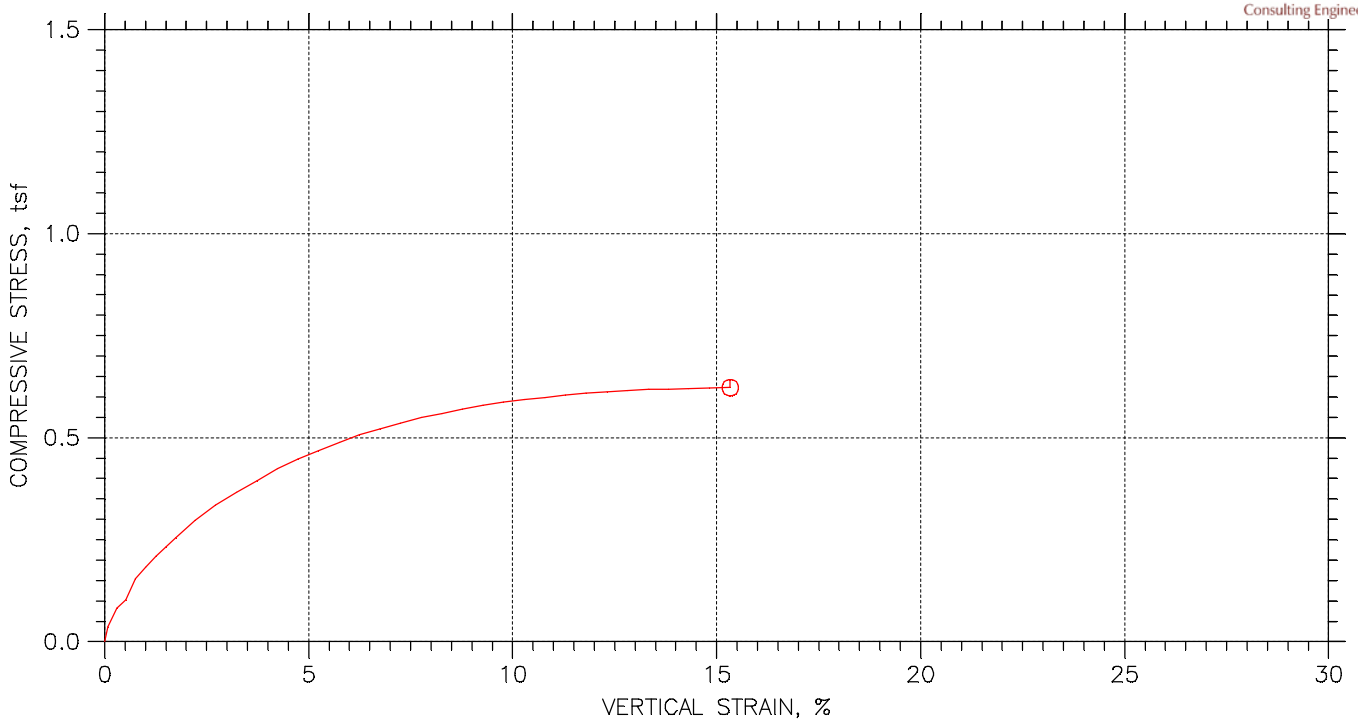

Symbol		⏲			
Test No.		HEN019S2			
Initial	Diameter, in	2.848			
	Height, in	5.8406			
	Water Content, %	33.10			
	Dry Density, pcf	89.03			
	Saturation, %	99.24			
	Void Ratio	0.90719			
Unconfined Compressive Strength, tsf		0.62255			
Undrained Shear Strength, tsf		0.31128			
Time to Failure, min		15.503			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		41			
Plastic Limit		22			
Plasticity Index		19			
Failure Sketch					

Project: DYNERGY HENNEPIN

Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HEN019 S2

Sample Type: 3.0" ST

Description: DARK BROWN LEAN CLAY WITH SAND CL

Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 15:04:02

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN019 S2
Sample No.: S-2
Test No.: HEN019S2

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 7.5'-9.5'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK BROWN LEAN CLAY WITH SAND CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 5.84 in
Specimen Area: 6.37 in^2
Specimen Volume: 37.21 in^3

Liquid Limit: 41
Plastic Limit: 22
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.3706	0	0
2	0.25415	0.0046585	0.079761	3.282	6.3757	0.037063	0.018532
3	0.50415	0.01772	0.3034	7.358	6.39	0.082908	0.041454
4	0.75388	0.0306	0.52392	9.1049	6.4041	0.10236	0.051182
5	1.0039	0.044301	0.75851	13.816	6.4193	0.15497	0.077483
6	1.2534	0.058916	1.0087	16.357	6.4355	0.183	0.091501
7	1.5034	0.073439	1.2574	18.686	6.4517	0.20854	0.10427
8	1.7534	0.08778	1.5029	20.91	6.4678	0.23277	0.11638
9	2.0034	0.10203	1.7469	22.921	6.4839	0.25453	0.12726
10	2.5034	0.12925	2.213	26.891	6.5148	0.2972	0.1486
11	3.0034	0.15884	2.7197	30.385	6.5487	0.33407	0.16704
12	3.5034	0.18853	3.228	33.455	6.5831	0.3659	0.18295
13	4.0034	0.21803	3.7331	36.314	6.6176	0.3951	0.19755
14	4.5034	0.24717	4.232	39.172	6.6521	0.42399	0.21199
15	5.0034	0.27658	4.7356	41.554	6.6873	0.44741	0.2237
16	5.5034	0.30645	5.247	43.778	6.7234	0.46881	0.23441
17	6.0034	0.33605	5.7537	45.842	6.7595	0.4883	0.24415
18	6.5034	0.36509	6.251	47.854	6.7954	0.50703	0.25352
19	7.0034	0.39387	6.7437	49.495	6.8313	0.52166	0.26083
20	7.5034	0.42355	7.252	51.136	6.8687	0.53602	0.26801
21	8.0034	0.45351	7.7649	52.671	6.9069	0.54906	0.27453
22	8.5034	0.48293	8.2685	53.994	6.9448	0.55978	0.27989
23	9.0034	0.51206	8.7674	55.265	6.9828	0.56984	0.28492
24	9.5034	0.54111	9.2647	56.482	7.0211	0.57922	0.28961
25	10.003	0.5708	9.773	57.541	7.0606	0.58677	0.29338
26	10.503	0.60094	10.289	58.6	7.1012	0.59415	0.29707
27	11.003	0.63063	10.797	59.394	7.1417	0.59879	0.29939
28	11.503	0.65995	11.299	60.347	7.1821	0.60497	0.30248
29	12.003	0.68936	11.803	61.088	7.2231	0.60892	0.30446
30	12.503	0.71905	12.311	61.776	7.265	0.61223	0.30612
31	13.003	0.74901	12.824	62.464	7.3078	0.61543	0.30771
32	13.503	0.77842	13.328	63.152	7.3502	0.61862	0.30931
33	14.003	0.8071	13.819	63.576	7.3921	0.61924	0.30962
34	14.503	0.83596	14.313	64.052	7.4347	0.6203	0.31015
35	15.003	0.86592	14.826	64.581	7.4795	0.62168	0.31084
36	15.503	0.89543	15.331	65.058	7.5241	0.62255	0.31128

UNCONFINED COMPRESSION TEST
ASTM D2166

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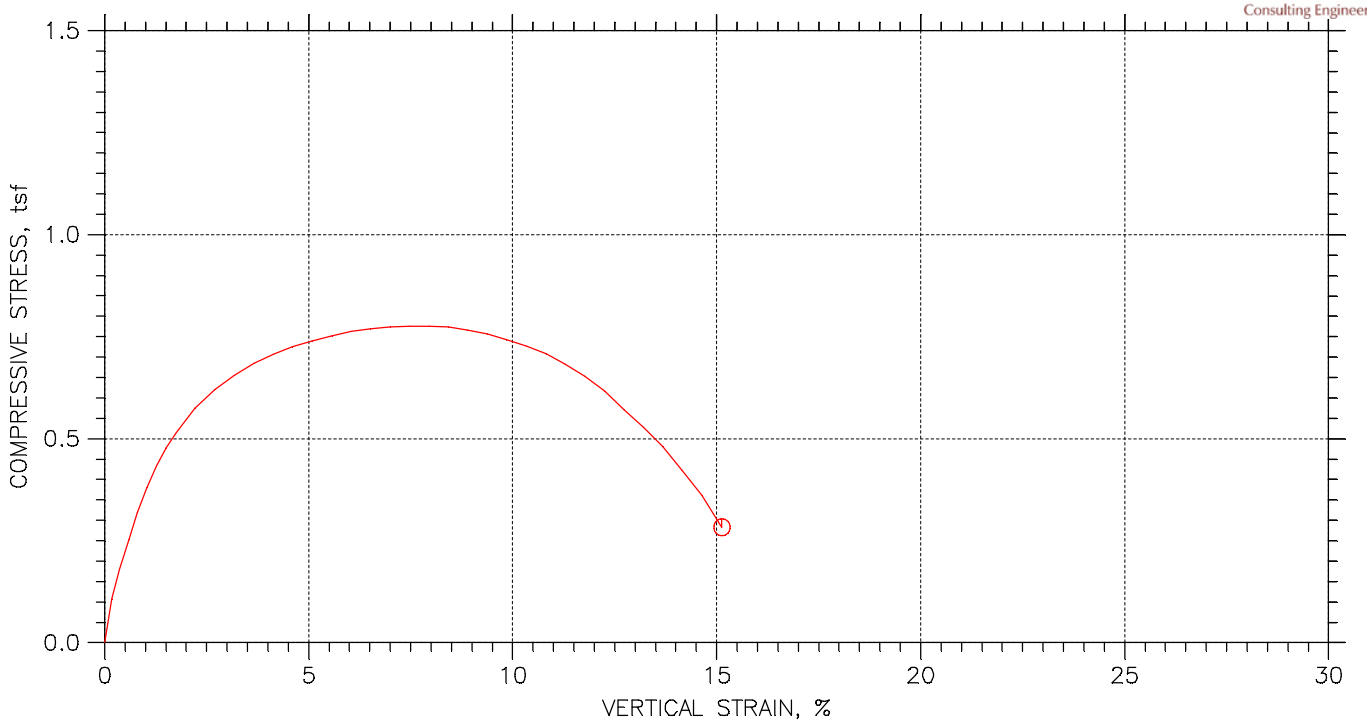

Symbol		⏲			
Test No.		HEN019S4			
Initial	Diameter, in	2.7374			
	Height, in	6.1728			
	Water Content, %	34.87			
	Dry Density, pcf	86.39			
	Saturation, %	98.22			
	Void Ratio	0.96564			
Unconfined Compressive Strength, tsf		0.77617			
Undrained Shear Strength, tsf		0.38809			
Time to Failure, min		8.5033			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		45			
Plastic Limit		24			
Plasticity Index		21			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN019 S4
Sample Type: 3.0" ST
Description: GRAY AND BROWN LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166. 436

Tue, 22-DEC-2015 15:07:07

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN019 S4
Sample No.: ST-4
Test No.: HEN019S4

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 12.5'-14.5'
Elevation: ----

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Soil Description: GRAY AND BROWN LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.17 in
Specimen Area: 5.89 in^2
Specimen Volume: 36.33 in^3

Liquid Limit: 45
Plastic Limit: 24
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	5.8853	0	0
2	0.25017	0.010413	0.16869	8.7873	5.8952	0.10732	0.053661
3	0.50018	0.022288	0.36106	14.716	5.9066	0.17939	0.089693
4	0.75357	0.036628	0.59338	20.751	5.9204	0.25236	0.12618
5	1.0033	0.049233	0.79758	26.309	5.9326	0.31929	0.15965
6	1.2533	0.06394	1.0358	31.391	5.9469	0.38005	0.19003
7	1.5033	0.078828	1.277	35.837	5.9614	0.43283	0.21642
8	1.7533	0.093443	1.5138	39.649	5.9757	0.47772	0.23886
9	2.0033	0.10806	1.7505	42.878	5.9901	0.51538	0.25769
10	2.5033	0.13701	2.2196	48.013	6.0189	0.57434	0.28717
11	3.0033	0.16633	2.6946	52.089	6.0483	0.62008	0.31004
12	3.5033	0.19593	3.1741	55.318	6.0782	0.65527	0.32764
13	4.0033	0.22562	3.655	58.07	6.1085	0.68446	0.34223
14	4.5033	0.25475	4.127	60.241	6.1386	0.70656	0.35328
15	5.0033	0.28407	4.602	62.199	6.1692	0.72592	0.36296
16	5.5033	0.31367	5.0814	63.629	6.2003	0.73887	0.36944
17	6.0033	0.34336	5.5624	65.111	6.2319	0.75225	0.37613
18	6.5033	0.37286	6.0403	66.328	6.2636	0.76244	0.38122
19	7.0033	0.40227	6.5168	67.281	6.2955	0.76947	0.38474
20	7.5033	0.4315	6.9903	67.969	6.3276	0.7734	0.3867
21	8.0033	0.461	7.4683	68.552	6.3603	0.77602	0.38801
22	8.5033	0.4906	7.9477	68.922	6.3934	0.77617	0.38809
23	9.0033	0.5201	8.4257	69.081	6.4268	0.77392	0.38696
24	9.5033	0.54942	8.9007	68.71	6.4603	0.76578	0.38289
25	10.003	0.57884	9.3771	68.287	6.4943	0.75708	0.37854
26	10.503	0.60852	9.8581	67.281	6.5289	0.74197	0.37098
27	11.003	0.63839	10.342	66.222	6.5641	0.72637	0.36319
28	11.503	0.66771	10.817	64.899	6.5991	0.70809	0.35404
29	12.003	0.69648	11.283	62.94	6.6338	0.68313	0.34156
30	12.503	0.72617	11.764	60.558	6.6699	0.65371	0.32686
31	13.003	0.75604	12.248	57.541	6.7067	0.61773	0.30887
32	13.503	0.78563	12.727	53.518	6.7435	0.5714	0.2857
33	14.003	0.81496	13.202	49.707	6.7805	0.52782	0.26391
34	14.503	0.844	13.673	45.472	6.8174	0.48024	0.24012
35	15.003	0.87369	14.154	40.284	6.8556	0.42308	0.21154
36	15.503	0.90392	14.644	34.567	6.8949	0.36096	0.18048
37	16.003	0.93379	15.127	27.262	6.9343	0.28307	0.14153

UNCONFINED COMPRESSION TEST
ASTM D2166

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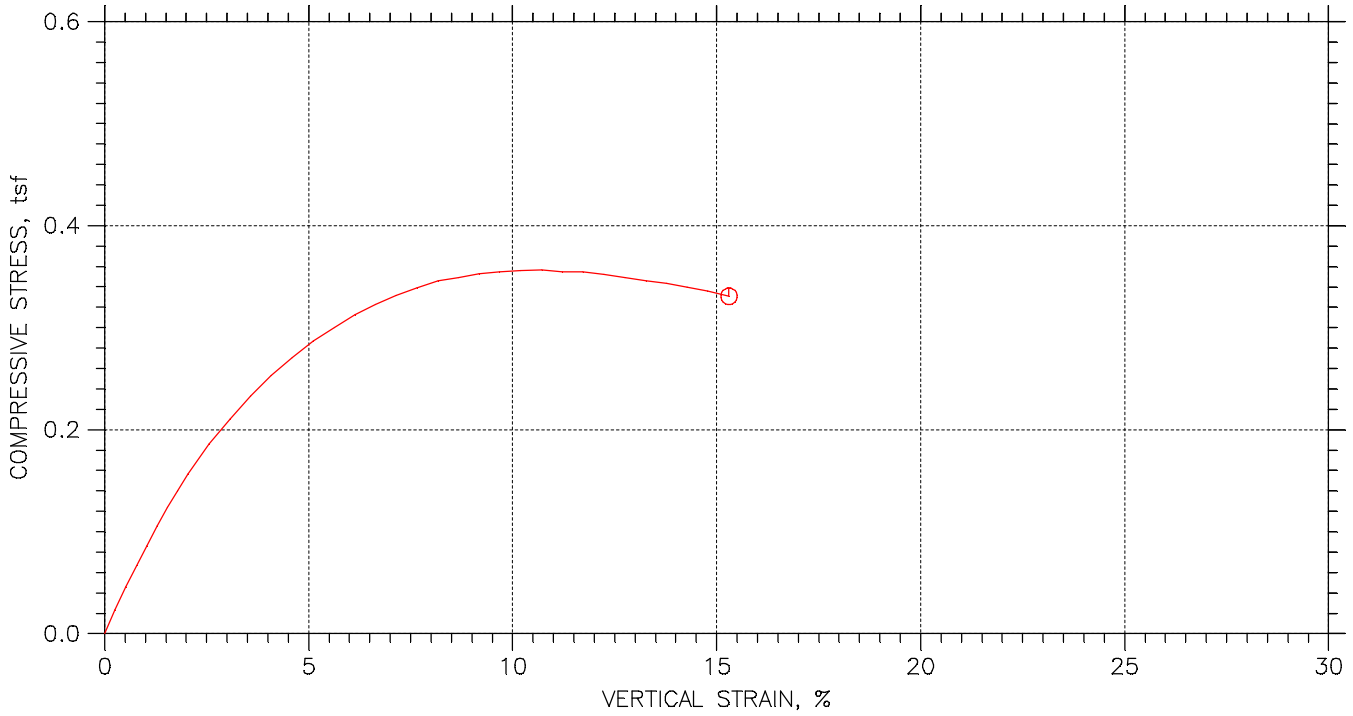

Symbol		⏲			
Test No.		HENB019S6			
Initial	Diameter, in	2.798			
	Height, in	6.1795			
	Water Content, %	33.84			
	Dry Density, pcf	86.79			
	Saturation, %	96.23			
	Void Ratio	0.9565			
Unconfined Compressive Strength, tsf		0.3564			
Undrained Shear Strength, tsf		0.1782			
Time to Failure, min		10.504			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		38			
Plastic Limit		22			
Plasticity Index		16			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HENB019 S-6
Sample Type: 3.0" ST
Description: BROWN AND GRAY LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 15:09:43

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HENB019 S-6
Sample No.: ST-6
Test No.: HENB019S6

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 20.0'-22.0'
Elevation: -----

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Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.18 in
Specimen Area: 6.15 in^2
Specimen Volume: 38.00 in^3

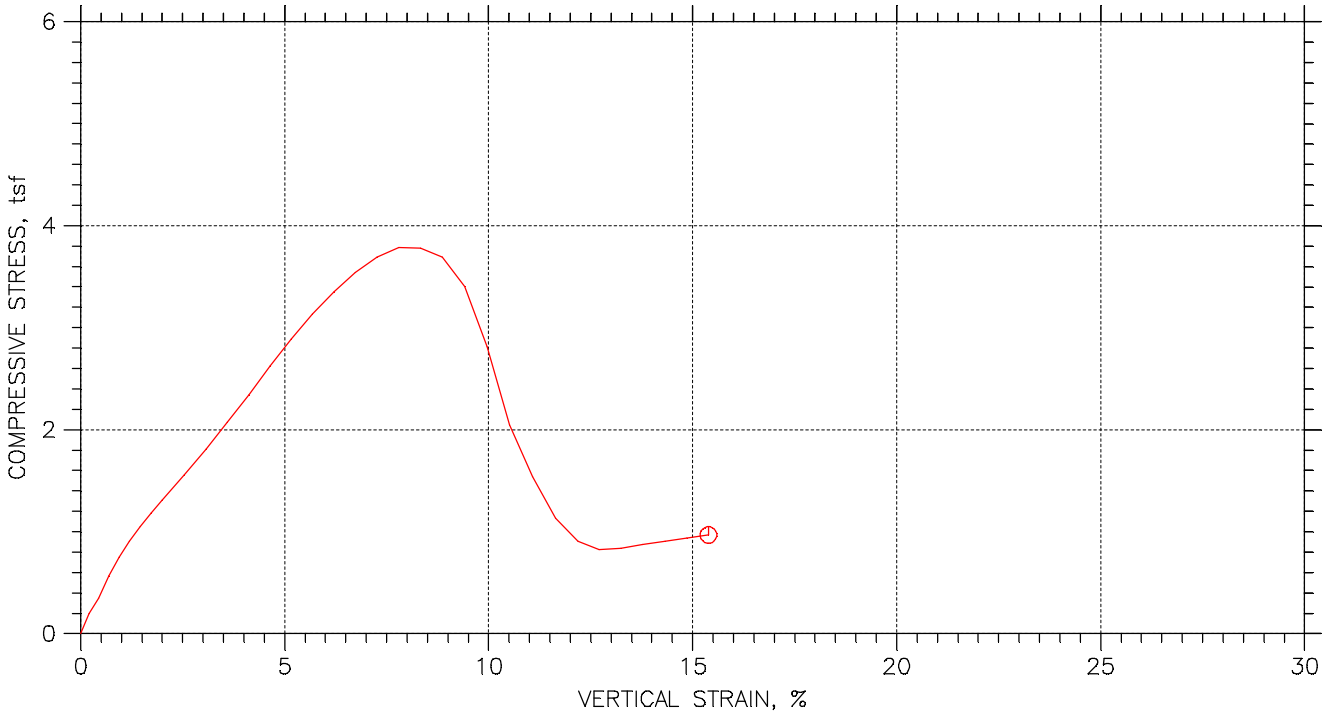
Liquid Limit: 38
Plastic Limit: 22
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.1489	0	0
2	0.25378	0.016051	0.25974	1.9931	6.1649	0.023277	0.011639
3	0.50378	0.032102	0.51949	3.9337	6.181	0.045822	0.022911
4	0.75378	0.048153	0.77923	5.7694	6.1972	0.06703	0.033515
5	1.0038	0.064019	1.036	7.4478	6.2132	0.086306	0.043153
6	1.2538	0.079517	1.2868	9.1261	6.229	0.10549	0.052744
7	1.5038	0.095014	1.5376	10.752	6.2449	0.12397	0.061983
8	1.7538	0.1106	1.7898	12.168	6.2609	0.13993	0.069966
9	2.0038	0.12619	2.0421	13.637	6.2771	0.15642	0.078209
10	2.5038	0.15783	2.5542	16.312	6.31	0.18612	0.093061
11	3.0038	0.18984	3.0722	18.567	6.3438	0.21073	0.10537
12	3.5038	0.22149	3.5842	20.665	6.3774	0.2333	0.11665
13	4.0038	0.25248	4.0858	22.553	6.4108	0.2533	0.12665
14	4.5038	0.28375	4.5918	24.231	6.4448	0.27071	0.13535
15	5.0038	0.31567	5.1083	25.805	6.4799	0.28673	0.14336
16	5.5038	0.34786	5.6293	27.169	6.5157	0.30022	0.15011
17	6.0038	0.37914	6.1353	28.427	6.5508	0.31245	0.15622
18	6.5038	0.40995	6.6339	29.529	6.5858	0.32283	0.16141
19	7.0038	0.44113	7.1385	30.473	6.6215	0.33135	0.16568
20	7.5038	0.47295	7.6535	31.365	6.6585	0.33915	0.16958
21	8.0038	0.50505	8.173	32.151	6.6961	0.34571	0.17285
22	8.5038	0.53632	8.679	32.623	6.7332	0.34885	0.17442
23	9.0038	0.56713	9.1776	33.2	6.7702	0.35308	0.17654
24	9.5038	0.59822	9.6807	33.515	6.8079	0.35445	0.17723
25	10.004	0.63032	10.2	33.882	6.8473	0.35627	0.17814
26	10.504	0.66252	10.721	34.092	6.8873	0.3564	0.1782
27	11.004	0.69351	11.223	34.144	6.9262	0.35494	0.17747
28	11.504	0.72442	11.723	34.302	6.9654	0.35457	0.17728
29	12.004	0.75587	12.232	34.302	7.0058	0.35253	0.17626
30	12.504	0.78788	12.75	34.197	7.0474	0.34937	0.17469
31	13.004	0.81998	13.269	34.039	7.0896	0.34569	0.17285
32	13.504	0.85079	13.768	33.987	7.1306	0.34318	0.17159
33	14.004	0.88188	14.271	33.83	7.1724	0.3396	0.1698
34	14.504	0.91361	14.785	33.672	7.2157	0.33599	0.168
35	15.004	0.94553	15.301	33.358	7.2597	0.33083	0.16542

UNCONFINED COMPRESSION TEST
ASTM D2166

Terracon
Consulting Engineers & Scientists



Symbol		⏲			
Test No.		HENB021S3			
Initial	Diameter, in	2.8783			
	Height, in	5.8752			
	Water Content, %	15.80			
	Dry Density, pcf	116.7			
	Saturation, %	94.44			
	Void Ratio	0.45507			
Unconfined Compressive Strength, tsf		3.7833			
Undrained Shear Strength, tsf		1.8917			
Time to Failure, min		7.5002			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		---			
Plastic Limit		---			
Plasticity Index		---			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HENB021 S-3
Sample Type: 3.0" ST
Description: BROWN TO BROWNISH GRAY LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: TEST PERFORMED AS PER ASTM D2166. 440

Tue, 22-DEC-2015 15:11:42

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HENB021 S-3
Sample No.: ST-3
Test No.: HENB021S3

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-6.0'
Elevation: -----

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Soil Description: BROWN TO BROWNISH GRAY LEAND CLAY WITH SAND AND GRAVEL CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 5.88 in
Specimen Area: 6.51 in^2
Specimen Volume: 38.23 in^3

Liquid Limit: ---
Plastic Limit: ---
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.5069	0	0
2	0.2502	0.012177	0.20725	17.57	6.5204	0.19402	0.097008
3	0.5002	0.026198	0.44591	31.627	6.5361	0.34839	0.1742
4	0.7502	0.040496	0.68928	51.453	6.5521	0.56541	0.2827
5	1.0002	0.055625	0.94678	68.499	6.5691	0.75077	0.37538
6	1.2502	0.070384	1.198	82.607	6.5858	0.90311	0.45156
7	1.5002	0.085882	1.4618	96.192	6.6035	1.0488	0.52441
8	1.7502	0.10156	1.7287	108.52	6.6214	1.18	0.59
9	2.0002	0.11734	1.9972	120.58	6.6395	1.3076	0.6538
10	2.5002	0.14898	2.5357	144.34	6.6762	1.5566	0.77832
11	3.0002	0.18034	3.0696	168.57	6.713	1.808	0.904
12	3.5002	0.21125	3.5956	194.22	6.7496	2.0718	1.0359
13	4.0002	0.24206	4.12	221.02	6.7865	2.3449	1.1724
14	4.5002	0.27277	4.6428	248.71	6.8237	2.6243	1.3121
15	5.0002	0.30331	5.1625	275.1	6.8611	2.8868	1.4434
16	5.5002	0.33403	5.6854	300.38	6.8992	3.1347	1.5674
17	6.0002	0.36484	6.2098	322.93	6.9377	3.3514	1.6757
18	6.5002	0.39583	6.7373	343.07	6.977	3.5404	1.7702
19	7.0002	0.42683	7.2649	359.91	7.0167	3.6931	1.8465
20	7.5002	0.45791	7.794	370.82	7.0569	3.7833	1.8917
21	8.0002	0.48937	8.3294	372.39	7.0982	3.7773	1.8887
22	8.5002	0.5211	8.8695	366.3	7.1402	3.6937	1.8469
23	9.0002	0.55311	9.4144	339.24	7.1832	3.4004	1.7002
24	9.5002	0.58522	9.9608	282.54	7.2268	2.815	1.4075
25	10	0.6175	10.51	206.7	7.2711	2.0468	1.0234
26	10.5	0.65071	11.076	156.61	7.3174	1.541	0.77051
27	11	0.68355	11.635	115.91	7.3637	1.1334	0.56668
28	11.5	0.71584	12.184	93.15	7.4097	0.90513	0.45256
29	12	0.74665	12.708	85.282	7.4542	0.82373	0.41187
30	12.5	0.77792	13.241	87.013	7.5	0.83533	0.41766
31	13	0.80947	13.778	91.629	7.5467	0.87419	0.4371
32	13.5	0.84129	14.319	95.3	7.5944	0.90351	0.45175
33	14	0.87275	14.855	99.811	7.6422	0.94036	0.47018
34	14.5	0.90402	15.387	103.38	7.6902	0.96787	0.48394

UNCONFINED COMPRESSION TEST
ASTM D2166

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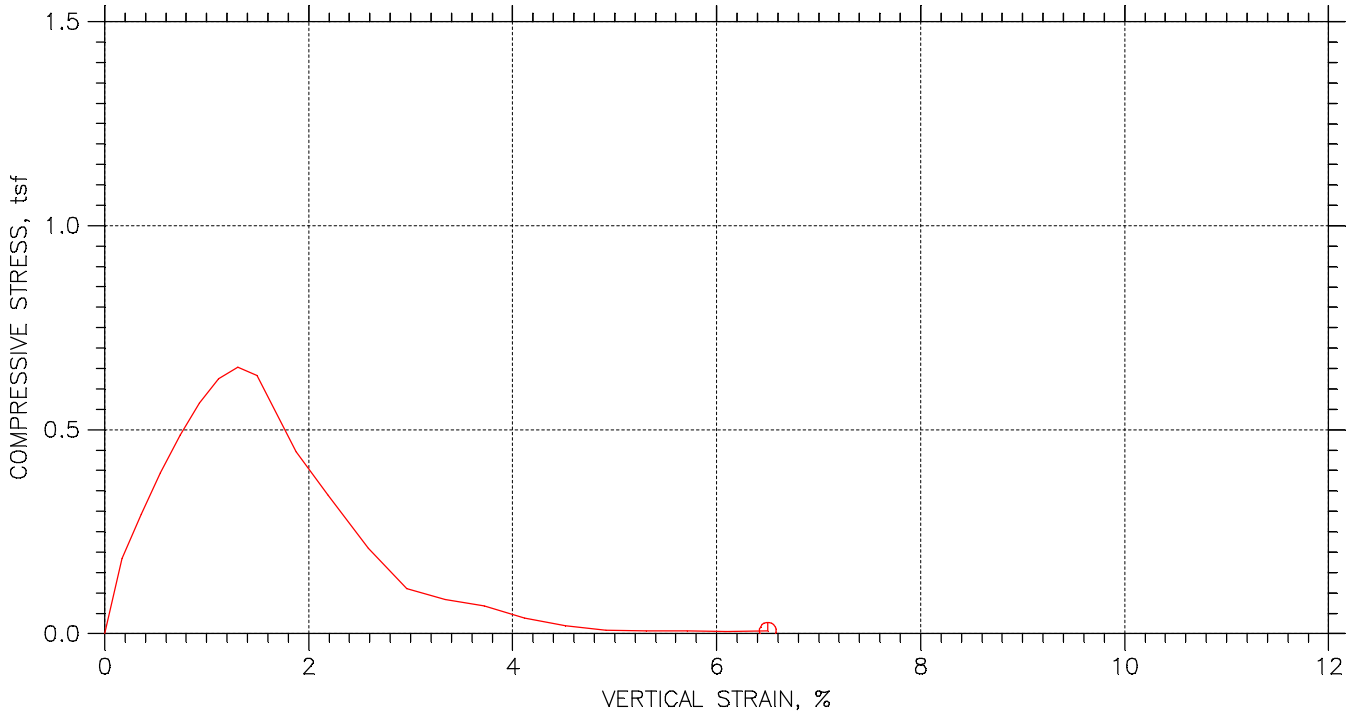

Symbol		⏲			
Test No.		HENB021S8			
Initial	Diameter, in	2.8717			
	Height, in	6.0697			
	Water Content, %	31.90			
	Dry Density, pcf	65.24			
	Saturation, %	61.09			
	Void Ratio	1.201			
Unconfined Compressive Strength, tsf		0.65256			
Undrained Shear Strength, tsf		0.32628			
Time to Failure, min		1.7542			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.30			
Liquid Limit		NP			
Plastic Limit		NP			
Plasticity Index		NP			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HENB021 S-8
Sample Type: 3.0" ST
Description: DARK GRAY VARVED FLY ASH
Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 15:16:20

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HENB021 S-8
Sample No.: S-8
Test No.: HENB021S8

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 22.0'-24.0'
Elevation: -----

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Soil Description: DARK GRAY VARVED FLY ASH
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.07 in
Specimen Area: 6.48 in^2
Specimen Volume: 39.31 in^3

Liquid Limit: NP
Plastic Limit: NP
Estimated Specific Gravity: 2.30

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.4767	0	0
2	0.25415	0.010239	0.1687	16.626	6.4876	0.18452	0.09226
3	0.50415	0.02177	0.35867	26.434	6.5	0.29281	0.14641
4	0.75415	0.033301	0.54865	35.665	6.5124	0.39431	0.19715
5	1.0042	0.044832	0.73862	44.11	6.5249	0.48674	0.24337
6	1.2542	0.056363	0.9286	51.348	6.5374	0.56552	0.28276
7	1.5042	0.067894	1.1186	56.802	6.55	0.6244	0.3122
8	1.7542	0.07924	1.3055	59.477	6.5624	0.65256	0.32628
9	2.0042	0.090587	1.4924	57.799	6.5748	0.63295	0.31647
10	2.5042	0.11402	1.8785	40.963	6.6007	0.44682	0.22341
11	3.0042	0.13311	2.1931	31.155	6.6219	0.33874	0.16937
12	3.5042	0.15691	2.5852	19.354	6.6486	0.20959	0.10479
13	4.0042	0.17988	2.9636	10.228	6.6745	0.11033	0.055164
14	4.5042	0.20276	3.3405	7.7625	6.7005	0.083411	0.041705
15	5	0.22591	3.722	6.2939	6.7271	0.067364	0.033682
16	5.5	0.24999	4.1187	3.5141	6.7549	0.037456	0.018728
17	6	0.27425	4.5184	1.8882	6.7832	0.020042	0.010021
18	6.5	0.29833	4.915	0.73429	6.8115	0.0077617	0.0038808
19	7	0.3224	5.3117	0.68184	6.84	0.0071772	0.0035886
20	7.5	0.34657	5.7099	0.62939	6.8689	0.0065973	0.0032986
21	8	0.3701	6.0974	0.47204	6.8973	0.0049276	0.0024638
22	8.5	0.39463	6.5017	0.73429	6.9271	0.0076322	0.0038161

UNCONFINED COMPRESSION TEST REPORT

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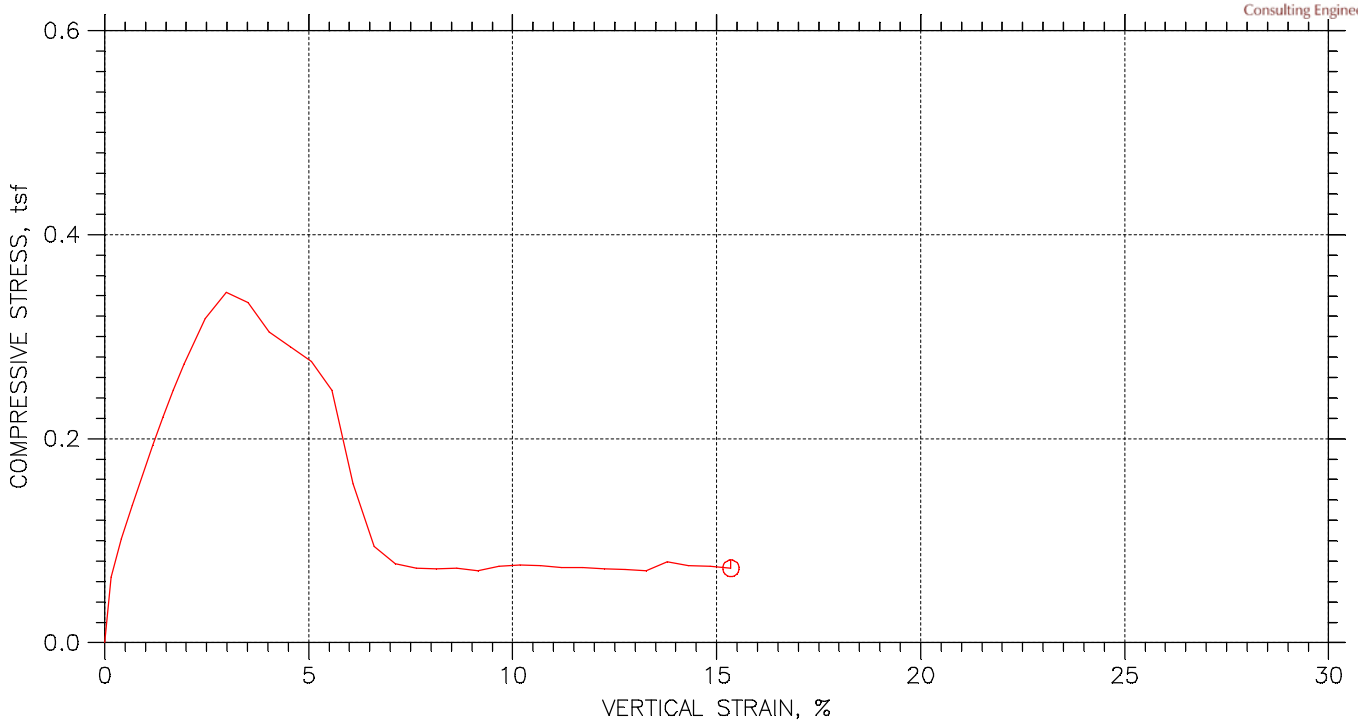

Symbol		⏲			
Test No.		HENB022S2			
Initial	Diameter, in	2.8346			
	Height, in	6.0874			
	Water Content, %	26.87			
	Dry Density, pcf	84.39			
	Saturation, %	88.11			
	Void Ratio	0.70142			
Unconfined Compressive Strength, tsf		0.34367			
Undrained Shear Strength, tsf		0.17183			
Time to Failure, min		3.0002			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.30			
Liquid Limit		NP			
Plastic Limit		NP			
Plasticity Index		NP			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HENB022 S-2
Sample Type: 3.0" ST
Description: VERY DARK GRAY VARVED FLY ASH WITH SAND AND GRAVEL
Remarks: TEST PERFORMED AS PER ASTM D2166. 444

Tue, 22-DEC-2015 15:18:26

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HENB022 S-2
Sample No.: ST-2
Test No.: HENB022S2

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 2.5'-4.5'
Elevation: -----

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Soil Description: VERY DARK GRAY VARVED FLY ASH WITH SAND AND GRAVEL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.09 in
Specimen Area: 6.31 in^2
Specimen Volume: 38.42 in^3

Liquid Limit: NP
Plastic Limit: NP
Estimated Specific Gravity: 2.30

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.3108	0	0
2	0.2502	0.0095937	0.1576	5.6121	6.3208	0.063927	0.031963
3	0.5002	0.025183	0.4137	8.9688	6.3371	0.1019	0.050951
4	0.7502	0.040681	0.66828	11.853	6.3533	0.13433	0.067166
5	1.0002	0.056086	0.92135	14.528	6.3695	0.16423	0.082113
6	1.2502	0.071491	1.1744	17.151	6.3858	0.19337	0.096687
7	1.5002	0.086804	1.426	19.668	6.4021	0.2212	0.1106
8	1.7502	0.10267	1.6866	22.081	6.4191	0.24767	0.12384
9	2.0002	0.11854	1.9473	24.441	6.4362	0.27342	0.13671
10	2.5002	0.15027	2.4685	28.532	6.4706	0.31749	0.15874
11	3.0002	0.18182	2.9868	31.05	6.5051	0.34367	0.17183
12	3.5041	0.21392	3.5142	30.263	6.5407	0.33314	0.16657
13	4.0041	0.24547	4.0324	27.798	6.576	0.30436	0.15218
14	4.5041	0.27665	4.5446	26.644	6.6113	0.29017	0.14508
15	5.0041	0.30811	5.0614	25.438	6.6473	0.27553	0.13776
16	5.5041	0.3391	5.5705	22.973	6.6831	0.24749	0.12375
17	6.0041	0.37028	6.0827	14.528	6.7196	0.15567	0.077836
18	6.5041	0.40192	6.6025	8.8639	6.757	0.094451	0.047225
19	7.0041	0.43365	7.1238	7.2904	6.7949	0.077251	0.038625
20	7.5041	0.46465	7.6329	6.9233	6.8324	0.072958	0.036479
21	8.0041	0.49491	8.13	6.9233	6.8693	0.072566	0.036283
22	8.5041	0.52535	8.6301	6.9757	6.9069	0.072717	0.036359
23	9.0041	0.5568	9.1468	6.8184	6.9462	0.070675	0.035338
24	9.5041	0.58798	9.659	7.238	6.9856	0.074601	0.037301
25	10.004	0.61962	10.179	7.4478	7.026	0.076322	0.038161
26	10.504	0.65071	10.689	7.3953	7.0662	0.075354	0.037677
27	11.004	0.68189	11.202	7.2904	7.1069	0.073859	0.036929
28	11.504	0.71362	11.723	7.2904	7.1489	0.073425	0.036713
29	12.004	0.74554	12.247	7.238	7.1916	0.072464	0.036232
30	12.504	0.77681	12.761	7.238	7.234	0.07204	0.03602
31	13.004	0.8079	13.272	7.1331	7.2766	0.07058	0.03529
32	13.504	0.83917	13.785	8.0772	7.3199	0.079448	0.039724
33	14.004	0.87127	14.313	7.71	7.365	0.075373	0.037687
34	14.504	0.90328	14.839	7.71	7.4104	0.074911	0.037455
35	15.004	0.93437	15.349	7.5527	7.4552	0.072942	0.036471

UNCONFINED COMPRESSION TEST REPORT

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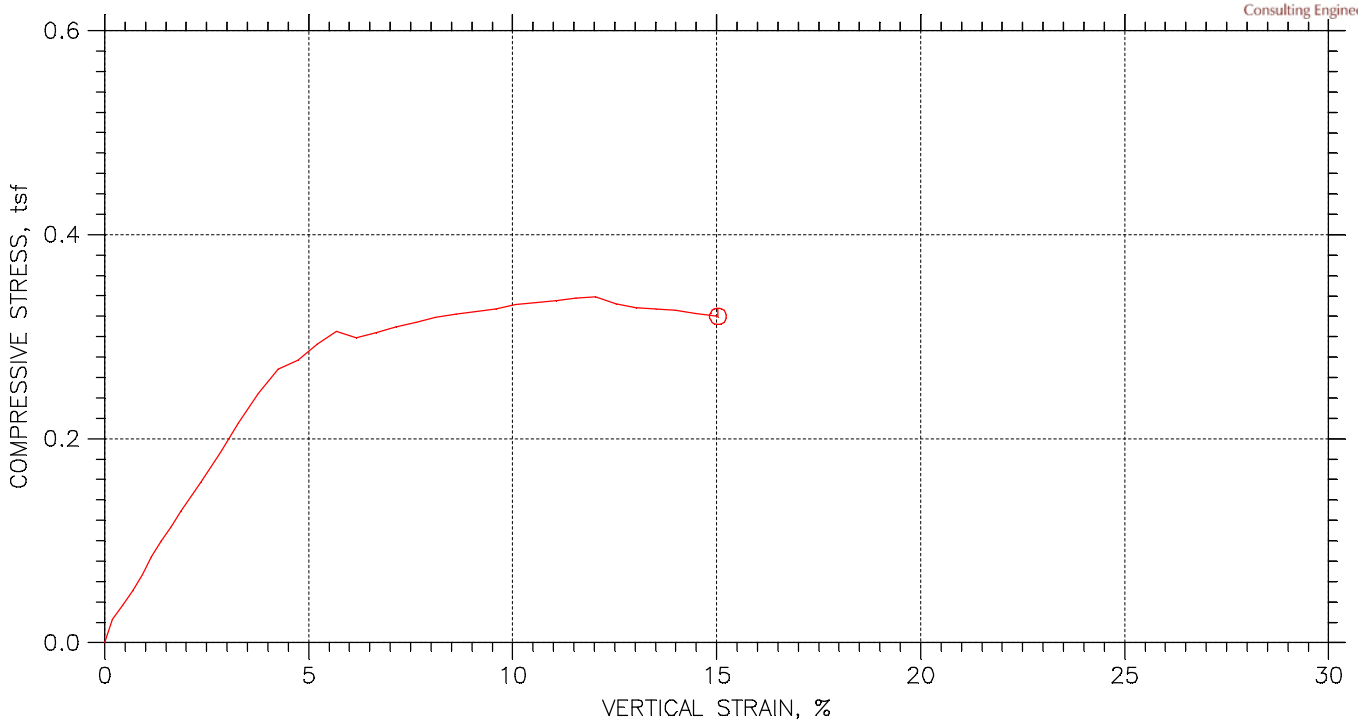

Symbol		⏲			
Test No.		HEN025S9			
Initial	Diameter, in	2.8591			
	Height, in	6.0091			
	Water Content, %	36.14			
	Dry Density, pcf	75.78			
	Saturation, %	92.89			
	Void Ratio	0.89482			
Unconfined Compressive Strength, tsf		0.33892			
Undrained Shear Strength, tsf		0.16946			
Time to Failure, min		12.504			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.30			
Liquid Limit		NP			
Plastic Limit		NP			
Plasticity Index		NP			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN025 S9
Sample Type: 3.0" ST
Description: DARK GRAY TO GRAY FLY ASH WITH SAND
Remarks: TEST PERFORMED AS PER ASTM D2166. 446

Tue, 22-DEC-2015 15:20:38

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN025 S9
Sample No.: S-9
Test No.: HEN025S9

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 25.0'-27.0'
Elevation: ----

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Soil Description: DARK GRAY TO GRAY FLY ASH WITH SAND
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.01 in
Specimen Area: 6.42 in^2
Specimen Volume: 38.58 in^3

Liquid Limit: NP
Plastic Limit: NP
Estimated Specific Gravity: 2.30

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.42	0	0
2	0.25405	0.011783	0.19609	2.0116	6.4326	0.022515	0.011258
3	0.50407	0.026307	0.43778	3.282	6.4482	0.036646	0.018323
4	0.75407	0.041104	0.68403	4.6054	6.4642	0.051296	0.025648
5	1.0041	0.055536	0.92421	6.0347	6.4799	0.067053	0.033526
6	1.2538	0.068507	1.1401	7.6227	6.494	0.084514	0.042257
7	1.5038	0.083304	1.3863	8.9991	6.5103	0.099525	0.049762
8	1.7538	0.097919	1.6295	10.322	6.5263	0.11388	0.05694
9	2.0038	0.11253	1.8727	11.699	6.5425	0.12874	0.064372
10	2.5038	0.14158	2.3561	14.346	6.5749	0.15709	0.078547
11	3.0038	0.17063	2.8395	17.151	6.6076	0.18689	0.093444
12	3.5038	0.19712	3.2803	19.851	6.6377	0.21532	0.10766
13	4.0038	0.22635	3.7667	22.656	6.6713	0.24452	0.12226
14	4.5038	0.25521	4.2471	24.986	6.7048	0.26831	0.13416
15	5.0038	0.28444	4.7335	25.938	6.739	0.27713	0.13856
16	5.5038	0.3134	5.2154	27.527	6.7732	0.29261	0.1463
17	6.0038	0.34116	5.6775	28.85	6.8064	0.30518	0.15259
18	6.5038	0.37048	6.1654	28.426	6.8418	0.29915	0.14957
19	7.0038	0.39971	6.6519	29.009	6.8775	0.30369	0.15185
20	7.5038	0.42885	7.1368	29.75	6.9134	0.30983	0.15492
21	8.0038	0.45836	7.6277	30.332	6.9501	0.31423	0.15711
22	8.5038	0.48777	8.1172	30.967	6.9872	0.31911	0.15955
23	9.0038	0.51736	8.6097	31.444	7.0248	0.32228	0.16114
24	9.5038	0.54687	9.1007	31.814	7.0628	0.32432	0.16216
25	10.004	0.576	9.5856	32.291	7.1006	0.32743	0.16371
26	10.504	0.60533	10.074	32.873	7.1392	0.33153	0.16577
27	11.004	0.63492	10.566	33.244	7.1785	0.33343	0.16672
28	11.504	0.66451	11.059	33.614	7.2182	0.33529	0.16765
29	12.004	0.69393	11.548	34.038	7.2582	0.33765	0.16882
30	12.504	0.72316	12.034	34.355	7.2983	0.33892	0.16946
31	13.004	0.75284	12.528	33.879	7.3395	0.33235	0.16617
32	13.504	0.78235	13.019	33.667	7.381	0.32842	0.16421
33	14.004	0.81158	13.506	33.72	7.4225	0.32709	0.16355
34	14.503	0.84099	13.995	33.773	7.4647	0.32575	0.16288
35	15.003	0.8704	14.485	33.667	7.5074	0.32288	0.16144
36	15.503	0.90009	14.979	33.561	7.5511	0.32001	0.16
37	15.558	0.90328	15.032	33.561	7.5558	0.31981	0.1599

UNCONFINED COMPRESSION TEST REPORT

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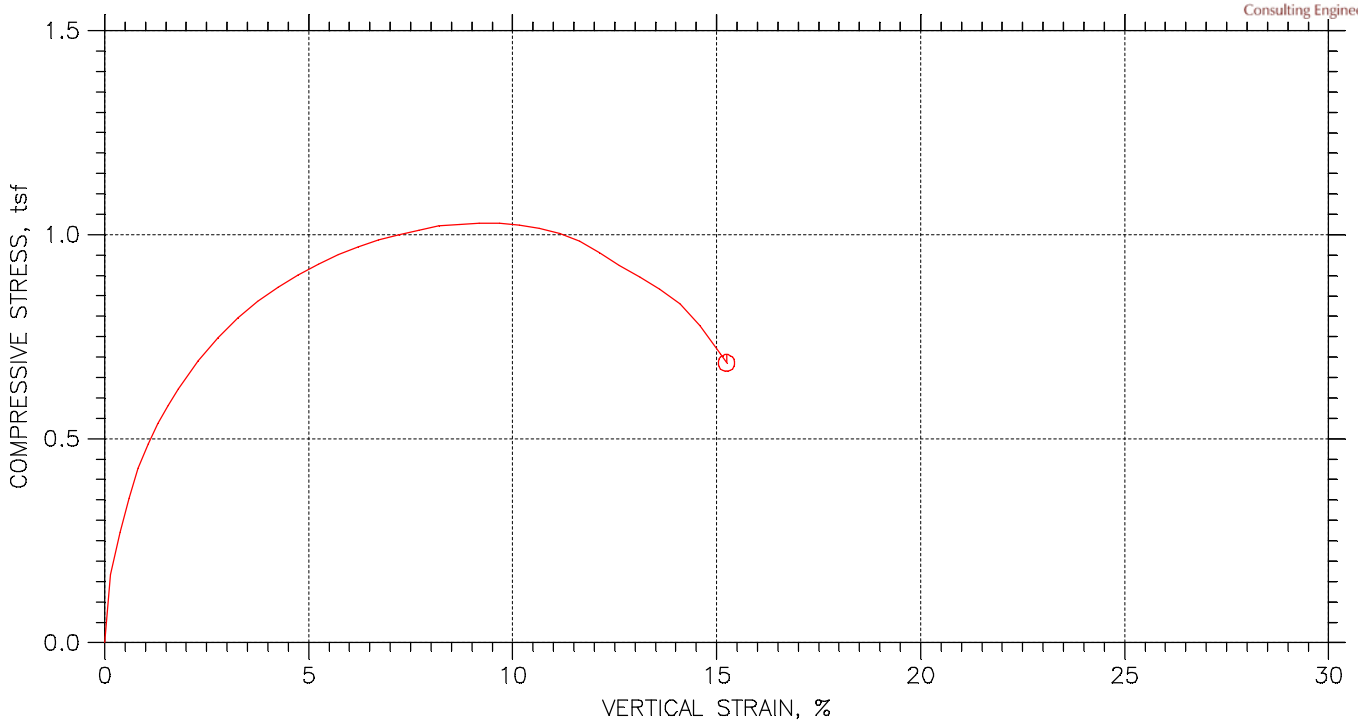

Symbol		⏲			
Test No.		HEN027S2			
Initial	Diameter, in	2.8106			
	Height, in	5.9756			
	Water Content, %	36.30			
	Dry Density, pcf	84.59			
	Saturation, %	98.00			
	Void Ratio	1.0075			
Unconfined Compressive Strength, tsf		1.0288			
Undrained Shear Strength, tsf		0.51438			
Time to Failure, min		10			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		---			
Plastic Limit		---			
Plasticity Index		---			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN027 S2
Sample Type: 3.0" ST
Description: GRAY LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: TEST PERFORMED AS PER ASTM D2166. 448

Tue, 22-DEC-2015 15:22:36

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN027 S2
Sample No.: ST-2
Test No.: HEN027S2

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

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Soil Description: GRAY LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 5.98 in
Specimen Area: 6.20 in^2
Specimen Volume: 37.07 in^3

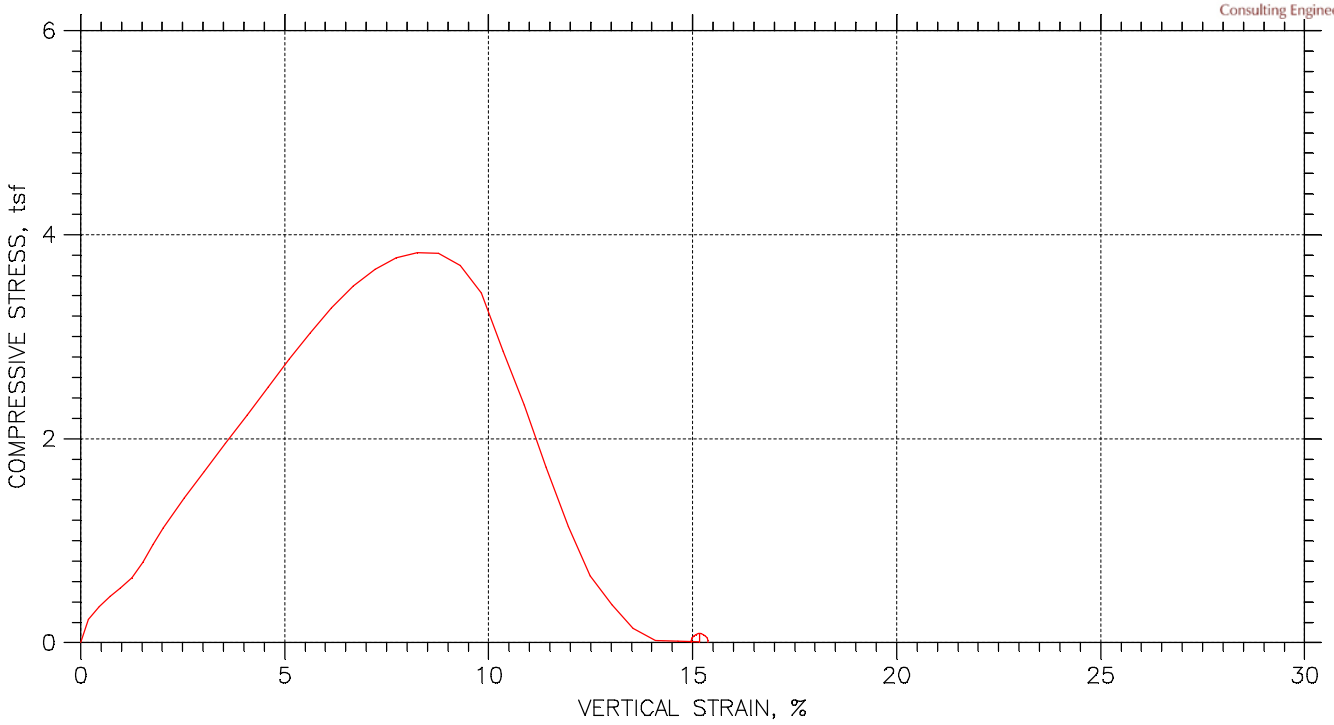
Liquid Limit: ---
Plastic Limit: ---
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.2044	0	0
2	0.2501	0.0081295	0.13604	14.346	6.2128	0.16625	0.083125
3	0.5001	0.022196	0.37145	23.345	6.2275	0.2699	0.13495
4	0.7501	0.035806	0.59921	30.597	6.2418	0.35294	0.17647
5	1.0001	0.048959	0.81932	37.055	6.2556	0.42649	0.21324
6	1.2501	0.063392	1.0608	42.348	6.2709	0.48623	0.24311
7	1.5001	0.078098	1.3069	46.954	6.2865	0.53777	0.26888
8	1.7501	0.092895	1.5546	50.871	6.3023	0.58117	0.29058
9	2.0001	0.1076	1.8007	54.63	6.3181	0.62255	0.31127
10	2.5001	0.13729	2.2975	60.876	6.3503	0.69022	0.34511
11	3.0001	0.16633	2.7836	66.222	6.382	0.7471	0.37355
12	3.5001	0.19529	3.2681	70.934	6.414	0.79626	0.39813
13	4.0001	0.22443	3.7557	74.851	6.4465	0.836	0.418
14	4.5001	0.25411	4.2525	78.451	6.4799	0.87168	0.43584
15	5.0001	0.28353	4.7447	81.574	6.5134	0.90173	0.45086
16	5.5001	0.31266	5.2324	84.326	6.5469	0.92738	0.46369
17	6.0001	0.34189	5.7215	86.867	6.5809	0.9504	0.4752
18	6.5001	0.37158	6.2183	89.144	6.6158	0.97016	0.48508
19	7.0001	0.40136	6.7166	91.155	6.6511	0.98678	0.49339
20	7.5001	0.43095	7.2119	92.849	6.6866	0.99978	0.49989
21	8.0001	0.46018	7.701	94.437	6.722	1.0115	0.50576
22	8.5001	0.48941	8.1902	95.972	6.7578	1.0225	0.51126
23	9.0001	0.51892	8.6839	96.66	6.7944	1.0243	0.51215
24	9.5001	0.54851	9.1792	97.56	6.8314	1.0282	0.51412
25	10	0.57801	9.6729	98.143	6.8688	1.0288	0.51438
26	10.5	0.60733	10.164	98.09	6.9063	1.0226	0.51131
27	11	0.63675	10.656	97.878	6.9443	1.0148	0.50741
28	11.5	0.66625	11.15	97.296	6.9829	1.0032	0.5016
29	12	0.69557	11.64	95.919	7.0217	0.98355	0.49177
30	12.5	0.72507	12.134	93.749	7.0612	0.95592	0.47796
31	13	0.75412	12.62	91.155	7.1004	0.92433	0.46217
32	13.5	0.78353	13.112	88.826	7.1407	0.89564	0.44782
33	14	0.81313	13.608	86.444	7.1816	0.86665	0.43333
34	14.5	0.84254	14.1	83.321	7.2227	0.83058	0.41529
35	15	0.87214	14.595	78.345	7.2646	0.77648	0.38824
36	15.504	0.90191	15.093	71.834	7.3073	0.70779	0.3539
37	15.654	0.91086	15.243	69.716	7.3202	0.68572	0.34286

UNCONFINED COMPRESSION TEST REPORT

Terracon
Consulting Engineers & Scientists



Symbol		⏲			
Test No.		HEN032S3			
Initial	Diameter, in	2.8303			
	Height, in	5.85			
	Water Content, %	14.10			
	Dry Density, pcf	115.8			
	Saturation, %	82.27			
	Void Ratio	0.46619			
Unconfined Compressive Strength, tsf		3.8231			
Undrained Shear Strength, tsf		1.9116			
Time to Failure, min		8.0041			
Strain Rate, %/min		1.14			
Estimated Specific Gravity		2.72			
Liquid Limit		35			
Plastic Limit		18			
Plasticity Index		17			
Failure Sketch					

Project: DYNERGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN032 S-3
Sample Type: 3.0" ST
Description: DARK BROWNISH GRAY LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: TEST PERFORMED AS PER ASTM D2166. 450

Tue, 22-DEC-2015 15:25:34

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN032 S-3
Sample No.: ST-3
Test No.: HEN032S3

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK BROWNISH GRAY LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 5.85 in
Specimen Area: 6.29 in^2
Specimen Volume: 36.81 in^3

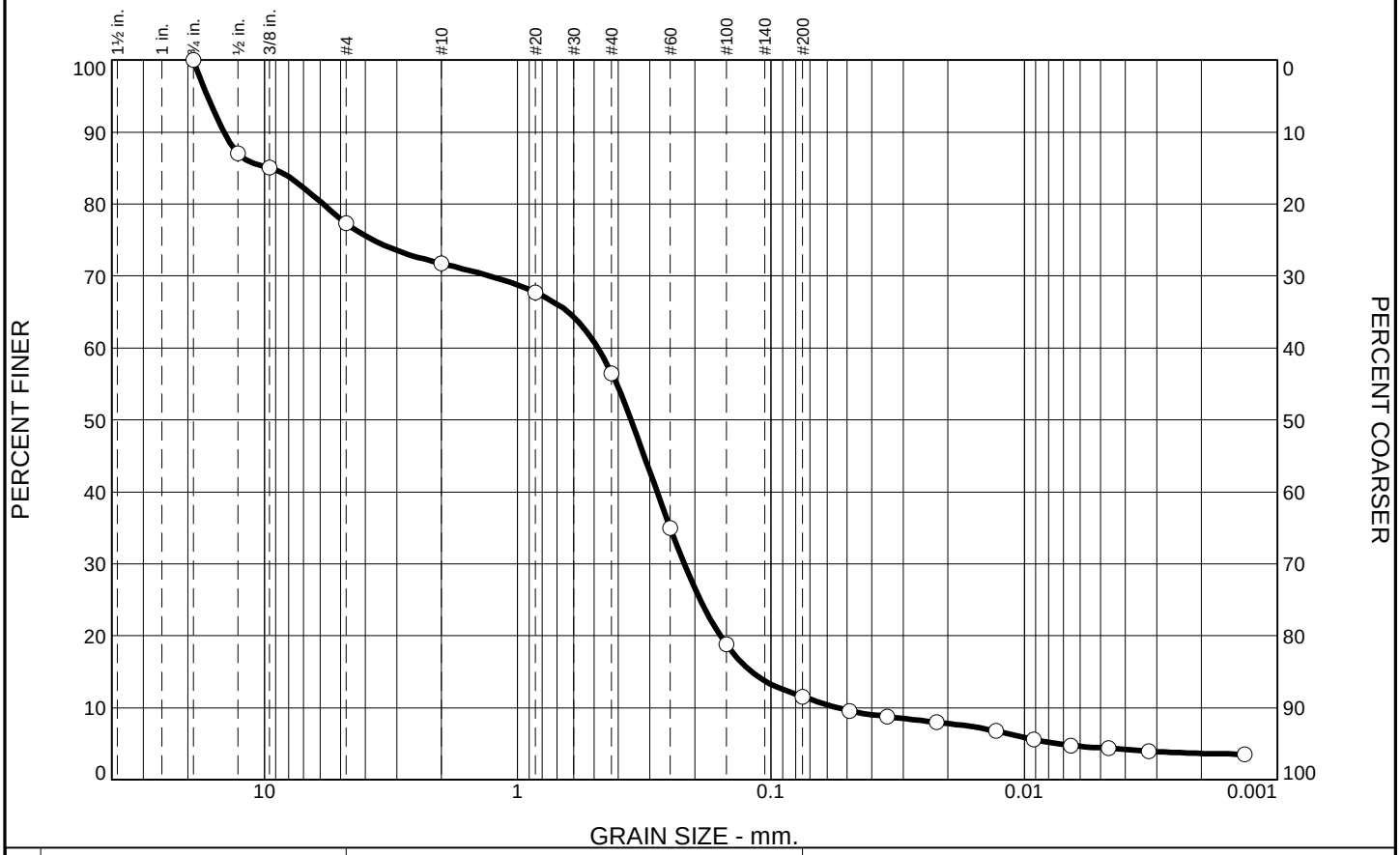
Liquid Limit: 35
Plastic Limit: 18
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.2916	0	0
2	0.25403	0.011115	0.18999	20.059	6.3036	0.22911	0.11456
3	0.50403	0.026602	0.45474	30.798	6.3203	0.35085	0.17543
4	0.75403	0.041999	0.71793	39.748	6.3371	0.45161	0.22581
5	1.004	0.057395	0.98111	47.382	6.3539	0.53692	0.26846
6	1.254	0.073065	1.249	56.543	6.3711	0.63899	0.31949
7	1.504	0.088735	1.5168	69.915	6.3885	0.78796	0.39398
8	1.7541	0.10358	1.7707	85.657	6.405	0.96289	0.48144
9	2.0041	0.11853	2.0261	100.35	6.4217	1.1251	0.56254
10	2.504	0.14841	2.5369	127.09	6.4553	1.4175	0.70875
11	3.004	0.17738	3.0321	151.41	6.4883	1.6802	0.8401
12	3.5041	0.20726	3.5429	176.95	6.5227	1.9532	0.97661
13	4.0041	0.23833	4.074	203.01	6.5588	2.2285	1.1143
14	4.5041	0.26903	4.5988	229.49	6.5949	2.5055	1.2527
15	5.0041	0.29937	5.1174	256.29	6.6309	2.7828	1.3914
16	5.5041	0.32943	5.6313	281.66	6.667	3.0418	1.5209
17	6.0041	0.36004	6.1545	305.56	6.7042	3.2816	1.6408
18	6.5041	0.39092	6.6825	327.41	6.7421	3.4965	1.7482
19	7.0041	0.42172	7.2089	344.52	6.7804	3.6584	1.8292
20	7.5041	0.45215	7.729	357.32	6.8186	3.773	1.8865
21	8.0041	0.48248	8.2476	364.11	6.8571	3.8231	1.9116
22	8.5041	0.51319	8.7724	365.79	6.8966	3.8189	1.9094
23	9.0041	0.54443	9.3066	356.58	6.9372	3.7009	1.8504
24	9.5041	0.57495	9.8283	332.2	6.9773	3.428	1.714
25	10.004	0.60556	10.352	278.29	7.0181	2.8551	1.4275
26	10.504	0.63636	10.878	228.38	7.0595	2.3293	1.1646
27	11.004	0.66724	11.406	169.79	7.1016	1.7214	0.8607
28	11.504	0.69895	11.948	113.14	7.1453	1.14	0.57002
29	12.004	0.73056	12.488	65.651	7.1894	0.65748	0.32874
30	12.504	0.76144	13.016	37.169	7.233	0.36999	0.185
31	13.004	0.79242	13.546	14.32	7.2773	0.14168	0.070839
32	13.504	0.82403	14.086	2.3165	7.3231	0.022775	0.011388
33	14.004	0.85619	14.636	1.5794	7.3703	0.015429	0.0077146
34	14.503	0.88735	15.168	0.7897	7.4165	0.0076665	0.0038332

Particle Size Analysis of Soils
ASTM D 422

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	22.7	5.6	15.2	44.9	7.2	4.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	87.0		
.375	85.1		
#4	77.3		
#10	71.7		
#20	67.7		
#40	56.5		
#60	35.0		
#100	18.8		
#200	11.6		

* (no specification provided)

BROWN POORLY GRADED SAND WITH SILT AND GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 14.4606 D_{85}= 9.3898 D_{60}= 0.4813
D_{50}= 0.3560 D_{30}= 0.2199 D_{15}= 0.1189
D_{10}= 0.0546 C_u= 8.82 C_c= 1.84

Classification

USCS= SP-SM AASHTO=

Remarks

F.M.=2.70

Source of Sample: HEN-B002 **Depth:** 15.0'-16.5'
Sample Number: S-6 **Date:** 12-4-15

Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	16.8	5.7	36.6	29.0	11.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	97.4		
.375	91.8		
#4	83.2		
#10	77.5		
#20	74.3		
#40	40.9		
#60	17.7		
#100	14.2		
#200	11.9		

* (no specification provided)

BROWN POORLY GRADED SAND WITH SILT AND GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 8.6465 D_{85}= 5.7731 D_{60}= 0.6002
D_{50}= 0.4992 D_{30}= 0.3457 D_{15}= 0.1731
D_{10}= C_u= C_c=

Classification

USCS= SP-SM AASHTO=

Remarks

F.M.=2.74

Source of Sample: HEN-B002 **Depth:** 55.0'-56.5'
Sample Number: S-14 **Date:** 11-25-15

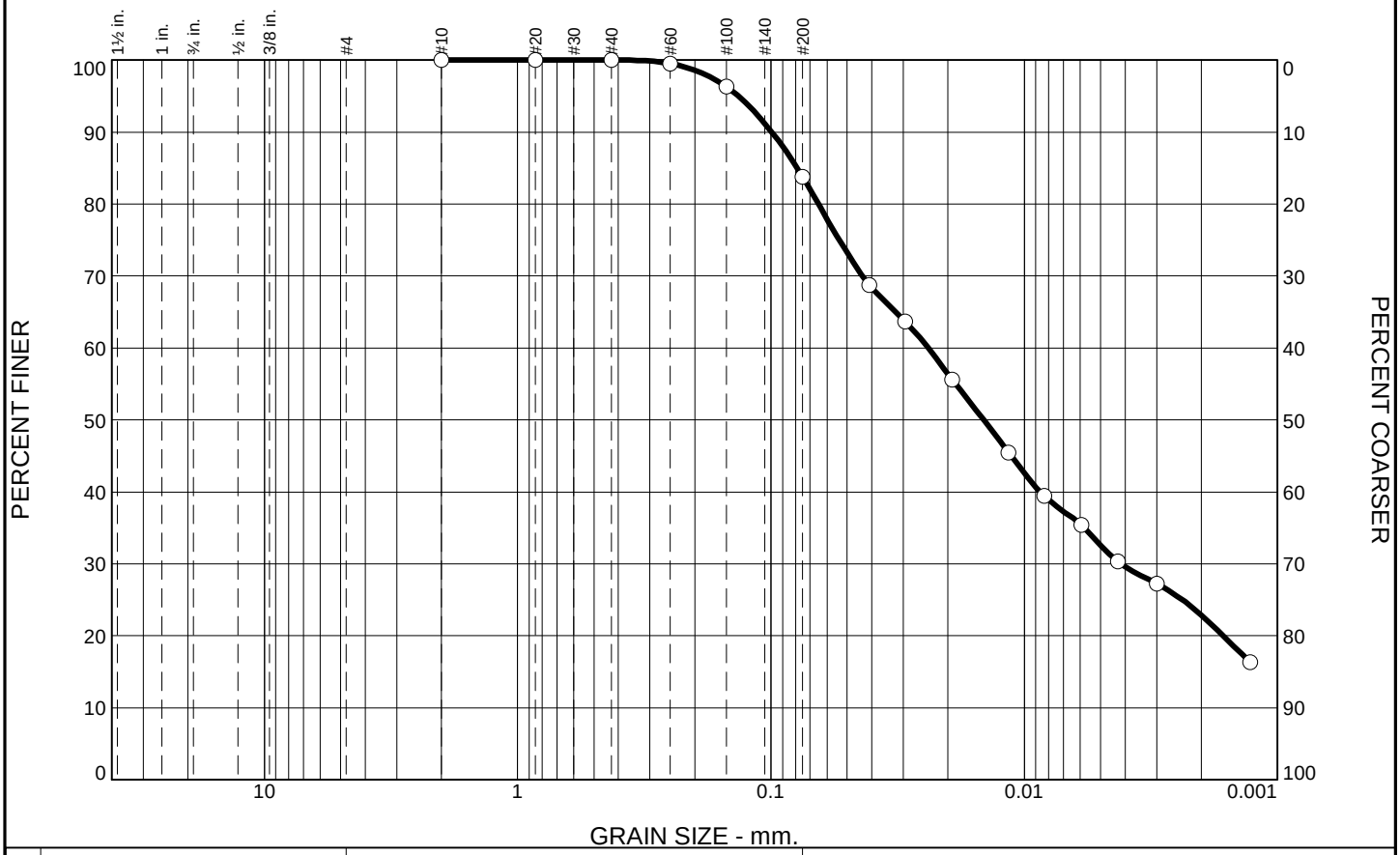
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	16.2	51.2	32.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	100.0		
#60	99.5		
#100	96.3		
#200	83.8		

* (no specification provided)

DARK GRAY LEAN CLAY WITH SAND AND FLY ASH

Atterberg Limits

PL= 24 LL= 43 PI= 19

Coefficients

D_{90}= 0.0992 D_{85}= 0.0788 D_{60}= 0.0240
D_{50}= 0.0145 D_{30}= 0.0042 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(17)

Remarks

F.M.=0.04

Source of Sample: HEN-B005 **Depth:** 12.5'-14.5'
Sample Number: S-4 **Date:** 12-17-15

Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.8	0.8	4.8	56.7	23.1	13.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.2		
#10	98.4		
#20	97.9		
#40	93.6		
#60	82.0		
#100	59.4		
#200	36.9		

* (no specification provided)

BROWN SILTY SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3360 D_{85}= 0.2738 D_{60}= 0.1522
D_{50}= 0.1189 D_{30}= 0.0460 D_{15}= 0.0056
D_{10}= 0.0015 C_u= 99.90 C_c= 9.12

Classification

USCS= SM AASHTO=

Remarks

F.M.=0.61

Source of Sample: HEN-B006 **Depth:** 15.0'-16.5'
Sample Number: S-6 **Date:** 12-4-15

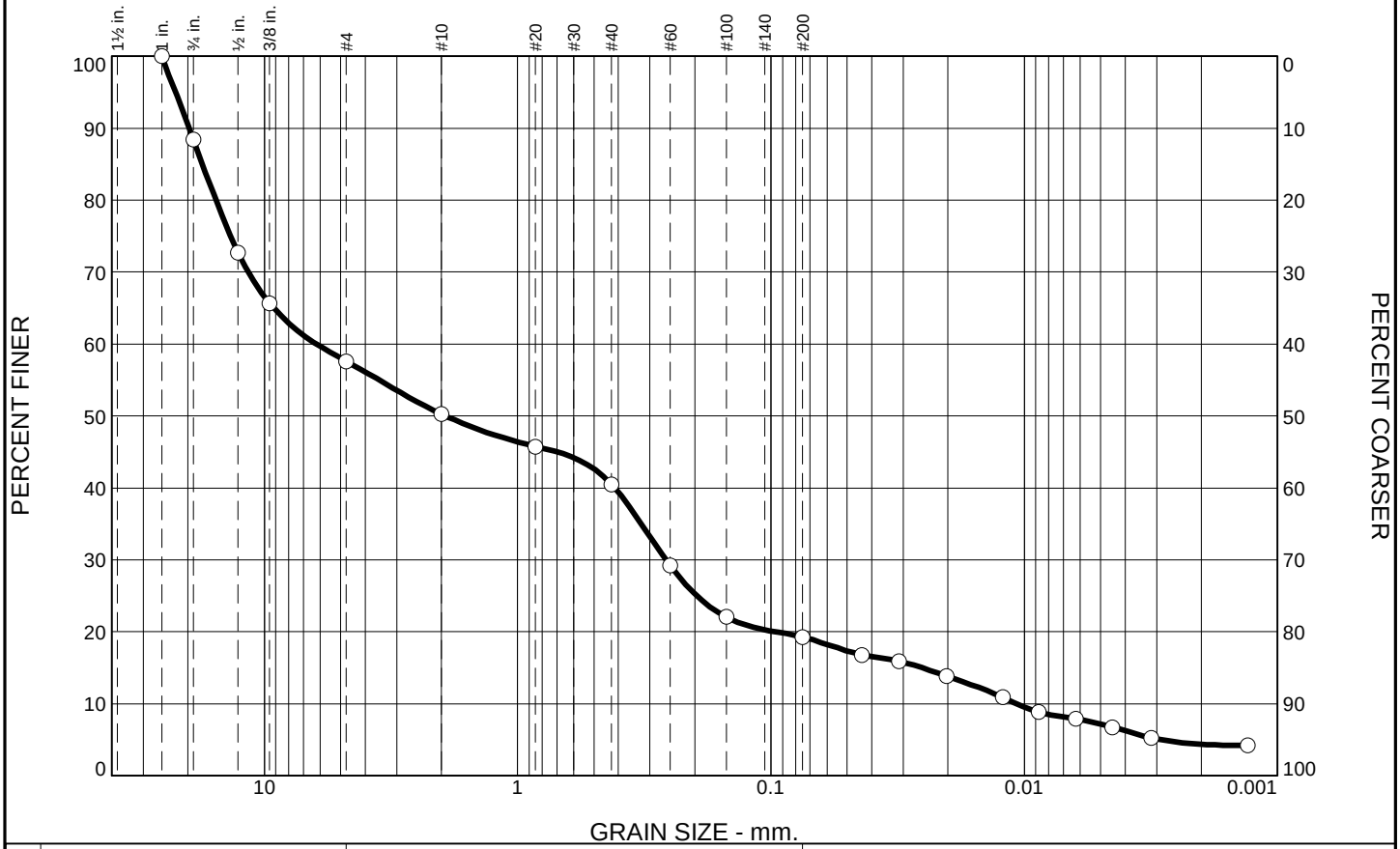
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	11.6	30.8	7.3	9.8	21.2	12.1	7.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	88.4		
.5	72.7		
.375	65.7		
#4	57.6		
#10	50.3		
#20	45.7		
#40	40.5		
#60	29.2		
#100	22.1		
#200	19.3		

* (no specification provided)

LIGHT BROWN SILTY GRAVEL WITH SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 19.7935 D_{85}= 17.5429 D_{60}= 6.2349
D_{50}= 1.9279 D_{30}= 0.2598 D_{15}= 0.0252
D_{10}= 0.0107 C_u= 583.74 C_c= 1.01

Classification

USCS= GM AASHTO=

Remarks

F.M.=3.90

Source of Sample: HEN-B006 **Depth:** 30.0'-31.5'
Sample Number: S-9 **Date:** 12-9-15

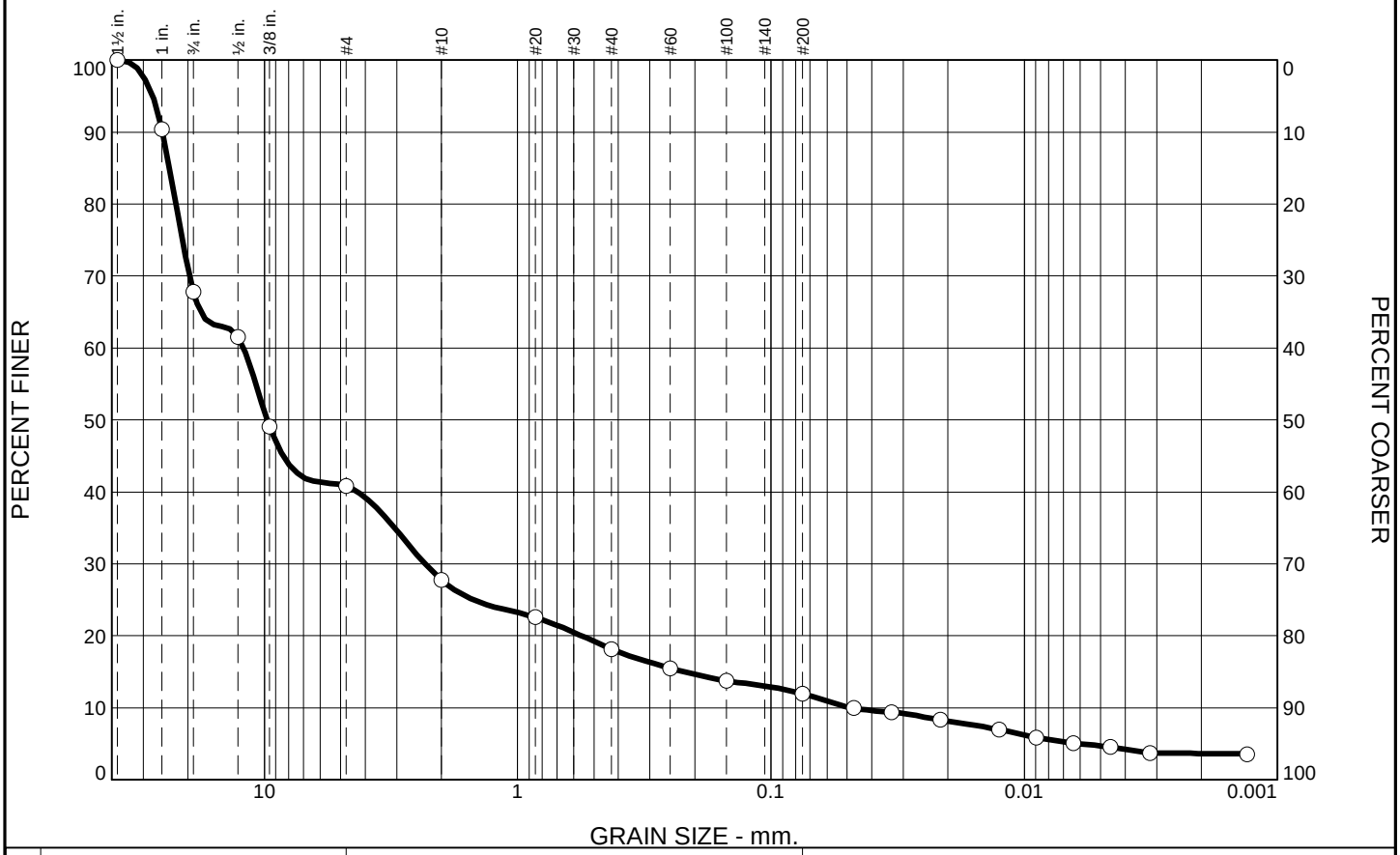
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	32.2	27.0	13.0	9.6	6.3	7.2	4.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.50	100.0		
1	90.4		
.75	67.8		
.5	61.5		
.375	49.0		
#4	40.8		
#10	27.8		
#20	22.6		
#40	18.2		
#60	15.5		
#100	13.8		
#200	11.9		

* (no specification provided)

BROWN GRAVEL WITH POORLY GRADED SAND AND SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 25.2429 D_{85}= 23.6694 D_{60}= 12.0960
D_{50}= 9.7410 D_{30}= 2.3148 D_{15}= 0.2213
D_{10}= 0.0481 C_u= 251.61 C_c= 9.21

Classification

USCS= GP AASHTO=

Remarks

F.M.=5.38

Source of Sample: HEN-B007 **Depth:** 15.0'-16.5'
Sample Number: S-6 **Date:** 12-9-15

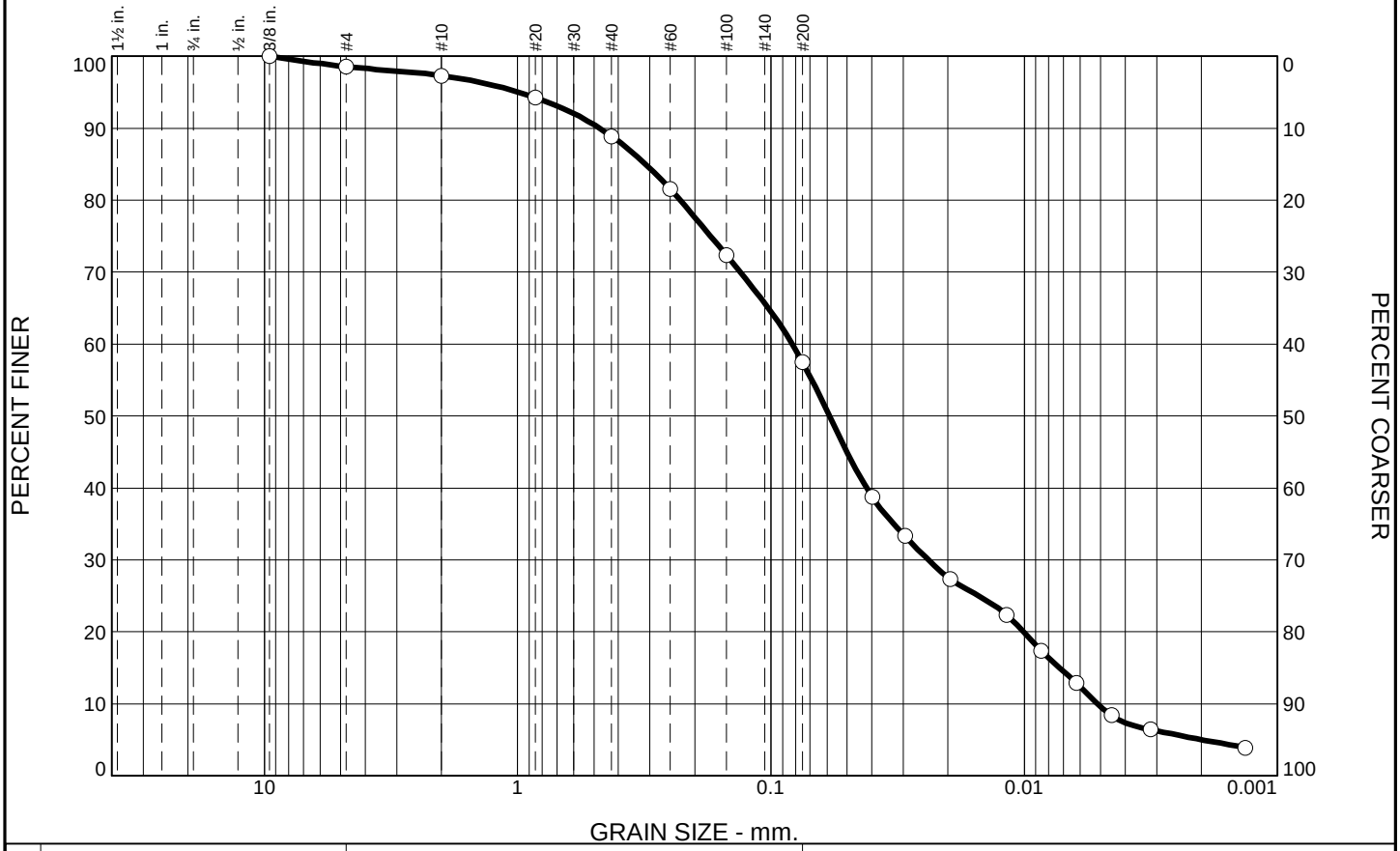
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.5	1.2	8.4	31.4	47.9	9.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	98.5		
#10	97.3		
#20	94.2		
#40	88.9		
#60	81.6		
#100	72.3		
#200	57.5		

* (no specification provided)

DARK GRAY TO BLACK SANDY SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4739 D_{85}= 0.3125 D_{60}= 0.0824
D_{50}= 0.0587 D_{30}= 0.0239 D_{15}= 0.0073
D_{10}= 0.0051 C_u= 16.02 C_c= 1.35

Classification

USCS= ML AASHTO=

Remarks

F.M.=0.59

Source of Sample: HEN-B008 **Depth:** 5.0'-6.5'
Sample Number: S-3 **Date:** 12-4-15

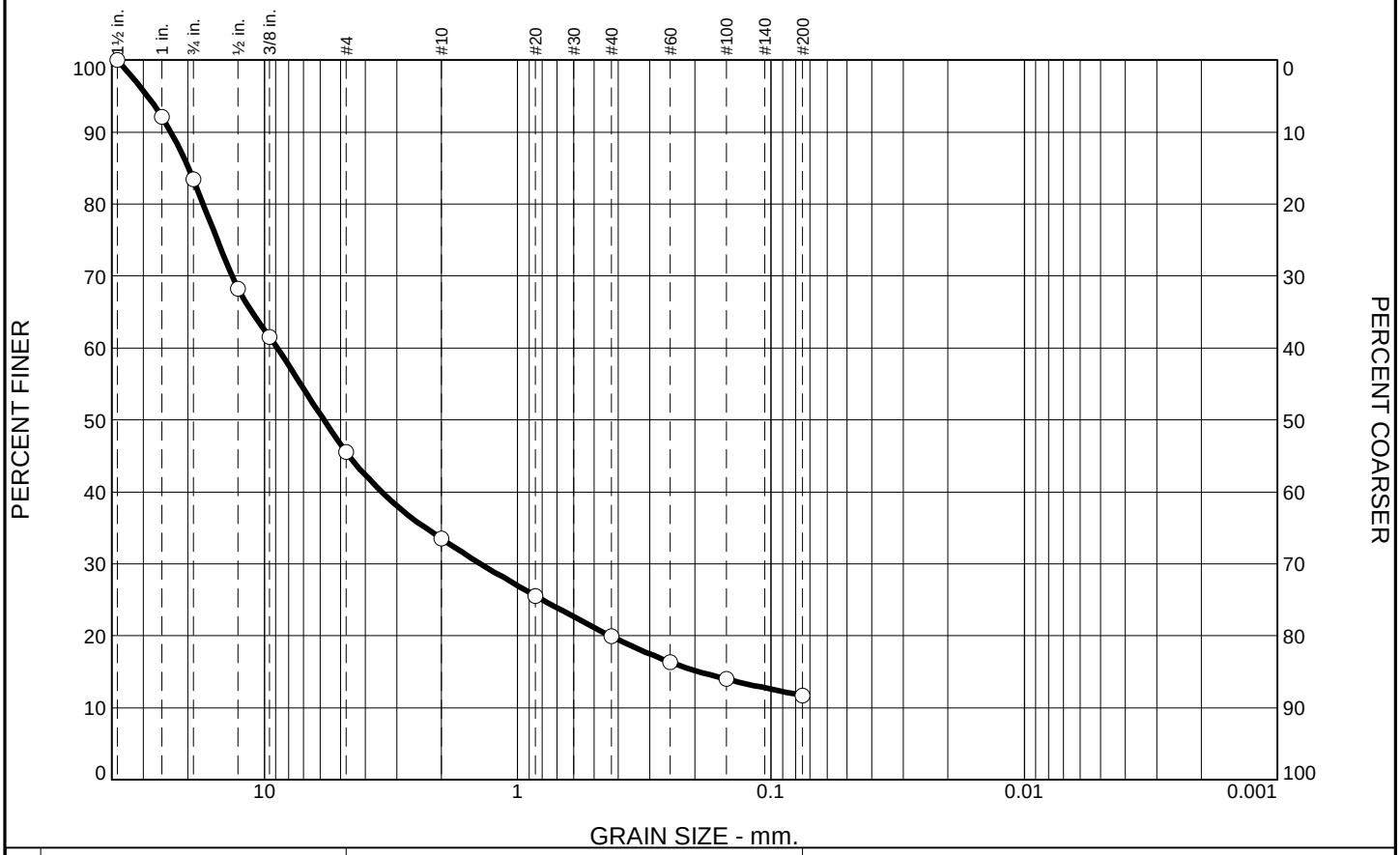
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.6	37.8	12.1	13.6	8.2	11.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	92.1		
.75	83.4		
.5	68.3		
.375	61.5		
#4	45.6		
#10	33.5		
#20	25.6		
#40	19.9		
#60	16.3		
#100	14.0		
#200	11.7		

* (no specification provided)

BROWN POORLY GRADED GRAVEL WITH SILT AND SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 23.4043 D_{85}= 19.9202 D_{60}= 8.8946
D_{50}= 5.8205 D_{30}= 1.3976 D_{15}= 0.1913
D_{10}= C_u= C_c=

Classification

USCS= GP-GM AASHTO=

Remarks

F.M.=4.92

Source of Sample: HEN-B008 **Depth:** 20.0'-21.5'
Sample Number: S-7 **Date:** 11-25-15

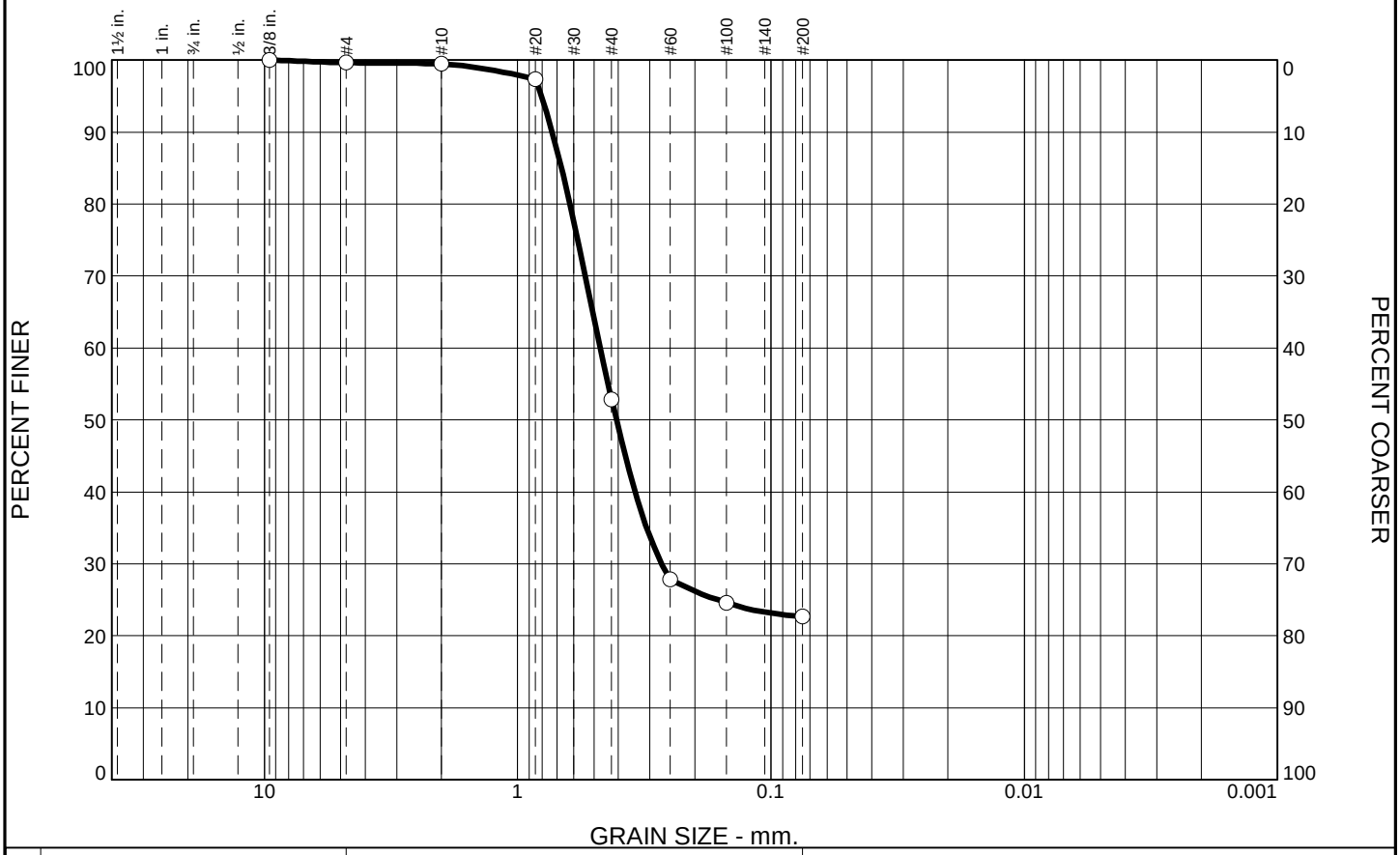
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	0.1	46.7	30.1	22.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.6		
#10	99.5		
#20	97.4		
#40	52.8		
#60	27.9		
#100	24.6		
#200	22.7		

* (no specification provided)

BROWN SILTY SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.7292 D_{85}= 0.6712 D_{60}= 0.4713
D_{50}= 0.4071 D_{30}= 0.2705 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

F.M.=1.67

Source of Sample: HEN-B009 **Depth:** 25.0'-26.5'
Sample Number: S-8 **Date:** 11-25-15

Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	1.3	68.8	29.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	99.5		
#40	98.5		
#60	95.9		
#100	48.3		
#200	29.7		

* (no specification provided)

BROWN SILTY SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2298 D_{85}= 0.2170 D_{60}= 0.1702
D_{50}= 0.1531 D_{30}= 0.0759 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

F.M.=0.56

Source of Sample: HEN-B009 **Depth:** 40.0'-41.5'
Sample Number: S-11 **Date:** 11-25-15

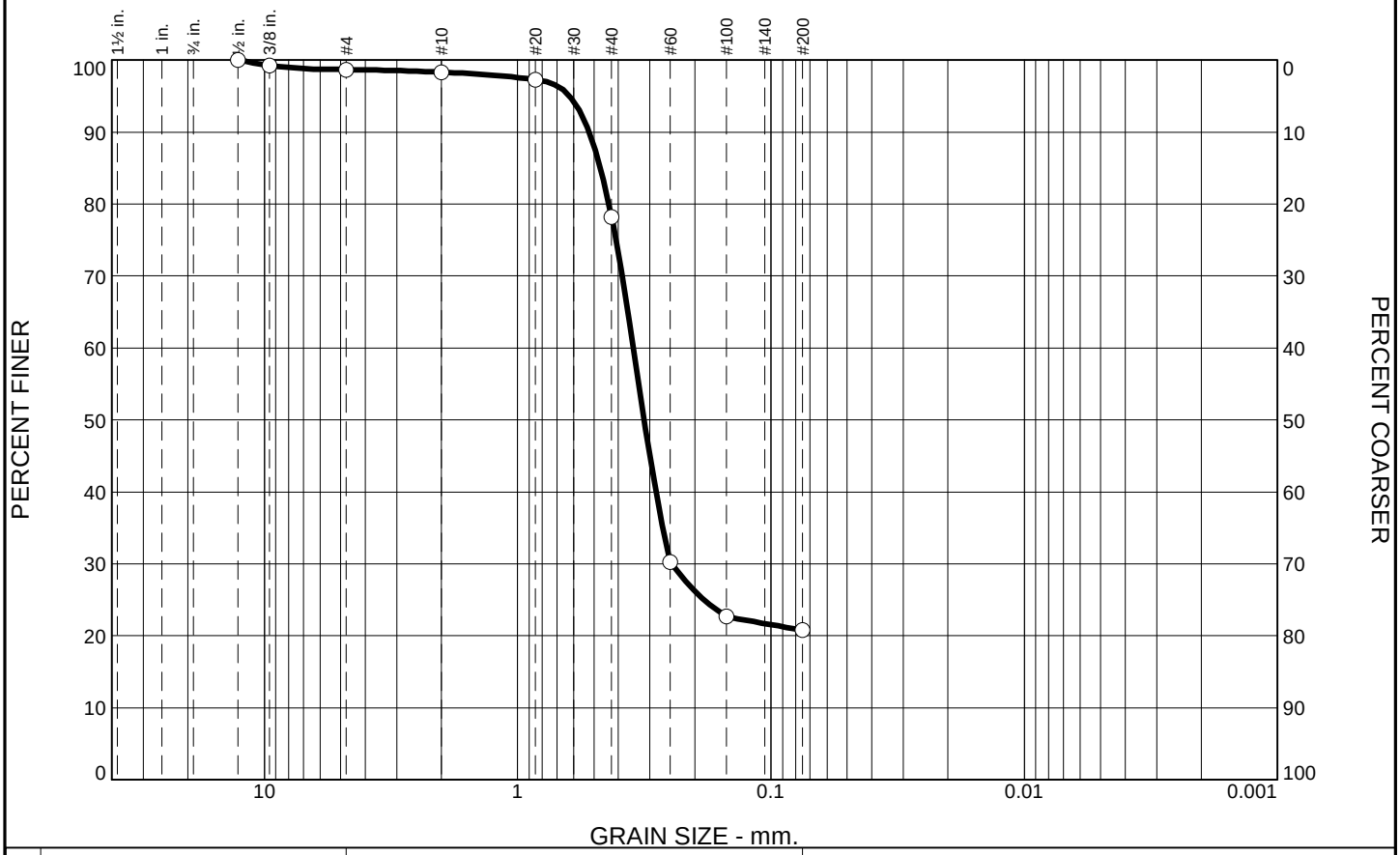
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.3	0.4	20.1	57.4	20.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.50	100.0		
.375	99.2		
#4	98.7		
#10	98.3		
#20	97.3		
#40	78.2		
#60	30.2		
#100	22.7		
#200	20.8		

* (no specification provided)

BROWN AND DARK BROWN SILTY SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5217 D_{85}= 0.4703 D_{60}= 0.3489
D_{50}= 0.3162 D_{30}= 0.2471 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

F.M.=1.44

Source of Sample: HEN-B010 **Depth:** 7.5'-9.0'
Sample Number: S-4 **Date:** 11-25-15

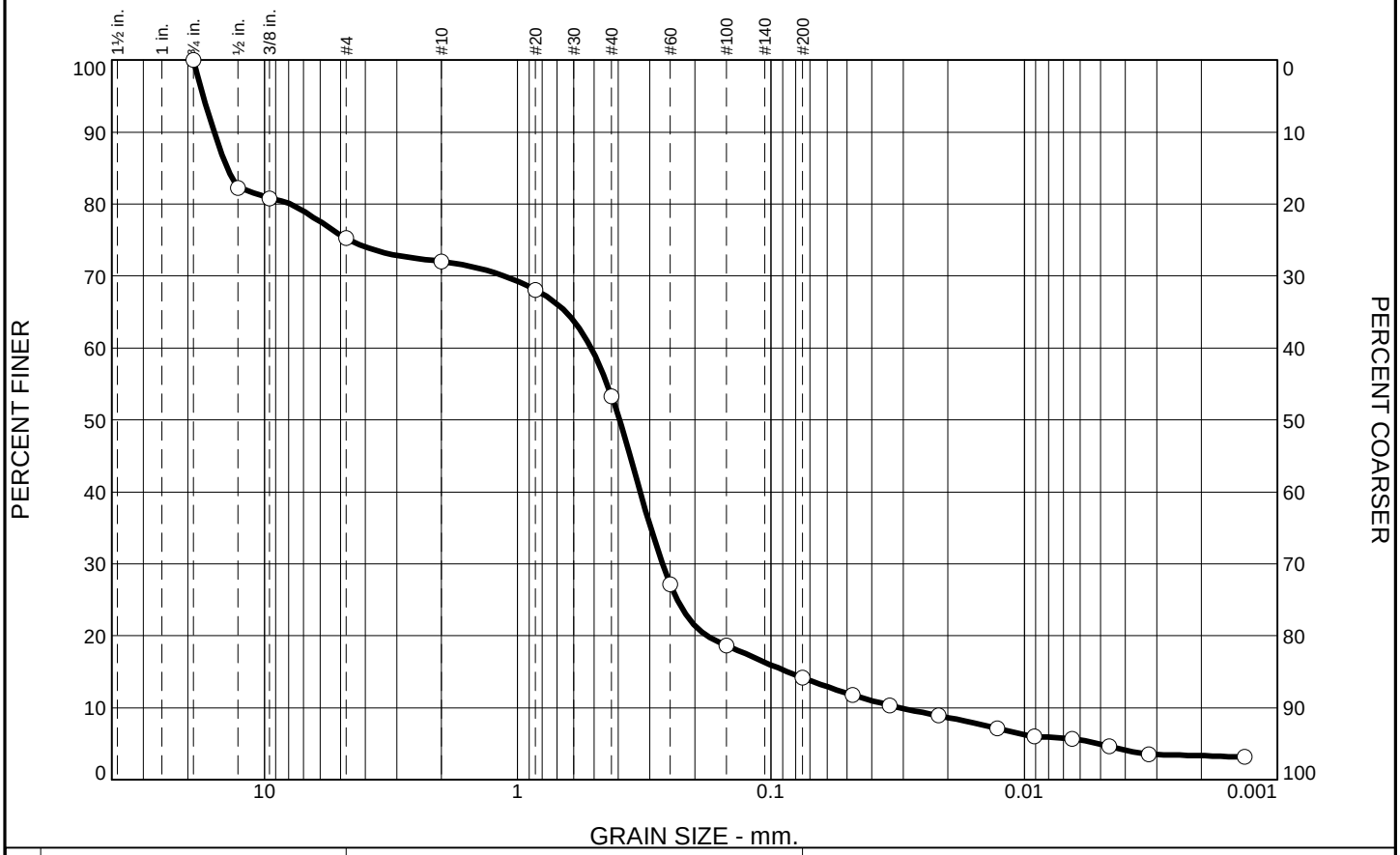
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	24.8	3.2	18.7	39.1	9.3	4.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	82.2		
.375	80.7		
#4	75.2		
#10	72.0		
#20	68.1		
#40	53.3		
#60	27.1		
#100	18.7		
#200	14.2		

* (no specification provided)

BROWN TO DARK BROWN POORLY GRADED SAND WITH SILT AND GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 15.7800 D_{85}= 14.0146 D_{60}= 0.5125
D_{50}= 0.3959 D_{30}= 0.2684 D_{15}= 0.0861
D_{10}= 0.0310 C_u= 16.55 C_c= 4.54

Classification

USCS= SP-SM AASHTO=

Remarks

F.M.=2.84

Source of Sample: HEN-B010 **Depth:** 20.0'-21.5'
Sample Number: S-7 **Date:** 12-4-15

Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	8.2	2.8	55.2	9.9	23.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	97.6		
.375	95.1		
#4	91.8		
#10	89.0		
#20	68.3		
#40	33.8		
#60	27.9		
#100	25.8		
#200	23.9		

* (no specification provided)

BROWN SILTY SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.3059 D_{85}= 1.4549 D_{60}= 0.7240
D_{50}= 0.6053 D_{30}= 0.3582 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

F.M.=2.39

Source of Sample: HEN-B010 **Depth:** 40.0'-41.5'
Sample Number: S-11 **Date:** 11-25-15

Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.9	30.5	7.7	12.7	16.2	16.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	83.1		
.5	72.9		
.375	65.1		
#4	52.6		
#10	44.9		
#20	40.0		
#40	32.2		
#60	22.6		
#100	18.1		
#200	16.0		

* (no specification provided)

BROWN SILTY GRAVEL WITH SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 21.7378 D_{85}= 19.8442 D_{60}= 7.6494
D_{50}= 3.7604 D_{30}= 0.3762 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GM AASHTO=

Remarks

F.M.=4.30

Source of Sample: HEN-B011 **Depth:** 15.0'-16.5'
Sample Number: S-6 **Date:** 11-25-15

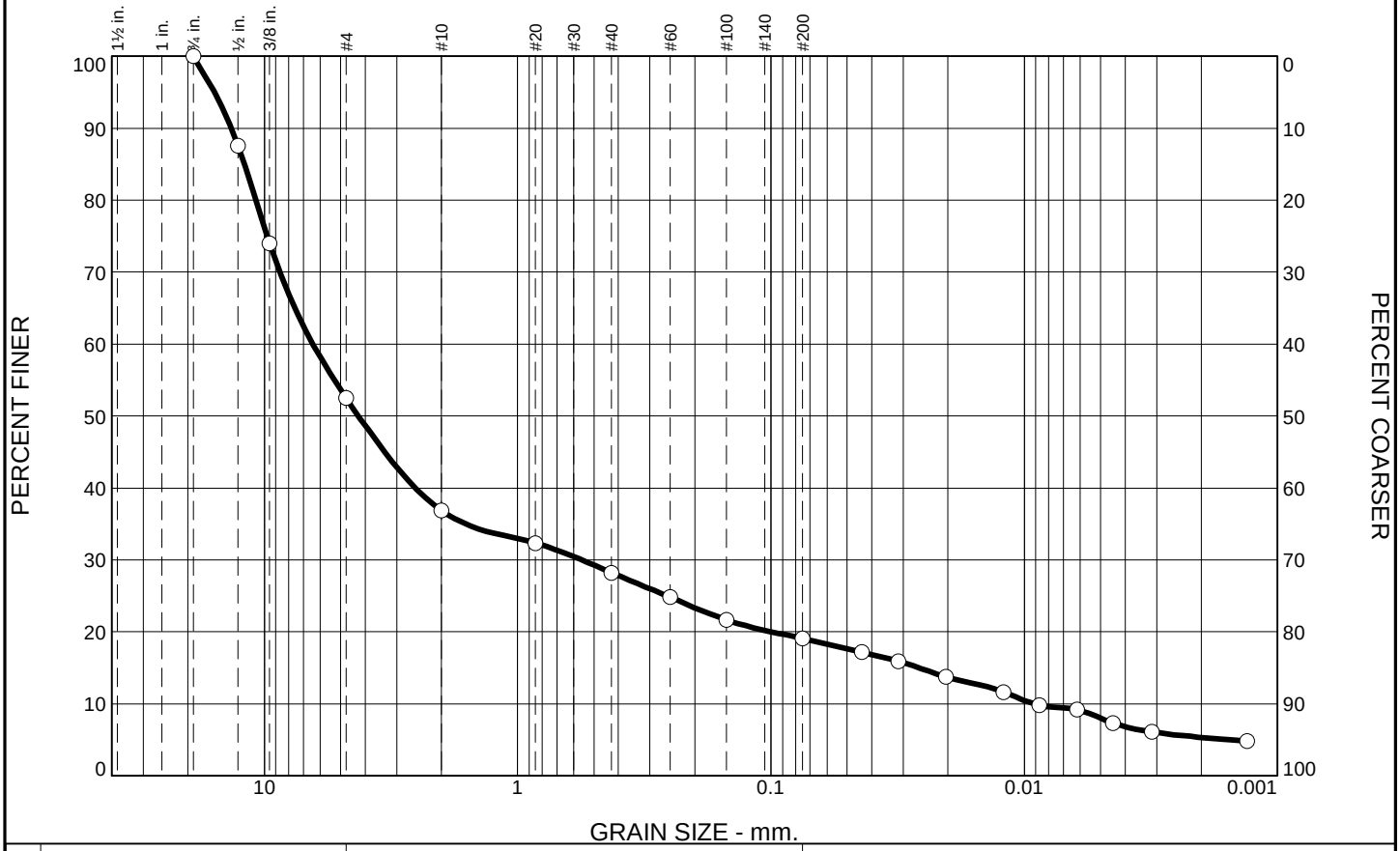
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	47.5	15.6	8.7	9.1	11.1	8.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	87.6		
.375	74.0		
#4	52.5		
#10	36.9		
#20	32.3		
#40	28.2		
#60	24.8		
#100	21.7		
#200	19.1		

* (no specification provided)

LIGHT BROWN AND LIGHT GRAY SILTY GRAVEL WITH SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 13.5067 D_{85}= 11.9845 D_{60}= 6.4325
D_{50}= 4.2474 D_{30}= 0.5575 D_{15}= 0.0261
D_{10}= 0.0092 C_u= 701.49 C_c= 5.27

Classification

USCS= GM AASHTO=

Remarks

F.M.=4.23

Source of Sample: HEN-B012 **Depth:** 2.5'-4.0'
Sample Number: S-2 **Date:** 12-4-15

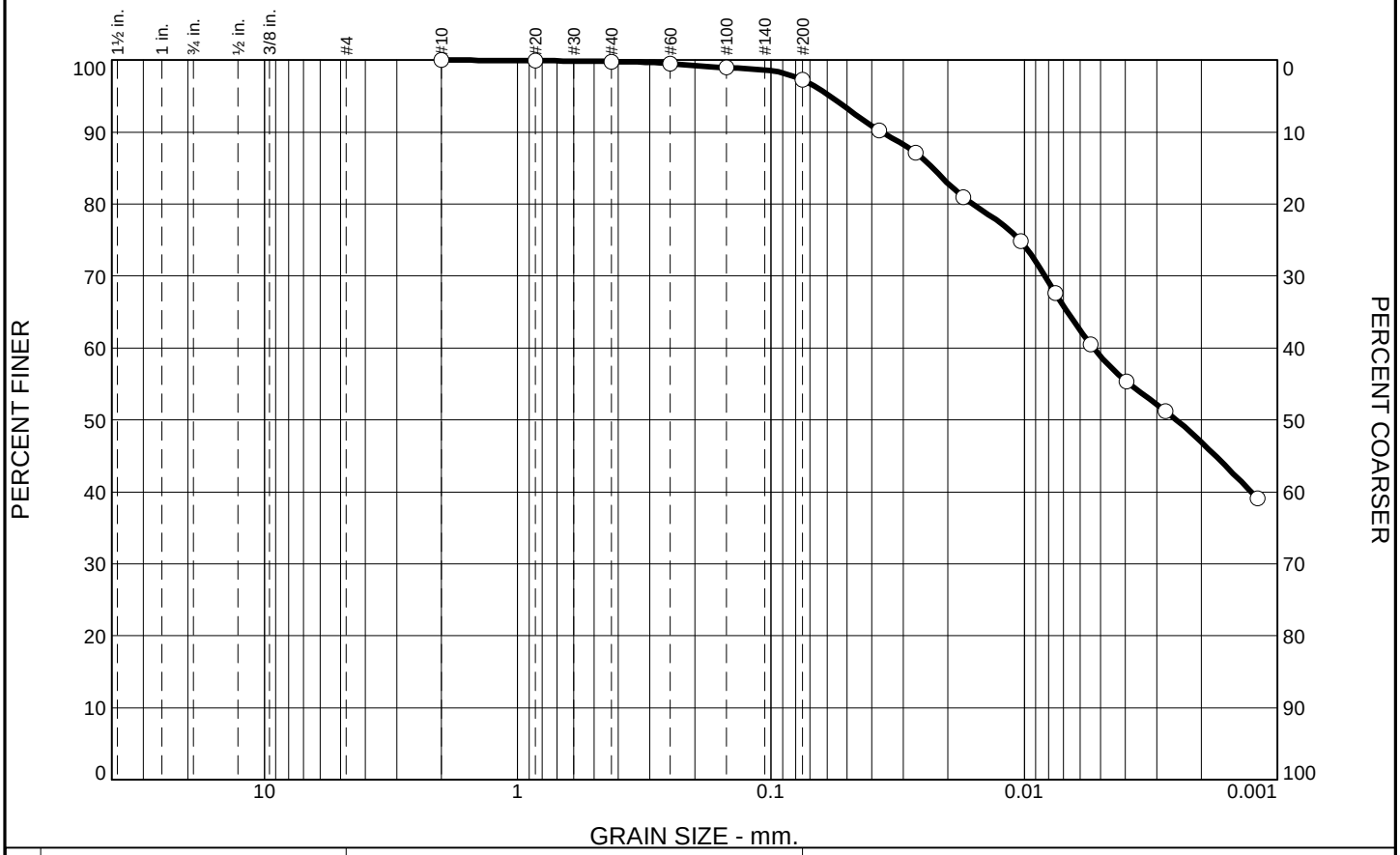
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	2.5	38.5	58.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	99.8		
#60	99.5		
#100	98.9		
#200	97.3		

* (no specification provided)

VERY DARK GRAY LEAN CLAY - ORGANICS NOTED

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0366 D_{85}= 0.0230 D_{60}= 0.0053
D_{50}= 0.0025 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

F.M.=0.02

Source of Sample: HEN-B012 **Depth:** 20.0'-22.0'
Sample Number: S-7

Date: 12-17-15

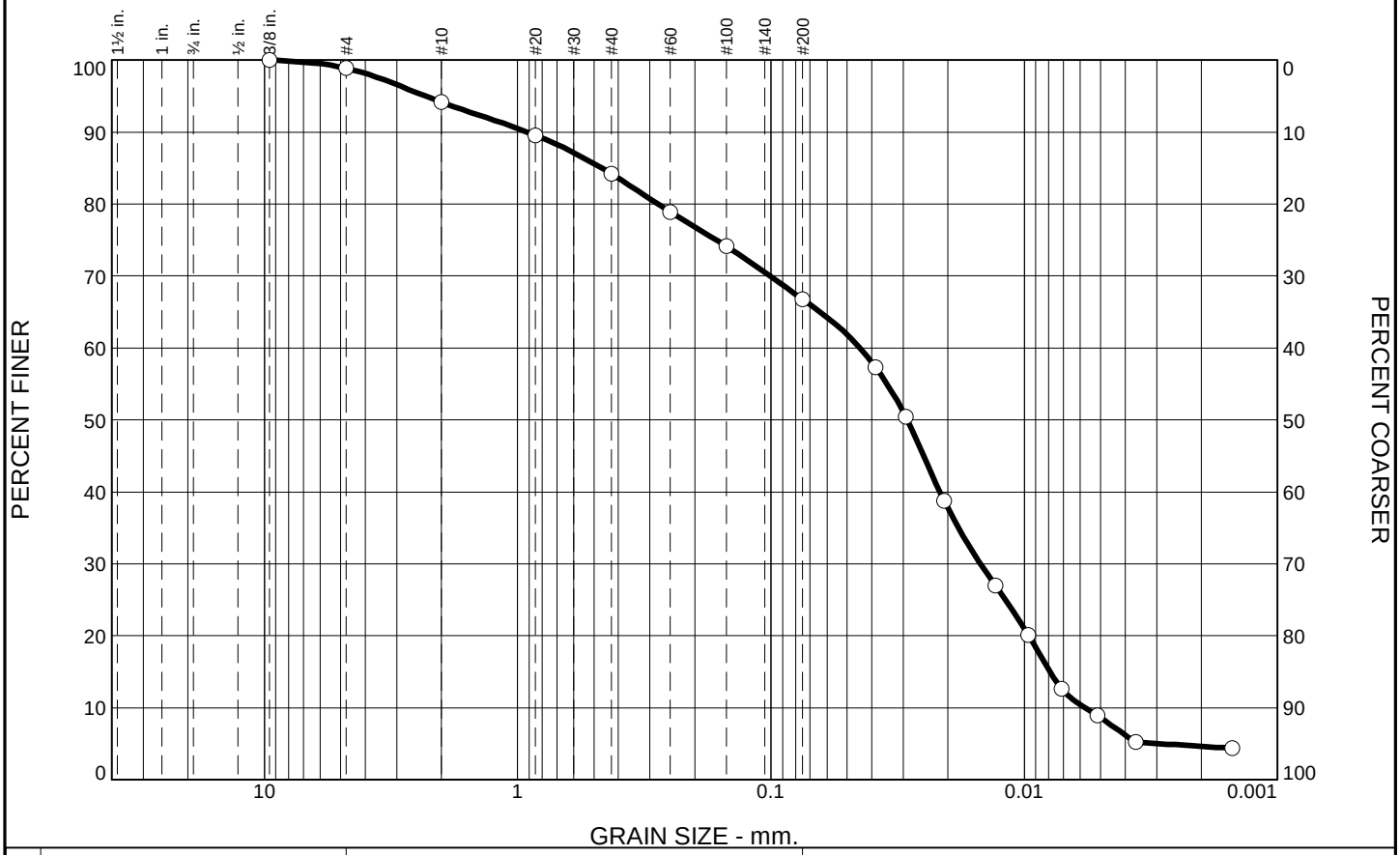
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.1	4.7	10.0	17.4	58.1	8.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	98.9		
#10	94.2		
#20	89.5		
#40	84.2		
#60	78.9		
#100	74.1		
#200	66.8		

* (no specification provided)

DARK GRAY FLY ASH

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.9160 D_{85}= 0.4652 D_{60}= 0.0445
D_{50}= 0.0290 D_{30}= 0.0149 D_{15}= 0.0079
D_{10}= 0.0058 C_u= 7.71 C_c= 0.86

Classification

USCS= AASHTO=

Remarks

F.M.=0.73

Source of Sample: HEN-B014 **Depth:** 7.5'-9.0'
Sample Number: S-4 **Date:** 12-9-15

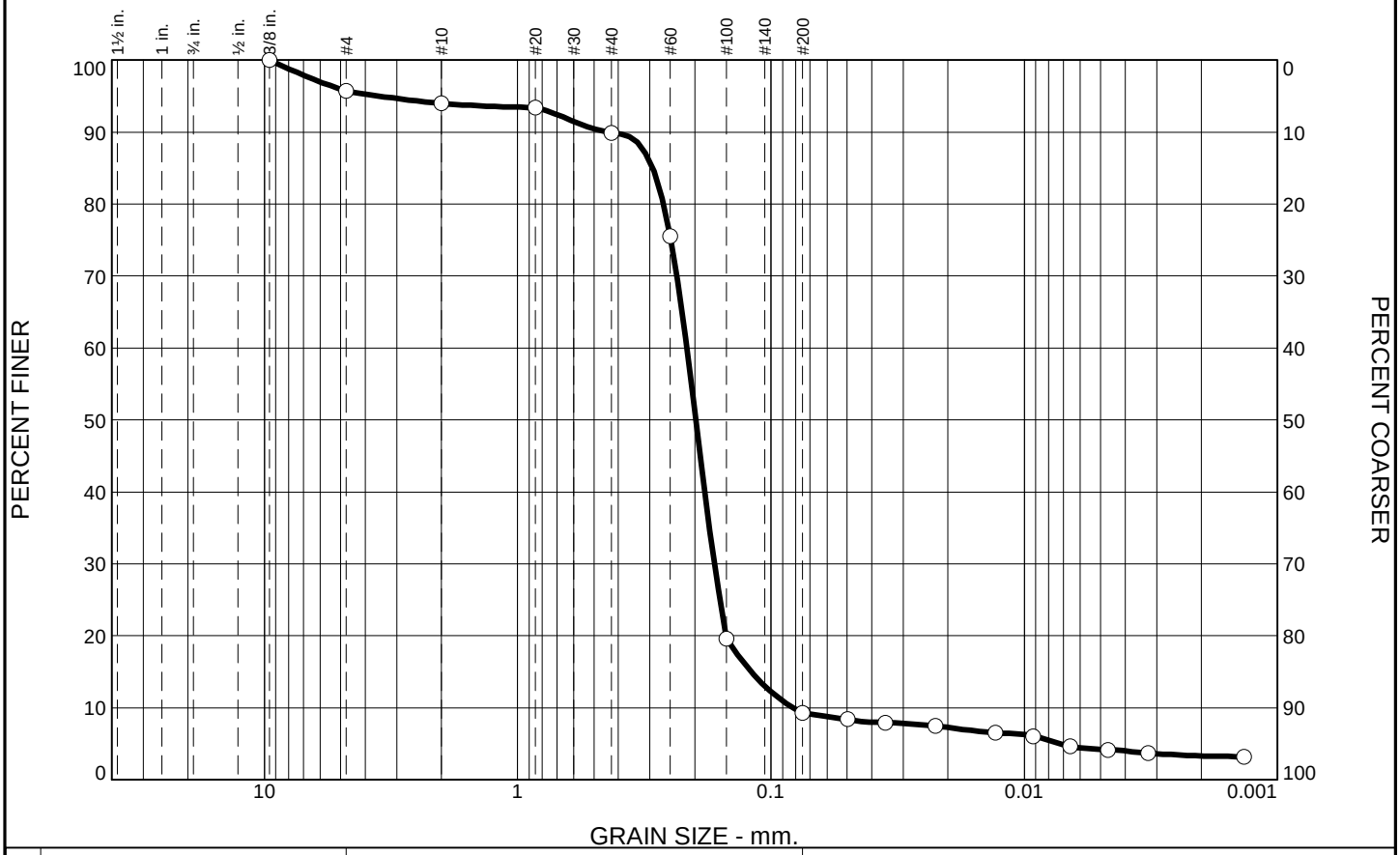
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.3	1.7	4.1	80.6	5.1	4.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	95.7		
#10	94.0		
#20	93.4		
#40	89.9		
#60	75.6		
#100	19.6		
#200	9.3		

* (no specification provided)

GRAY POORLY GRADED SAND WITH SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4408 D_{85}= 0.2931 D_{60}= 0.2146
D_{50}= 0.1976 D_{30}= 0.1670 D_{15}= 0.1195
D_{10}= 0.0819 C_u= 2.62 C_c= 1.59

Classification

USCS= SP-SM AASHTO=

Remarks

F.M.=1.20

Source of Sample: HEN-B014 **Depth:** 45.0'-46.5'
Sample Number: S-12 **Date:** 12-4-15

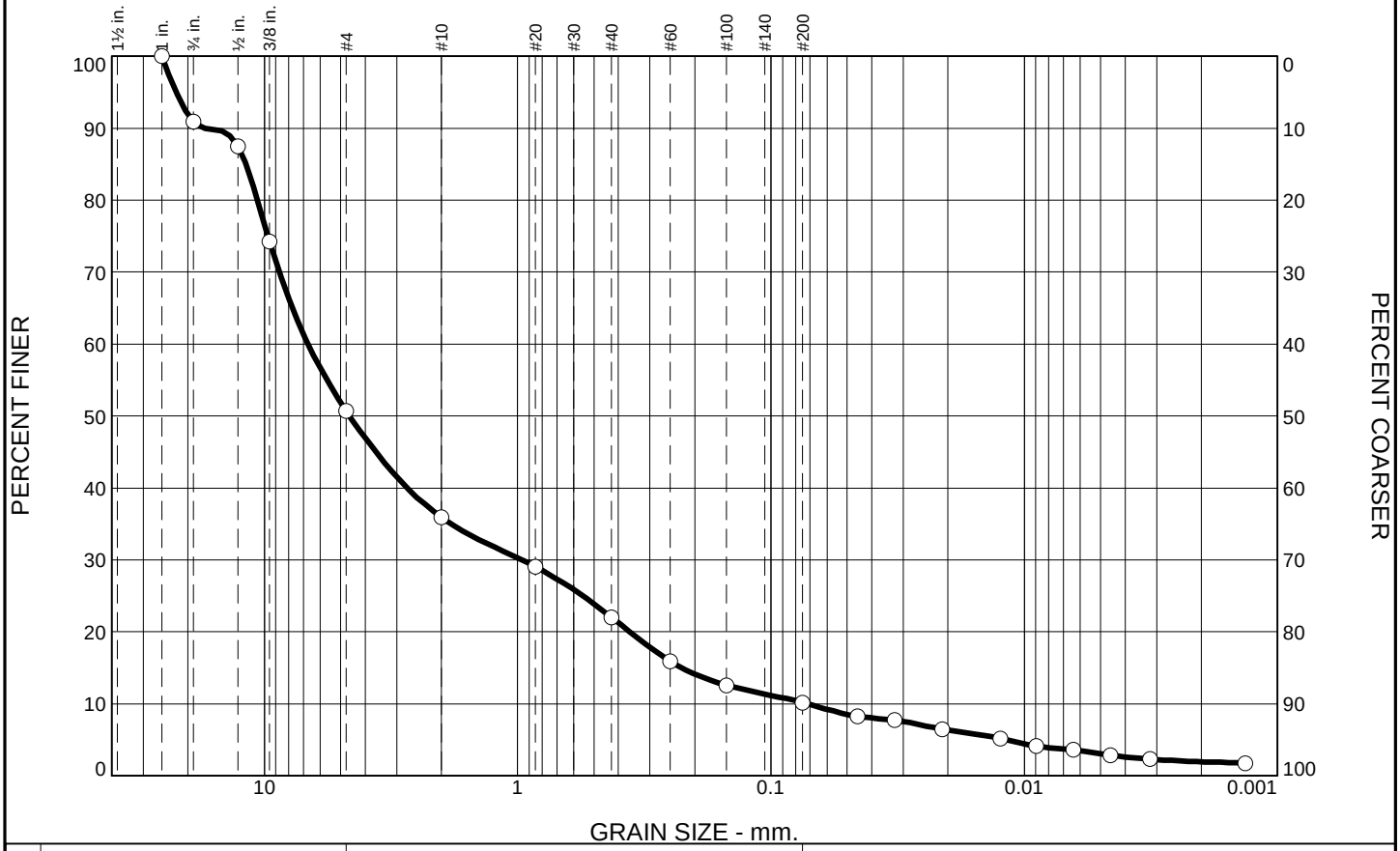
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	9.1	40.2	14.8	13.9	11.8	7.1	3.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	90.9		
.5	87.5		
.375	74.2		
#4	50.7		
#10	35.9		
#20	29.1		
#40	22.0		
#60	15.9		
#100	12.6		
#200	10.2		

* (no specification provided)

GRAY AND BROWN POORLY GRADED GRAVEL WITH SILT AND SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 17.2255 D_{85}= 11.8295 D_{60}= 6.7167
D_{50}= 4.6068 D_{30}= 0.9599 D_{15}= 0.2250
D_{10}= 0.0718 C_u= 93.58 C_c= 1.91

Classification

USCS= GP-GM AASHTO=

Remarks

F.M.=4.59

Source of Sample: HEN-B015 **Depth:** 45.0'-46.5'
Sample Number: S-12 **Date:** 12-4-15

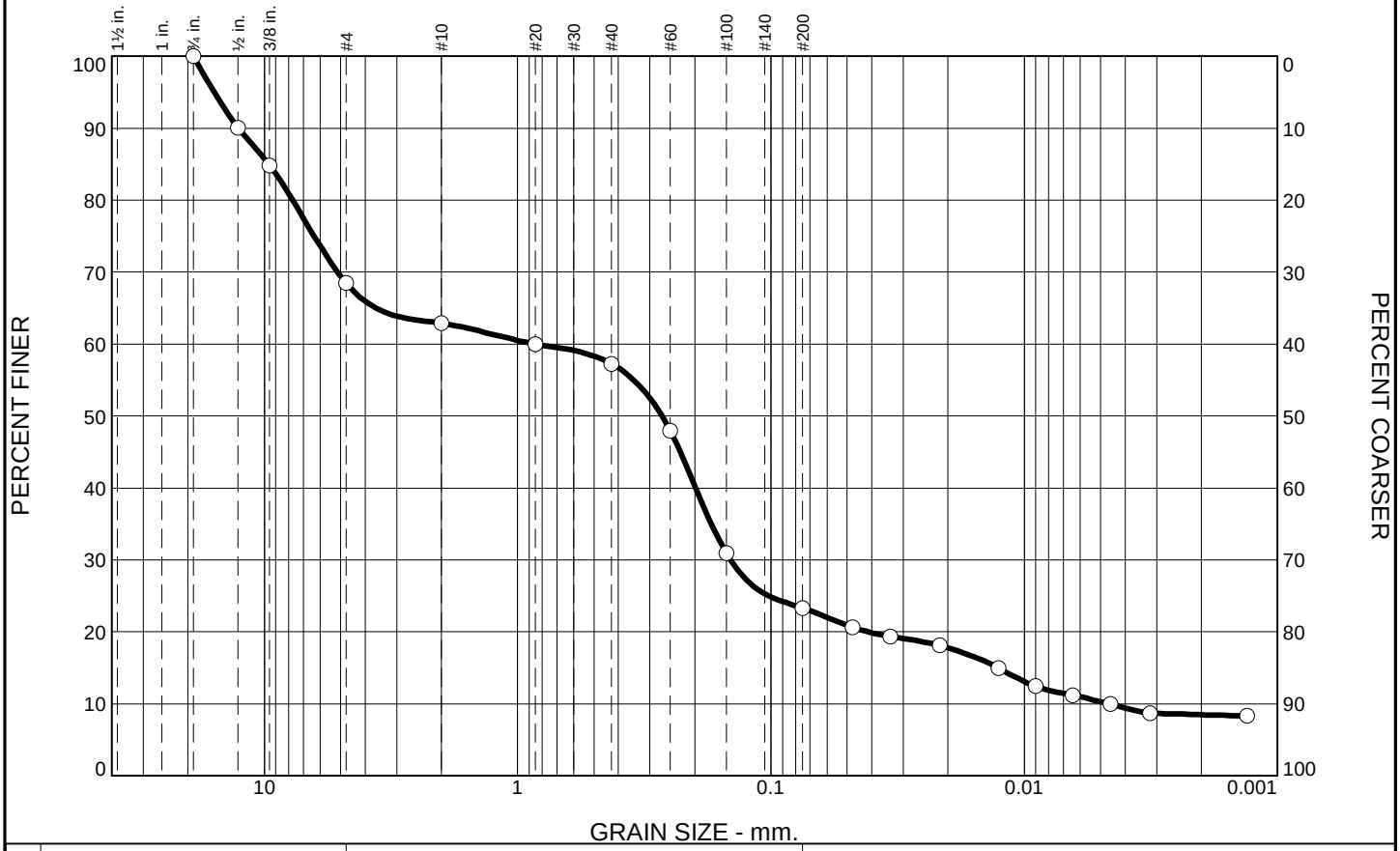
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	31.5	5.6	5.7	33.9	13.0	10.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	90.1		
.375	84.8		
#4	68.5		
#10	62.9		
#20	60.0		
#40	57.2		
#60	48.0		
#100	30.9		
#200	23.3		

* (no specification provided)

DARK BROWN AND BROWN SILTY SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 12.6514 D_{85}= 9.6003 D_{60}= 0.8530
D_{50}= 0.2690 D_{30}= 0.1447 D_{15}= 0.0127
D_{10}= 0.0046 C_u= 183.51 C_c= 5.28

Classification

USCS= AASHTO=

Remarks

F.M.=2.80

Source of Sample: HEN-B016 **Depth:** 5.0'-6.5'
Sample Number: S-3 **Date:** 12-9-15

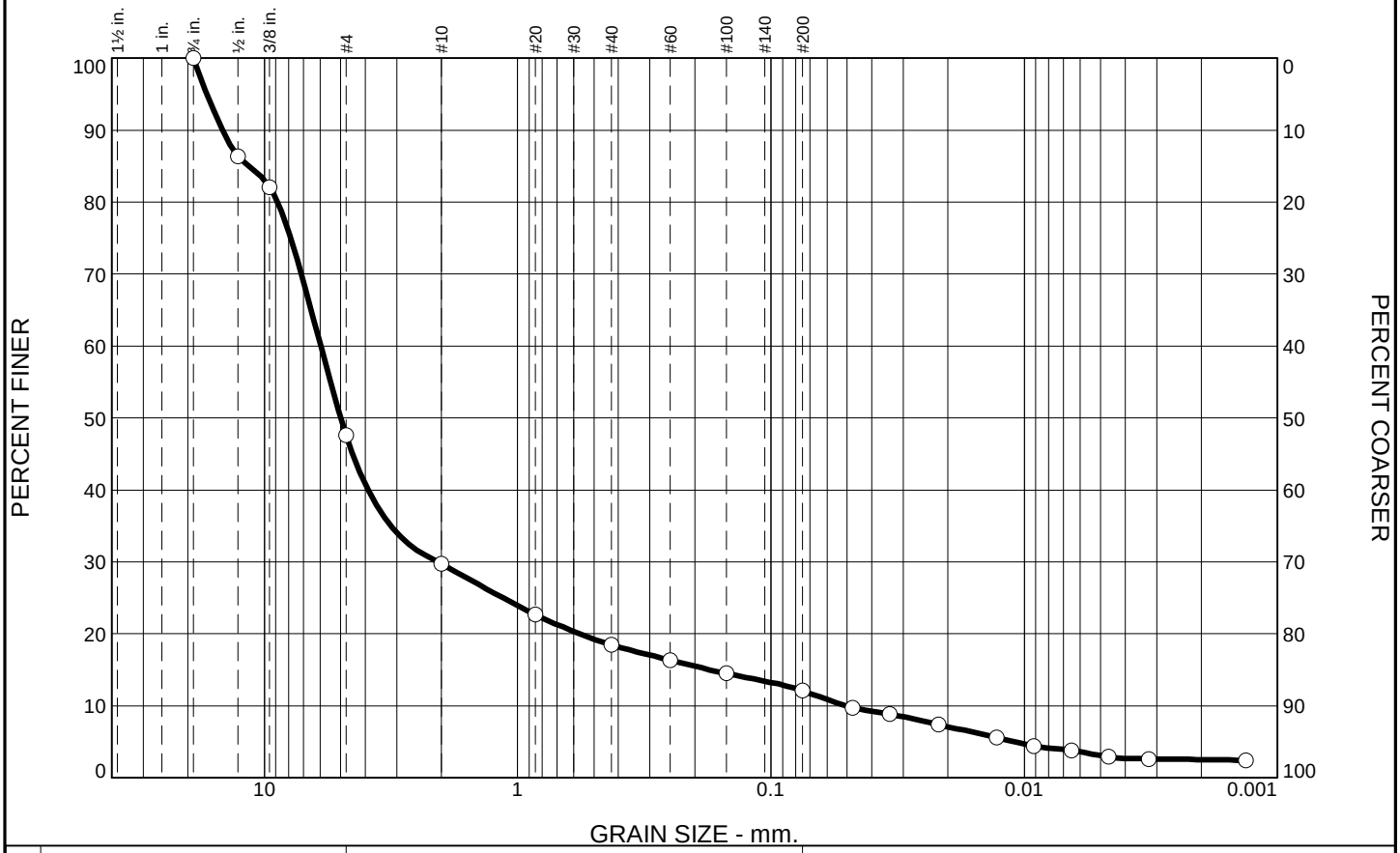
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	52.4	17.9	11.2	6.4	9.0	3.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	86.4		
.375	82.1		
#4	47.6		
#10	29.7		
#20	22.7		
#40	18.5		
#60	16.3		
#100	14.5		
#200	12.1		

* (no specification provided)

BROWNISH GRAY GRAVEL WITH SILT AND SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 14.6414 D_{85}= 11.5354 D_{60}= 5.9837
D_{50}= 4.9929 D_{30}= 2.0751 D_{15}= 0.1743
D_{10}= 0.0507 C_u= 117.95 C_c= 14.19

Classification

USCS= GP-GM AASHTO=

Remarks

F.M.=4.62

Source of Sample: HEN-B016 **Depth:** 70.0'-71.5'
Sample Number: S-17 **Date:** 12-9-15

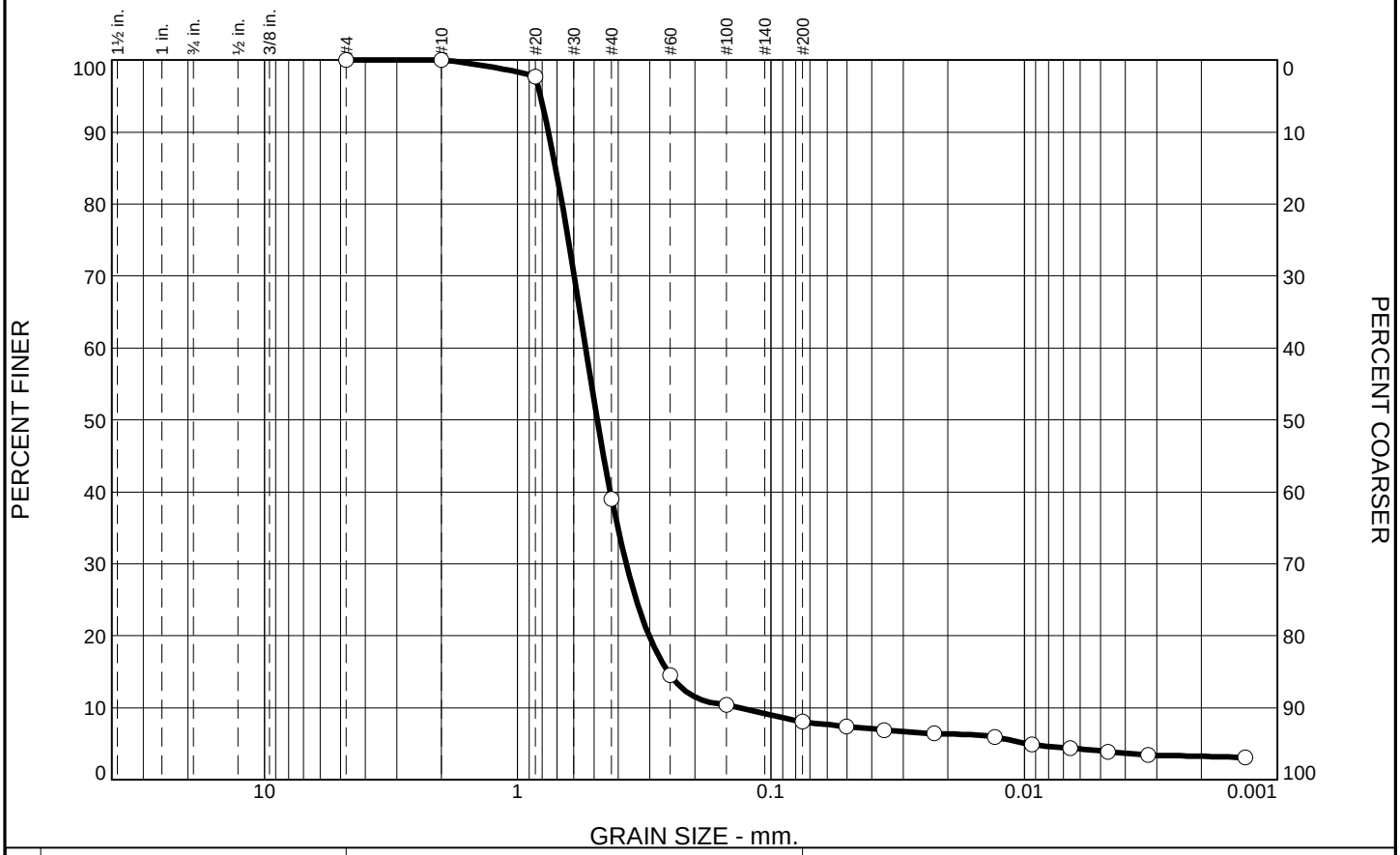
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	60.9	31.0	4.1	4.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	97.7		
#40	39.1		
#60	14.5		
#100	10.4		
#200	8.1		

* (no specification provided)

DARK GRAY SAND WITH SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.7541 D_{85}= 0.7076 D_{60}= 0.5389
D_{50}= 0.4840 D_{30}= 0.3721 D_{15}= 0.2553
D_{10}= 0.1325 C_u= 4.07 C_c= 1.94

Classification

USCS= SM AASHTO=

Remarks

F.M.=2.01

Source of Sample: HEN-B017 **Depth:** 45.0'-46.5'
Sample Number: S-12 **Date:** 12-9-15

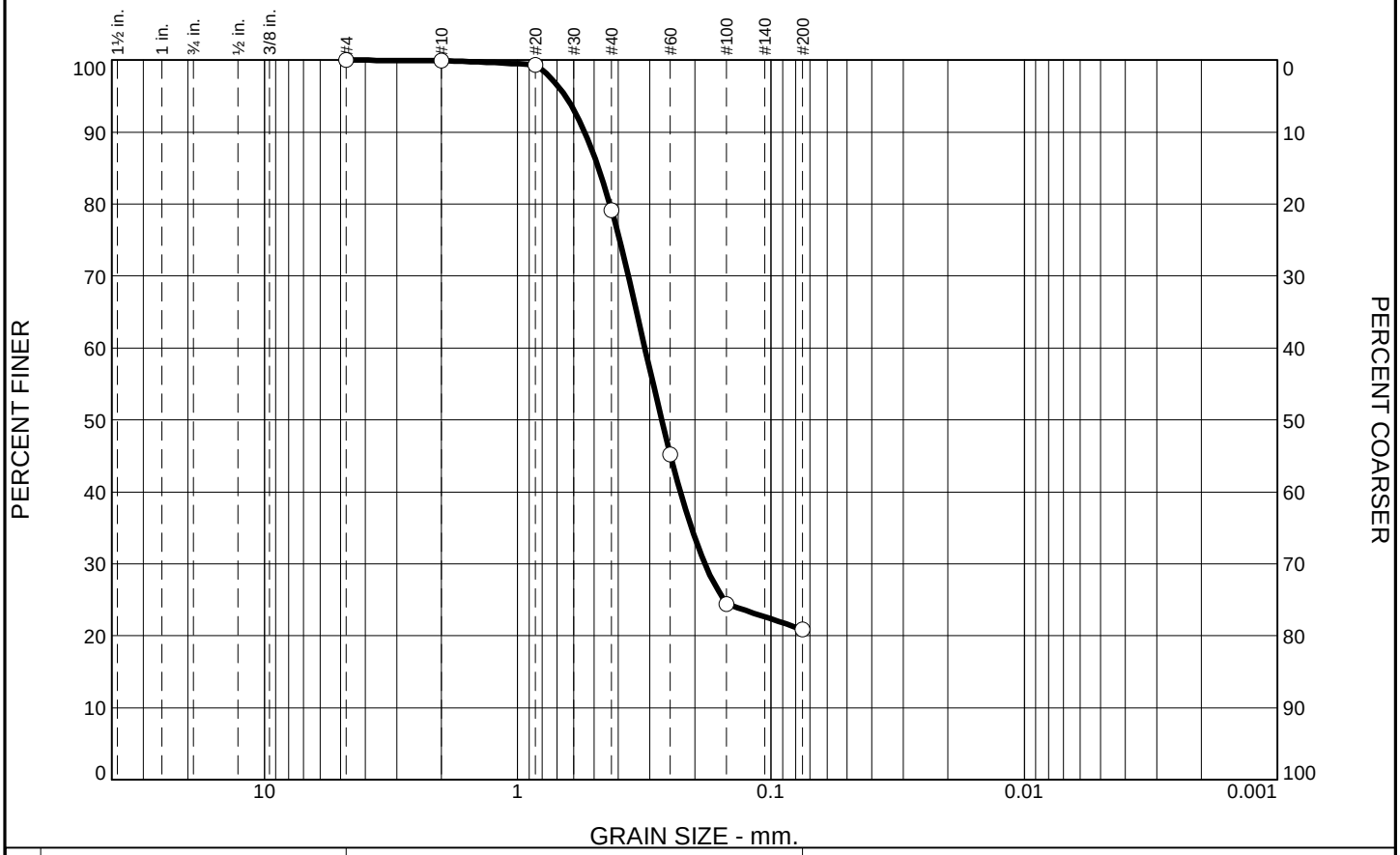
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	20.7	58.3	20.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.3		
#40	79.2		
#60	45.2		
#100	24.4		
#200	20.9		

* (no specification provided)

GRAY AND BROWN SILTY SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5438 D_{85}= 0.4786 D_{60}= 0.3142
D_{50}= 0.2703 D_{30}= 0.1817 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

F.M.=1.26

Source of Sample: HEN-B018 **Depth:** 55.0'-56.5'
Sample Number: S-14 **Date:** 12-7-15

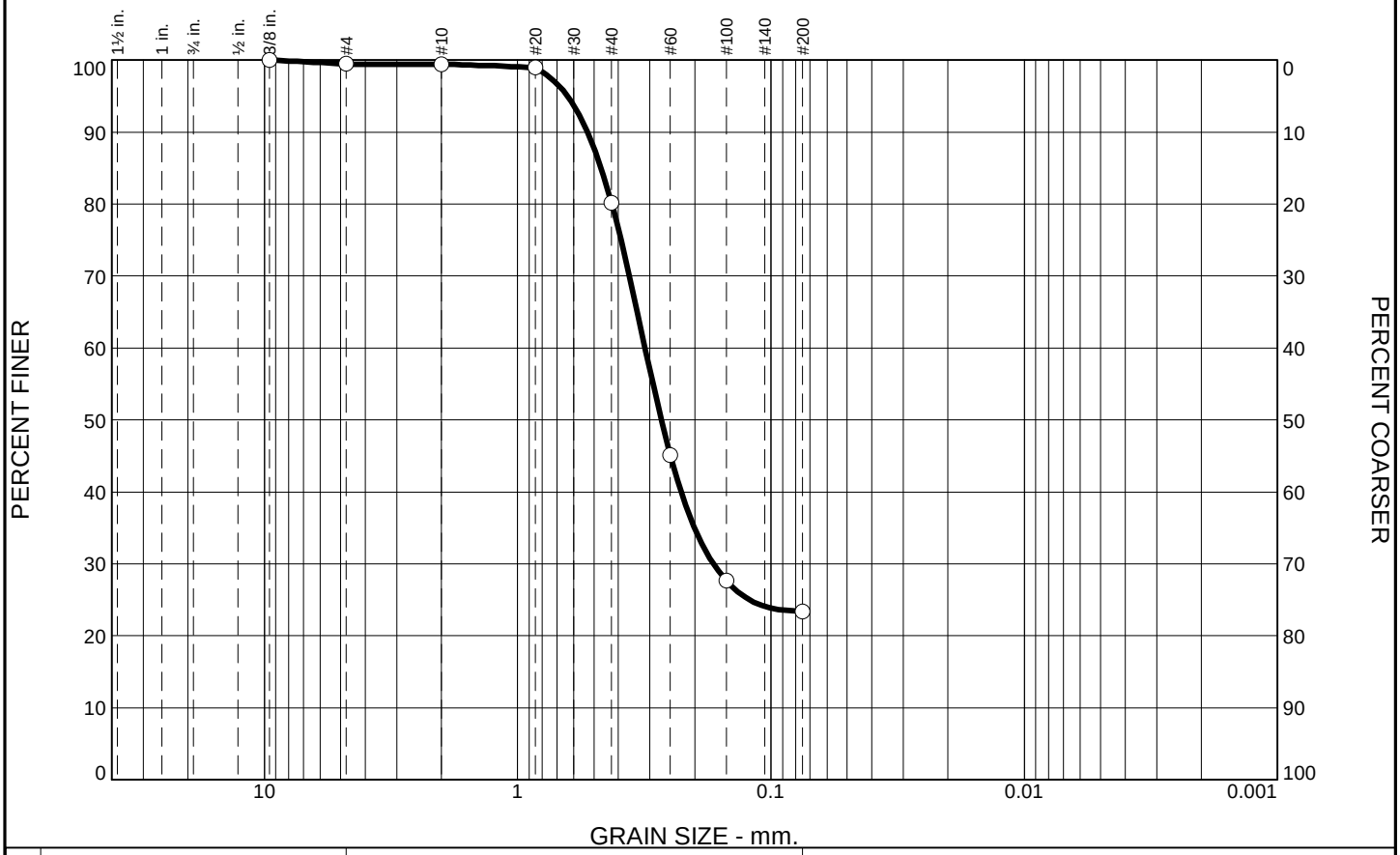
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.1	19.3	56.7	23.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.5		
#10	99.4		
#20	99.0		
#40	80.1		
#60	45.2		
#100	27.7		
#200	23.4		

* (no specification provided)

BROWN AND GRAY SILTY SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5299 D_{85}= 0.4677 D_{60}= 0.3138
D_{50}= 0.2709 D_{30}= 0.1686 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

F.M.=1.24

Source of Sample: HEN-B019 **Depth:** 40.0'-41.5'
Sample Number: S-10 **Date:** 12-7-15

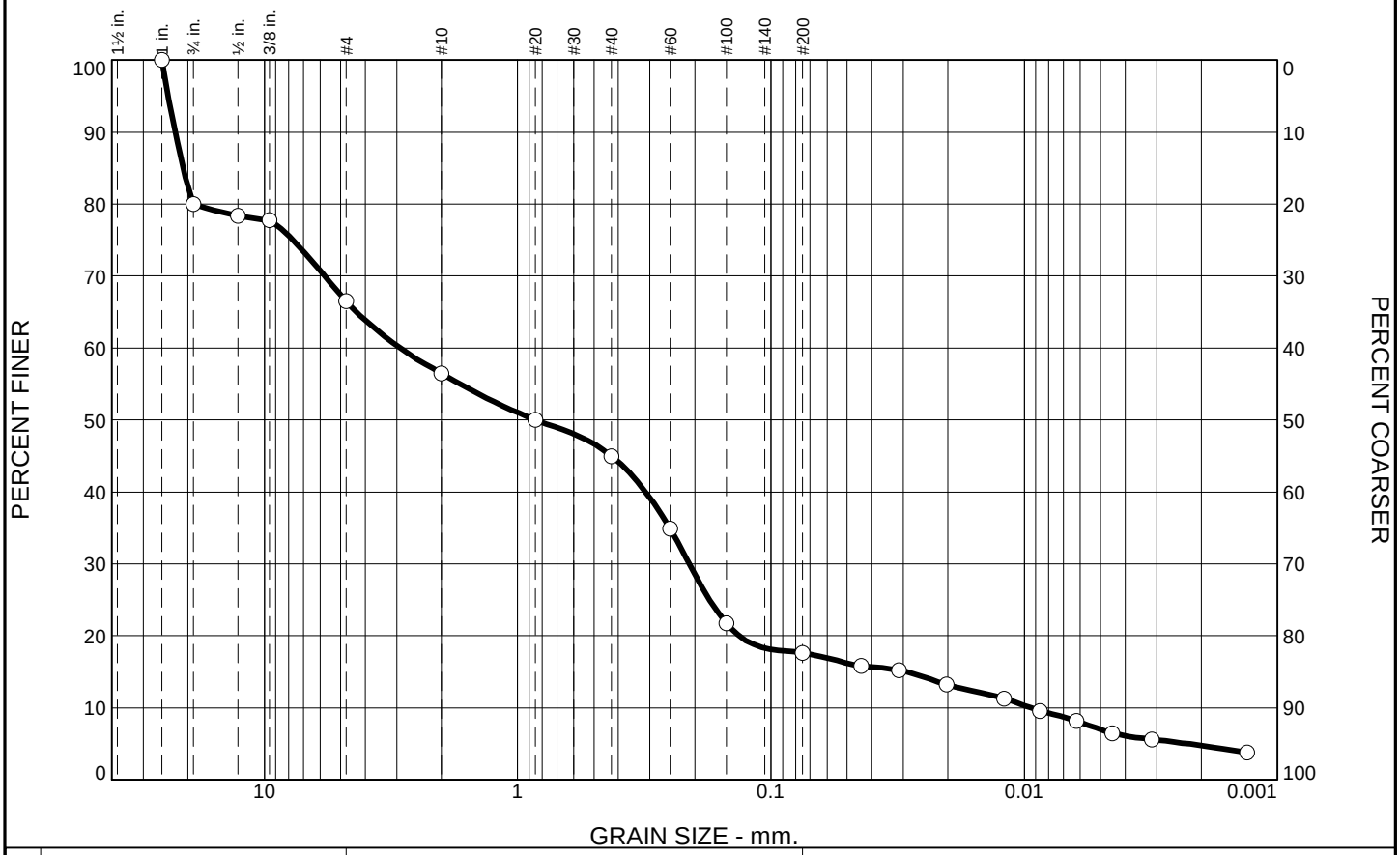
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	20.0	13.5	10.0	11.5	27.4	10.6	7.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	80.0		
.5	78.4		
.375	77.7		
#4	66.5		
#10	56.5		
#20	50.0		
#40	45.0		
#60	34.8		
#100	21.7		
#200	17.6		

* (no specification provided)

BROWN AND REDDISH BROWN SILTY SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 22.4706 D_{85}= 20.9381 D_{60}= 2.9071
D_{50}= 0.8484 D_{30}= 0.2097 D_{15}= 0.0290
D_{10}= 0.0094 C_u= 309.22 C_c= 1.61

Classification

USCS= SM AASHTO=

Remarks

F.M.=3.57

Source of Sample: HEN-B020 **Depth:** 20.0'-21.4'
Sample Number: S-7 **Date:** 12-9-15

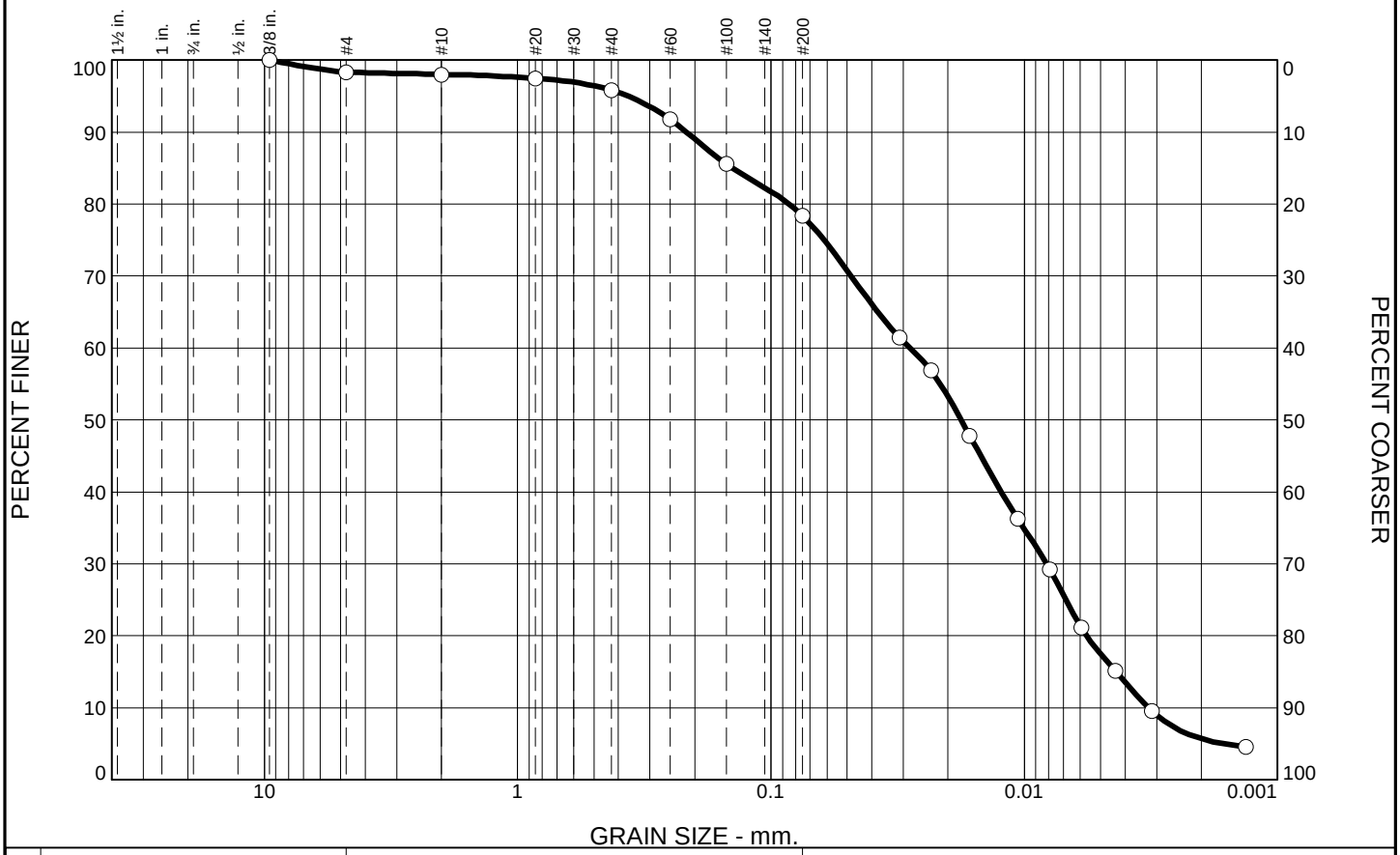
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.7	0.3	2.2	17.5	60.8	17.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	98.3		
#10	98.0		
#20	97.5		
#40	95.8		
#60	91.7		
#100	85.5		
#200	78.3		

* (no specification provided)

DARK GRAY VARVED FLY ASH

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2157 D_{85}= 0.1423 D_{60}= 0.0283
D_{50}= 0.0178 D_{30}= 0.0082 D_{15}= 0.0043
D_{10}= 0.0032 C_u= 8.74 C_c= 0.73

Classification

USCS= AASHTO=

Remarks

F.M.=0.30

Source of Sample: HEN-B021 **Depth:** 22.0'-24.0'
Sample Number: S-8 **Date:** 12-17-15

Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.9	0.5	4.1	39.7	31.6	23.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.1		
#10	98.6		
#20	98.0		
#40	94.5		
#60	80.4		
#100	63.1		
#200	54.8		

* (no specification provided)

DARK GRAY AND BLACK SILTY SAND WITH CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3417 D_{85}= 0.2870 D_{60}= 0.1290
D_{50}= 0.0484 D_{30}= 0.0097 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

F.M.=0.58

Source of Sample: HEN-B021 **Depth:** 35.0'-36.5'
Sample Number: S-11 **Date:** 12-9-15

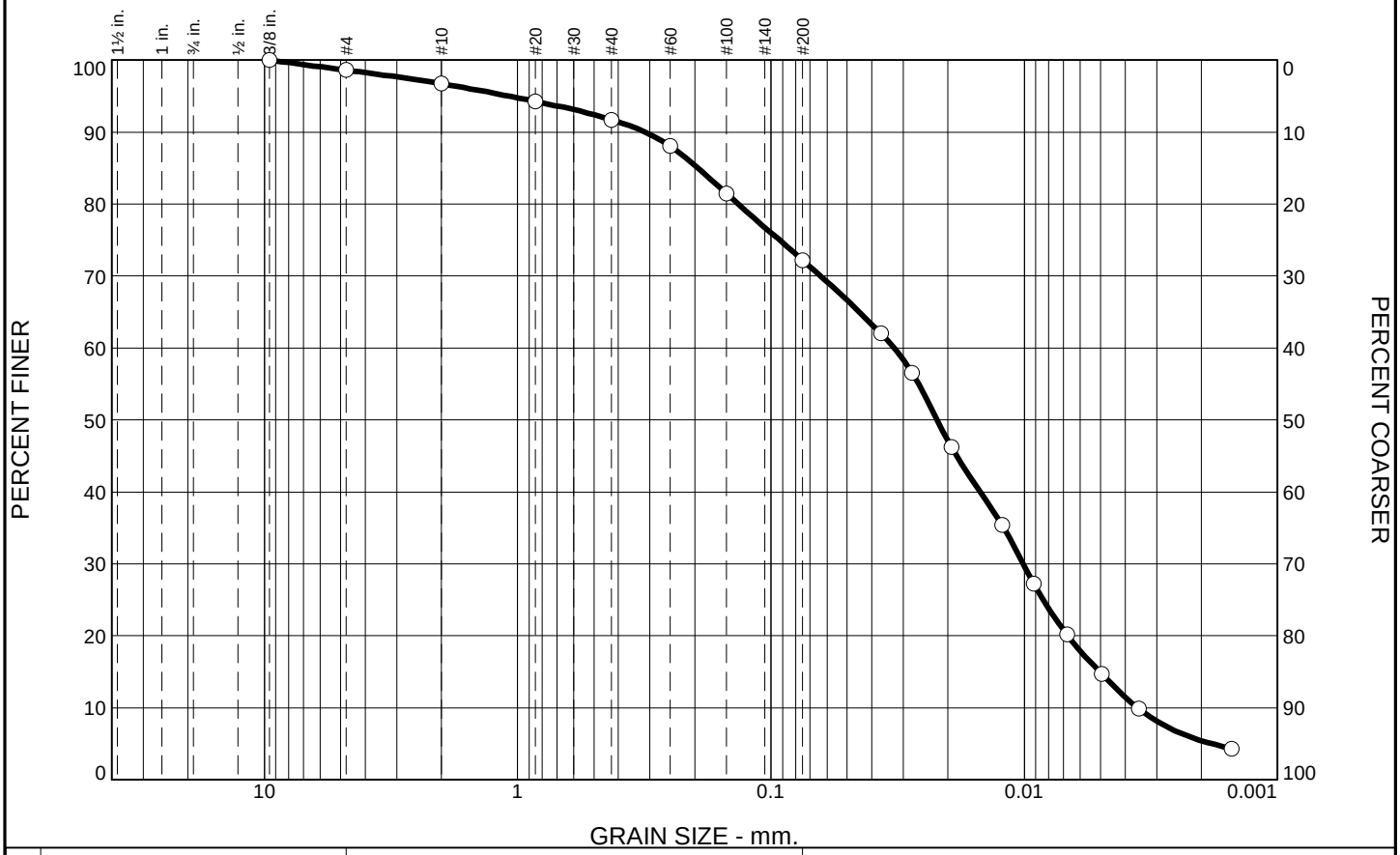
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.4	1.9	5.0	19.5	57.3	14.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	98.6		
#10	96.7		
#20	94.2		
#40	91.7		
#60	88.0		
#100	81.5		
#200	72.2		

* (no specification provided)

VERY DARK GRAY VARVED FLY ASH WITH SAND - SAND SEAMS NOTED

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3145 D_{85}= 0.1939 D_{60}= 0.0327
D_{50}= 0.0221 D_{30}= 0.0101 D_{15}= 0.0050
D_{10}= 0.0036 C_u= 9.15 C_c= 0.88

Classification

USCS= AASHTO=

Remarks

F.M.=0.45

Source of Sample: HEN-B022 **Depth:** 7.5'-9.0'
Sample Number: S-4 **Date:** 12-15-15

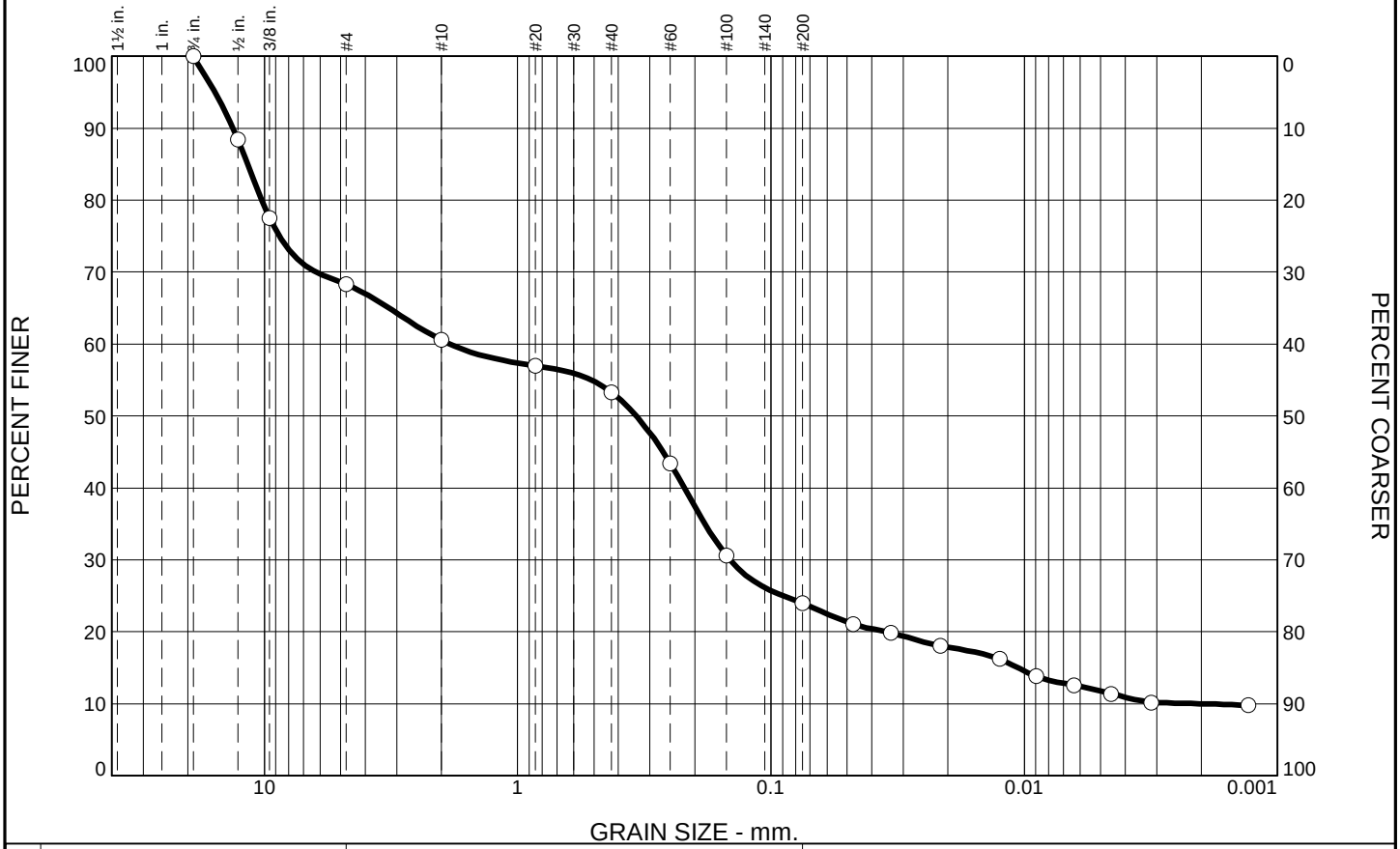
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	31.7	7.8	7.2	29.3	12.2	11.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	88.4		
.375	77.5		
#4	68.3		
#10	60.5		
#20	57.0		
#40	53.3		
#60	43.4		
#100	30.6		
#200	24.0		

* (no specification provided)

BROWN AND TAN SILTY SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 13.2956 D_{85}= 11.6290 D_{60}= 1.8552
D_{50}= 0.3396 D_{30}= 0.1452 D_{15}= 0.0106
D_{10}= 0.0021 C_u= 894.27 C_c= 5.48

Classification

USCS= SM AASHTO=

Remarks

F.M.=3.00

Source of Sample: HEN-B023 **Depth:** 2.5'-4.0'
Sample Number: S-2 **Date:** 12-9-15

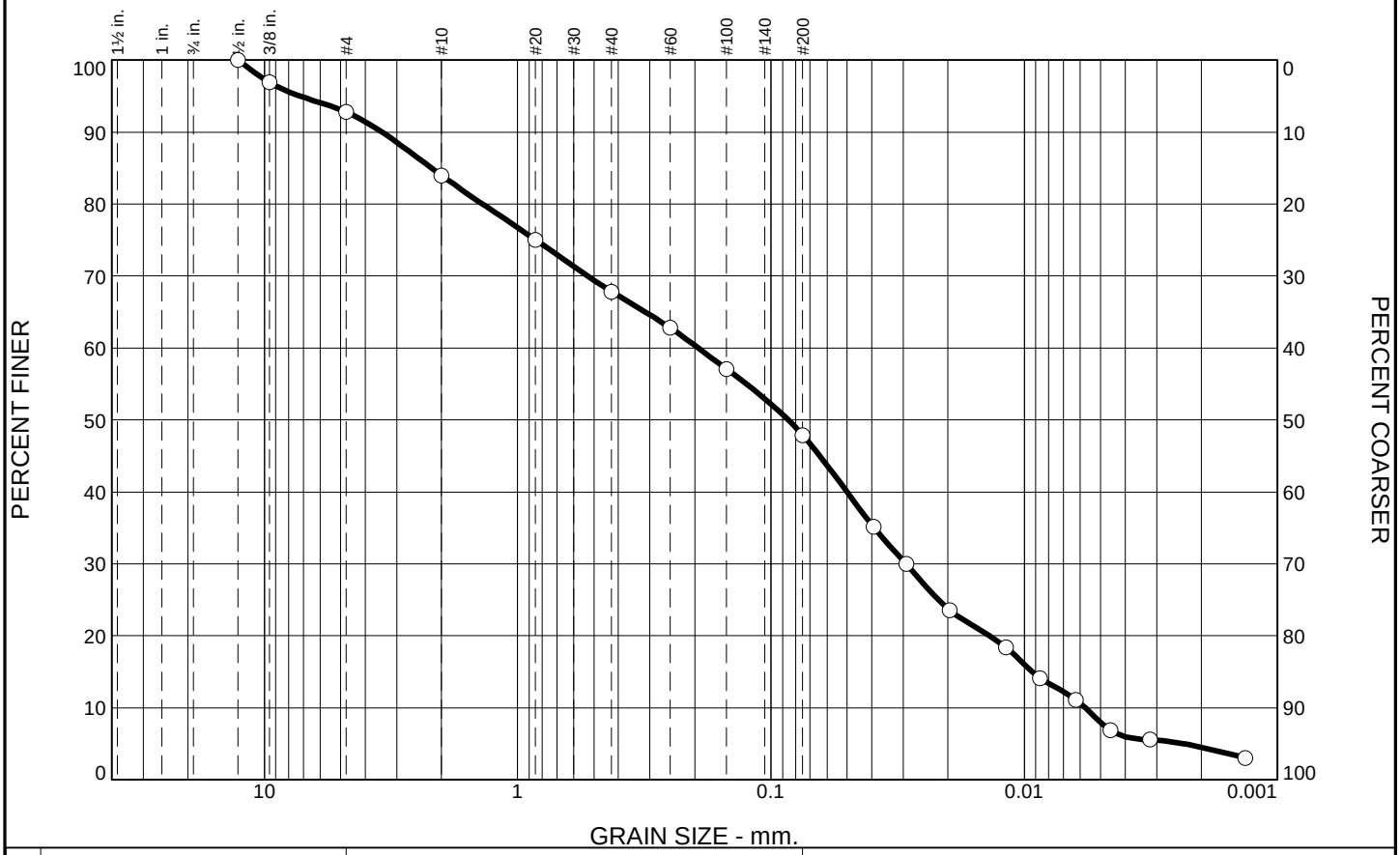
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.2	8.8	16.2	19.9	39.9	8.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.5	100.0		
.375	96.9		
#4	92.8		
#10	84.0		
#20	75.0		
#40	67.8		
#60	62.8		
#100	57.1		
#200	47.9		

* (no specification provided)

DARK GRAY AND BLACK SILTY SAND AND FLY ASH - CINDERS NOTED

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.4369 D_{85}= 2.1877 D_{60}= 0.1934
D_{50}= 0.0854 D_{30}= 0.0293 D_{15}= 0.0093
D_{10}= 0.0058 C_u= 33.63 C_c= 0.77

Classification

USCS= SM AASHTO=

Remarks

F.M.=1.53

Source of Sample: HEN-B023 **Depth:** 20.0'-21.5'
Sample Number: S-7 **Date:** 12-17-15

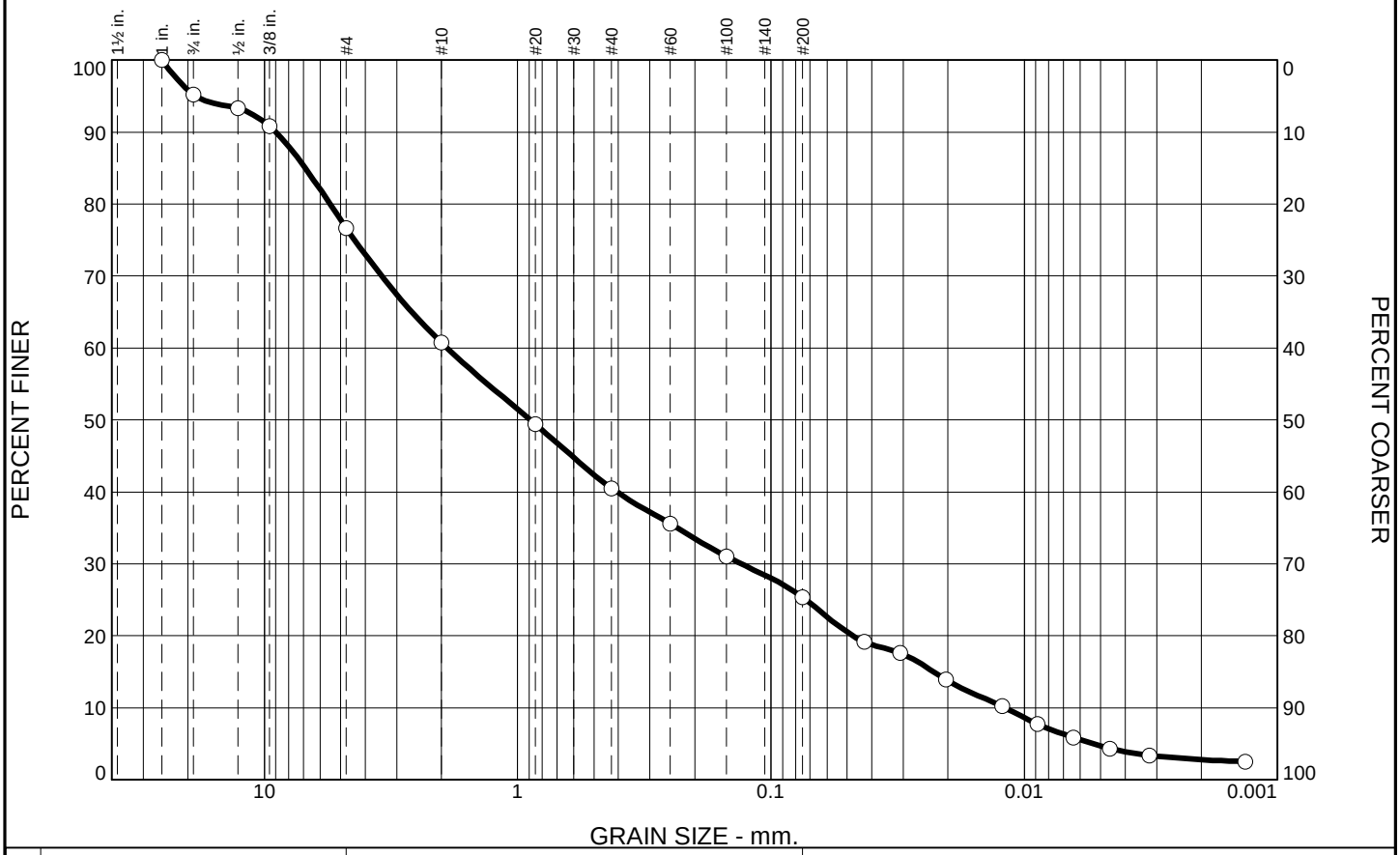
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.8	18.5	16.0	20.2	15.2	20.6	4.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	95.2		
.5	93.3		
.375	90.8		
#4	76.7		
#10	60.7		
#20	49.4		
#40	40.5		
#60	35.6		
#100	31.0		
#200	25.3		

* (no specification provided)

DARK GRAY FLY ASH WITH SAND AND CINDERS

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 9.0077 D_{85}= 6.8824 D_{60}= 1.9019
D_{50}= 0.8884 D_{30}= 0.1309 D_{15}= 0.0229
D_{10}= 0.0119 C_u= 159.31 C_c= 0.75

Classification

USCS= AASHTO=

Remarks

F.M.=3.07

Source of Sample: HEN-B023 **Depth:** 35.0'-36.5'
Sample Number: S-11 **Date:** 12-17-15

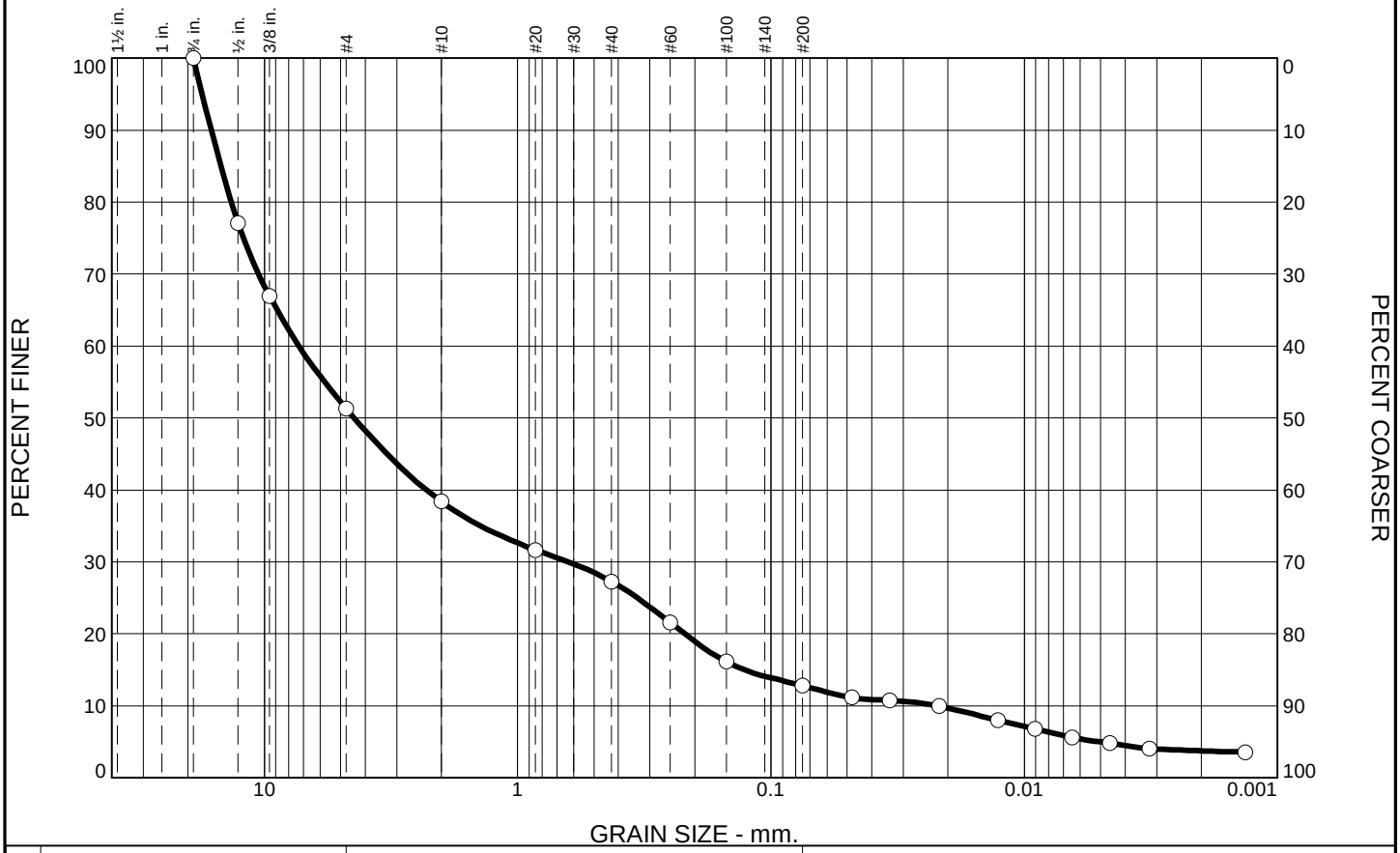
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	48.7	12.9	11.1	14.5	7.8	5.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	77.1		
.375	66.9		
#4	51.3		
#10	38.4		
#20	31.7		
#40	27.3		
#60	21.6		
#100	16.1		
#200	12.8		

* (no specification provided)

LIGHT BROWN POORLY GRADED GRAVEL WITH SAND AND SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 16.1906 D_{85}= 14.8494 D_{60}= 7.2956
D_{50}= 4.4253 D_{30}= 0.6301 D_{15}= 0.1271
D_{10}= 0.0221 C_u= 330.63 C_c= 2.47

Classification

USCS= GP-GM AASHTO=

Remarks

F.M.=4.38

Source of Sample: HEN-B023 **Depth:** 50.0'-51.0'
Sample Number: S-14 **Date:** 12-15-15

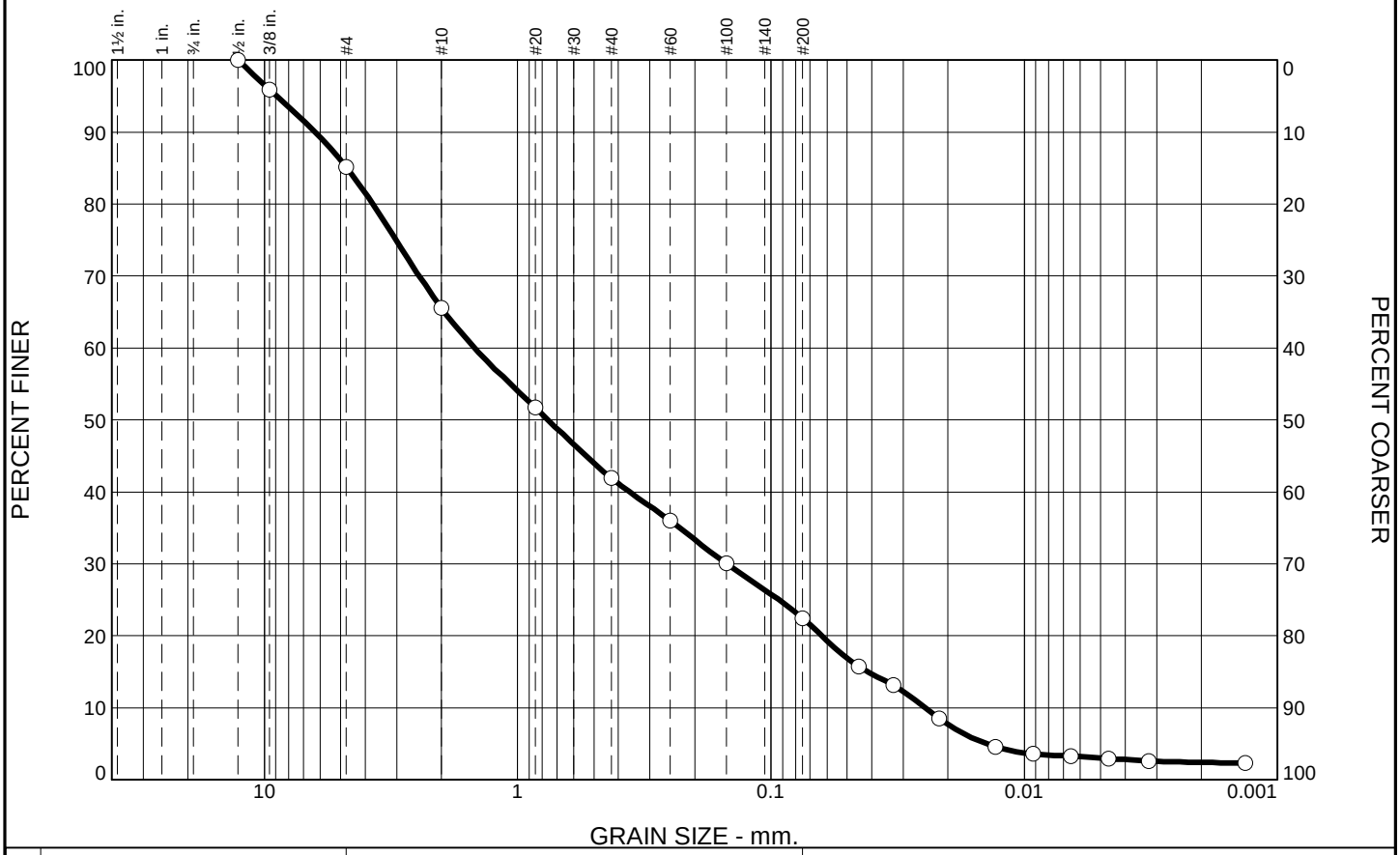
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	14.8	19.6	23.7	19.5	19.4	3.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.50	100.0		
.375	95.9		
#4	85.2		
#10	65.6		
#20	51.7		
#40	41.9		
#60	36.0		
#100	30.0		
#200	22.4		

* (no specification provided)

BLACK FLY ASH WITH CINCERS AND SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 6.3009 D_{85}= 4.7122 D_{60}= 1.4780
D_{50}= 0.7577 D_{30}= 0.1495 D_{15}= 0.0415
D_{10}= 0.0247 C_u= 59.92 C_c= 0.61

Classification

USCS= AASHTO=

Remarks

F.M.=2.79

Source of Sample: HEN-B024 **Depth:** 15.0'-16.5'
Sample Number: S-6 **Date:** 12-17-15

Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.9	37.7	7.5	7.9	19.0	11.1	5.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	89.1		
.5	72.6		
.375	68.3		
#4	51.4		
#10	43.9		
#20	40.1		
#40	36.0		
#60	29.6		
#100	21.8		
#200	17.0		

* (no specification provided)

BROWN AND DARK BROWN SILTY GRAVEL WITH SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 19.4555 D_{85}= 17.3788 D_{60}= 6.6192
D_{50}= 4.4334 D_{30}= 0.2558 D_{15}= 0.0594
D_{10}= 0.0170 C_u= 390.47 C_c= 0.58

Classification

USCS= GM AASHTO=

Remarks

F.M.=4.13

Source of Sample: HEN-B024 **Depth:** 45.0'-46.5'
Sample Number: S-13 **Date:** 12-17-15

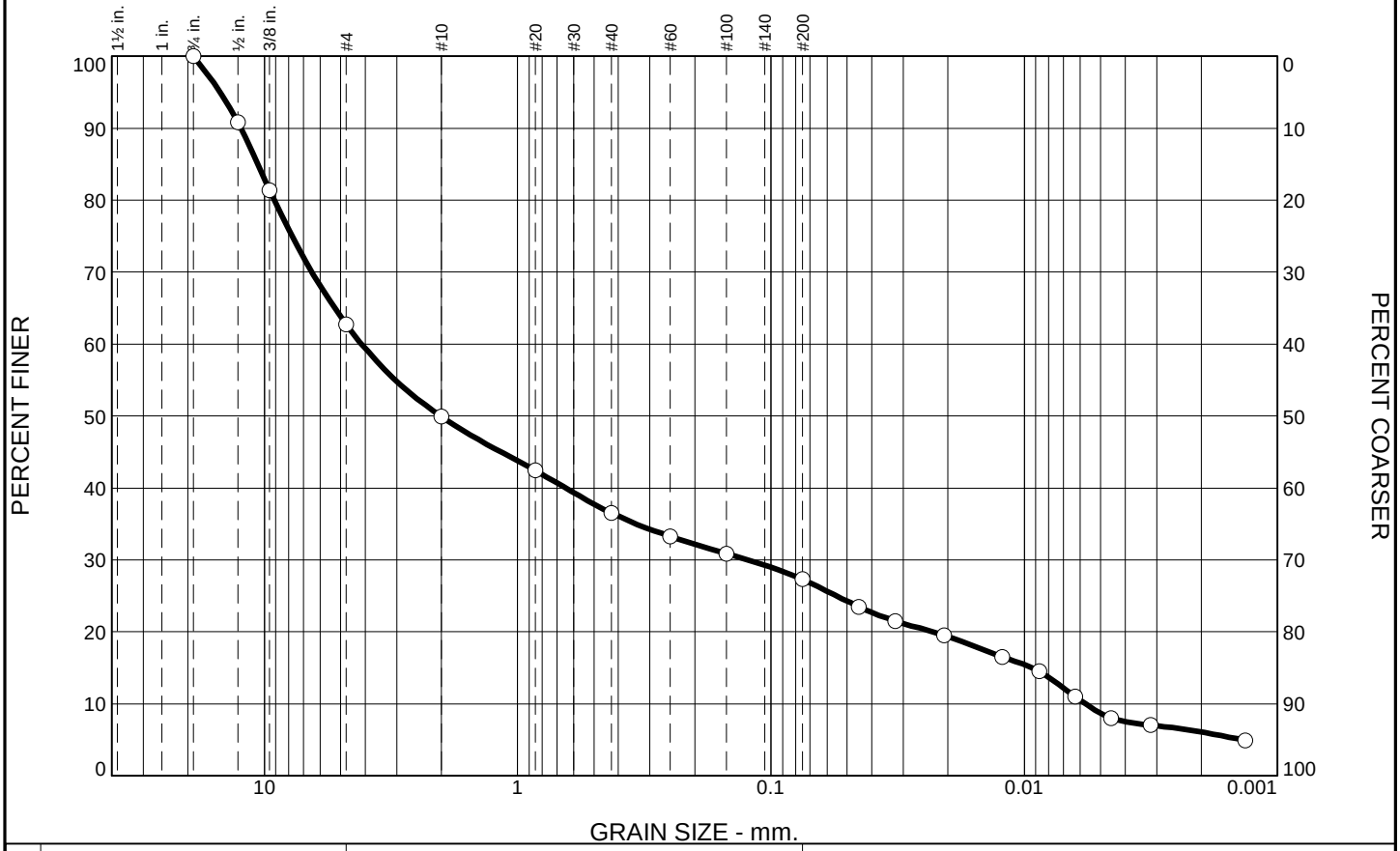
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	37.3	12.8	13.4	9.2	18.6	8.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	90.8		
.375	81.4		
#4	62.7		
#10	49.9		
#20	42.4		
#40	36.5		
#60	33.3		
#100	30.9		
#200	27.3		

* (no specification provided)

BROWN AND GRAY SILTY GRAVEL WITH SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 12.3694 D_{85}= 10.6049 D_{60}= 4.1296
D_{50}= 2.0193 D_{30}= 0.1239 D_{15}= 0.0093
D_{10}= 0.0057 C_u= 719.10 C_c= 0.65

Classification

USCS= GM AASHTO=

Remarks

F.M.=3.55

Source of Sample: HEN-B025 **Depth:** 5.0'-6.5'
Sample Number: S-3 **Date:** 12-15-15

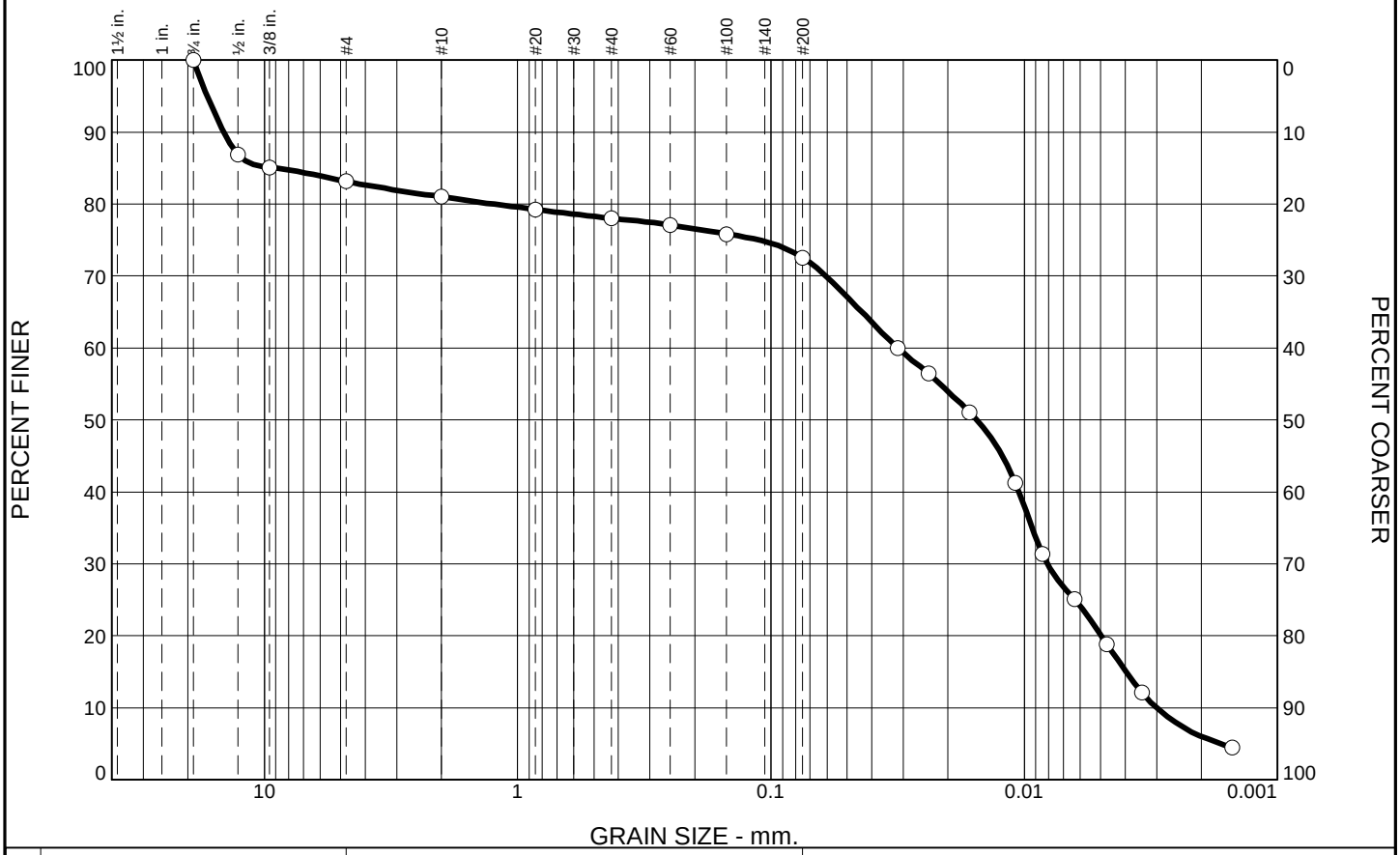
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	16.8	2.2	3.0	5.5	52.3	20.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	86.9		
.375	85.1		
#4	83.2		
#10	81.0		
#20	79.2		
#40	78.0		
#60	77.1		
#100	75.8		
#200	72.5		

* (no specification provided)

VERY DARK GRAY FLY ASH WITH SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 14.4848 D_{85}= 9.0363 D_{60}= 0.0315
D_{50}= 0.0154 D_{30}= 0.0081 D_{15}= 0.0040
D_{10}= 0.0030 C_u= 10.52 C_c= 0.70

Classification

USCS= AASHTO=

Remarks

F.M.=1.39

Source of Sample: HEN-B025 **Depth:** 11.5'-14.0'
Sample Number: S-6 **Date:** 12-15-15

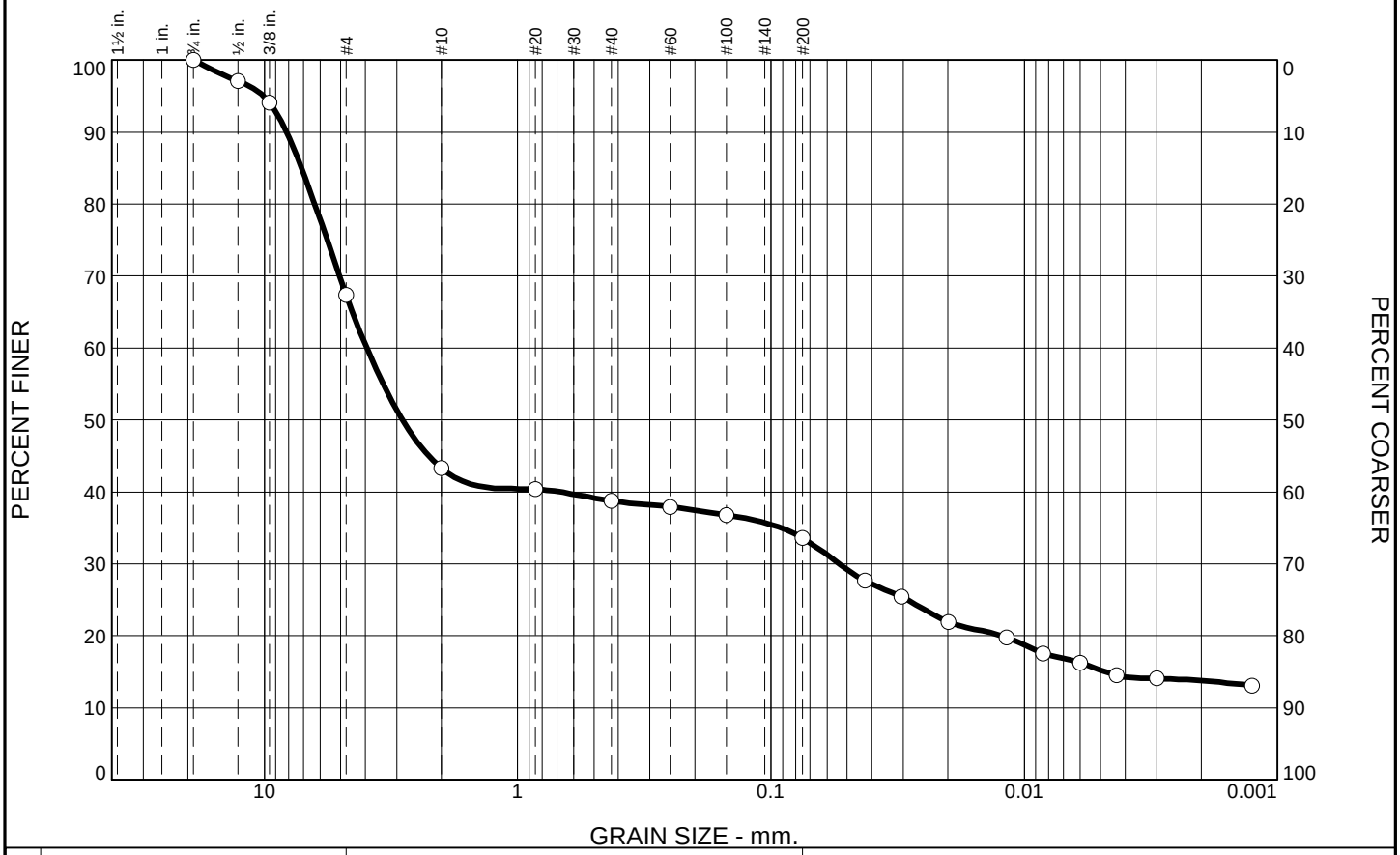
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	32.6	24.1	4.6	5.1	18.4	15.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	97.1		
.375	94.1		
#4	67.4		
#10	43.3		
#20	40.4		
#40	38.7		
#60	37.9		
#100	36.8		
#200	33.6		

* (no specification provided)

BROWN SILTY SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 8.1578 D_{85}= 7.1123 D_{60}= 3.9390
D_{50}= 2.8475 D_{30}= 0.0538 D_{15}= 0.0048
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

F.M.=3.38

Source of Sample: HEN-B026A **Depth:** 13.5'-15.0'
Sample Number: S-2 **Date:** 12-15-15

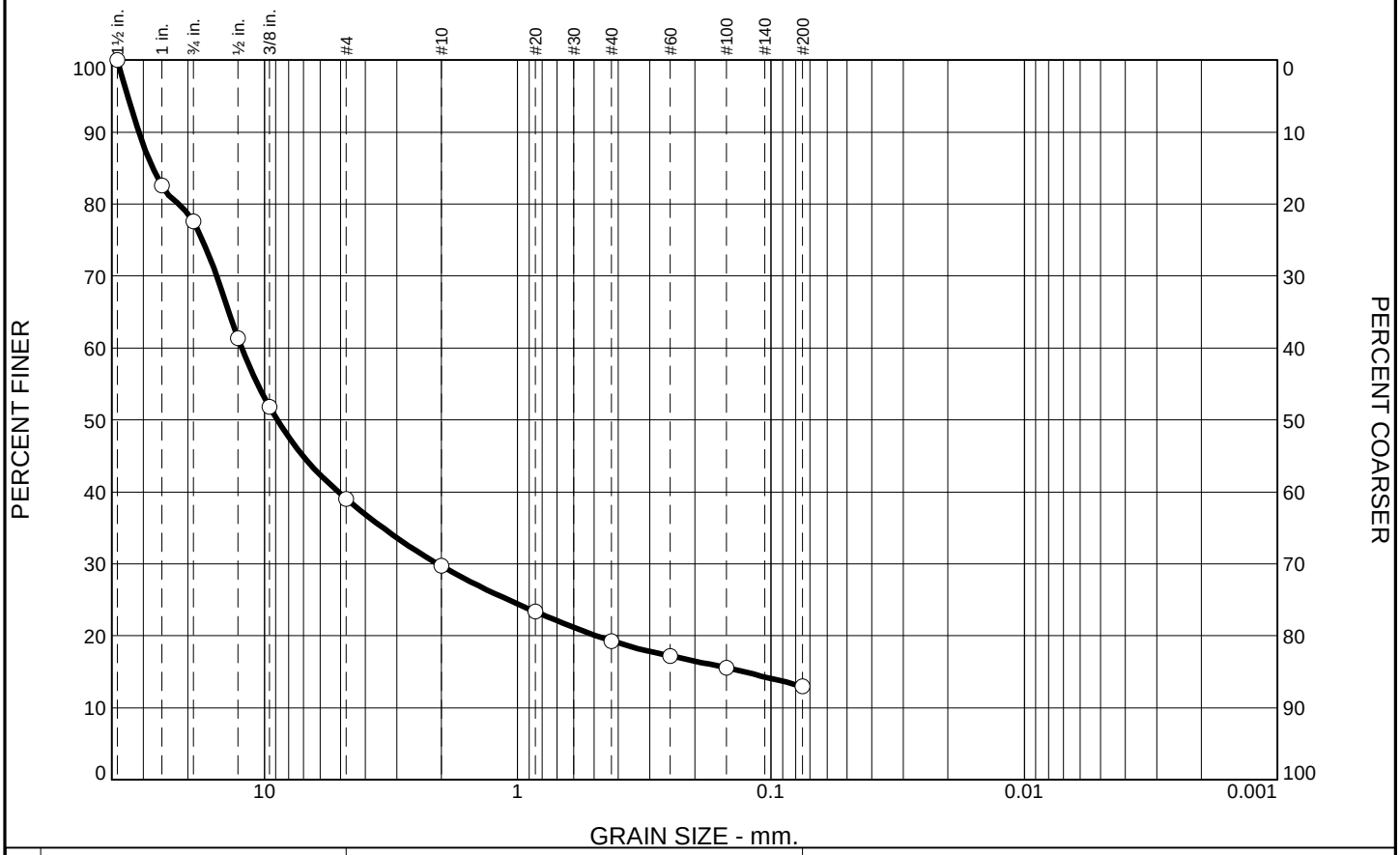
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	22.4	38.6	9.3	10.4	6.3	13.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	82.5		
.75	77.6		
.5	61.4		
.375	51.8		
#4	39.0		
#10	29.7		
#20	23.4		
#40	19.3		
#60	17.2		
#100	15.6		
#200	13.0		

* (no specification provided)

LIGHT BROWN POORLY GRADED GRAVEL WITH SAND AND CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 31.2310 D_{85}= 27.6077 D_{60}= 12.2743
D_{50}= 8.8861 D_{30}= 2.0649 D_{15}= 0.1281
D_{10}= C_u= C_c=

Classification

USCS= GP-GC AASHTO=

Remarks

F.M.=5.20

Source of Sample: HEN-B029 **Depth:** 35.0'-36.5'
Sample Number: S-10 **Date:** 12-10-15

Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	34.0	16.5	12.6	16.6	11.0	9.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	97.0		
.375	84.6		
#4	66.0		
#10	49.5		
#20	43.8		
#40	36.9		
#60	29.1		
#100	23.5		
#200	20.3		

* (no specification provided)

BROWN AND LIGHT BROWN SILTY SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 10.7082 D_{85}= 9.6174 D_{60}= 3.5682
D_{50}= 2.0785 D_{30}= 0.2659 D_{15}= 0.0154
D_{10}= 0.0064 C_u= 557.69 C_c= 3.10

Classification

USCS= SM AASHTO=

Remarks

F.M.=3.56

Source of Sample: HEN-B030 **Depth:** 2.5'-4.0'
Sample Number: S-2 **Date:** 12-15-15

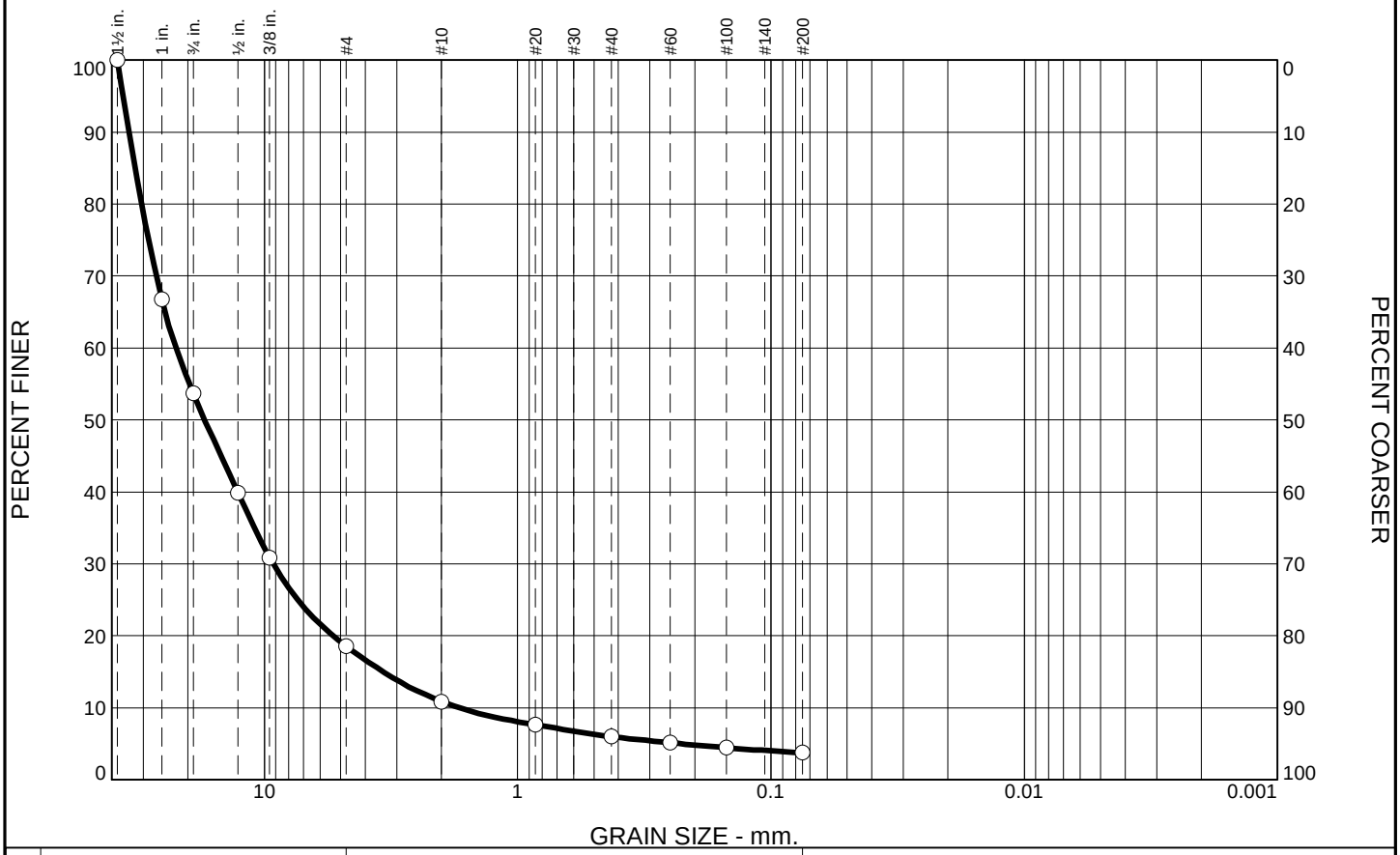
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	46.3	35.1	7.7	4.9	2.2	3.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	66.8		
.75	53.7		
.5	39.9		
.375	30.9		
#4	18.6		
#10	10.9		
#20	7.6		
#40	6.0		
#60	5.1		
#100	4.4		
#200	3.8		

* (no specification provided)

LIGHT BROWN AND TAN WELL GRADED GRAVEL WITH SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 34.1590 D_{85}= 32.2869 D_{60}= 22.3306
D_{50}= 17.1780 D_{30}= 9.2189 D_{15}= 3.3953
D_{10}= 1.7025 C_u= 13.12 C_c= 2.24

Classification

USCS= GW AASHTO=

Remarks

F.M.=6.60

Source of Sample: HEN-B030 **Depth:** 15.0'-16.5'
Sample Number: S-6 **Date:** 12-10-15

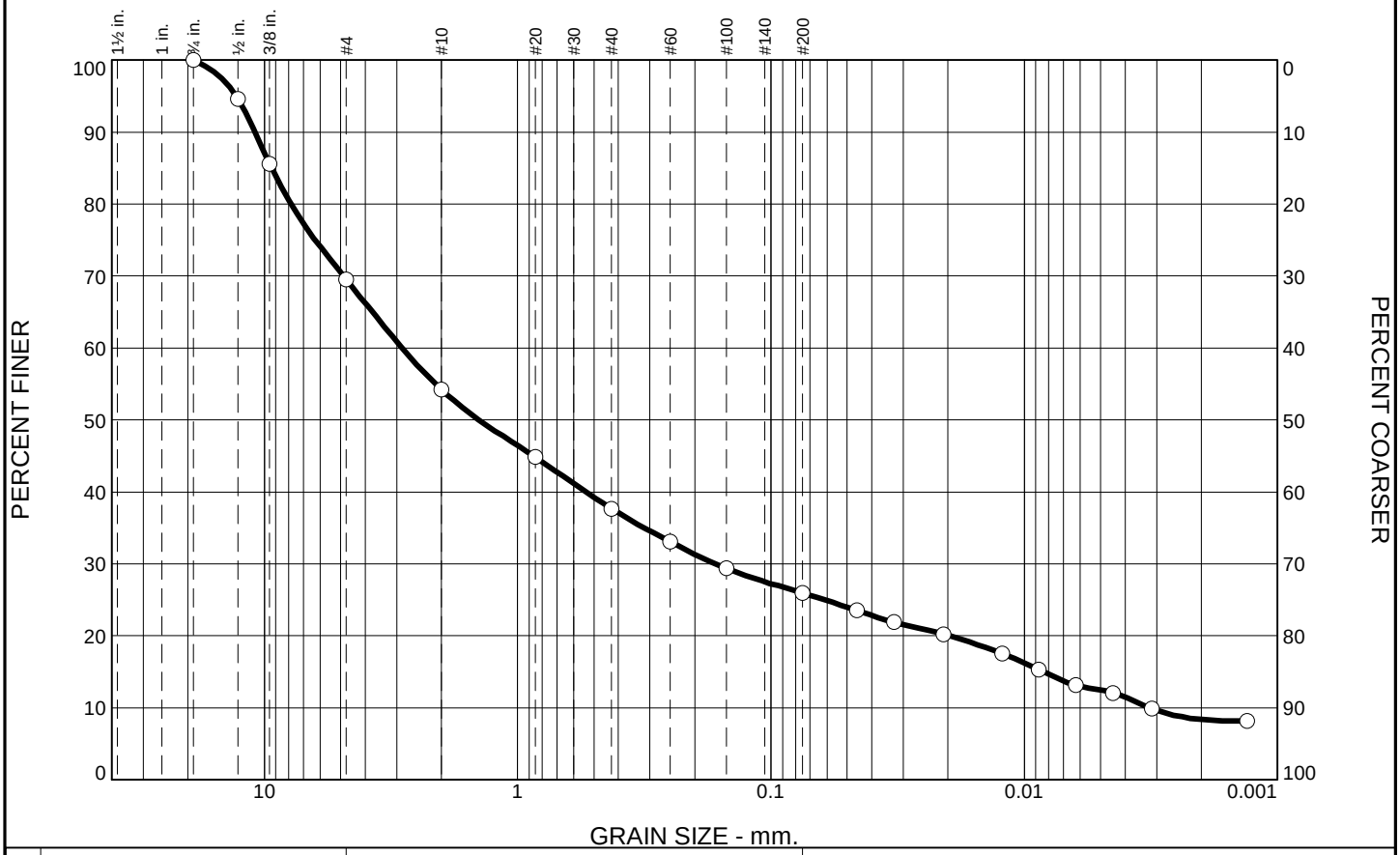
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	30.5	15.3	16.5	11.8	13.4	12.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	94.6		
.375	85.6		
#4	69.5		
#10	54.2		
#20	44.8		
#40	37.7		
#60	33.1		
#100	29.4		
#200	25.9		

* (no specification provided)

BROWN SILTY SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 10.8888 D_{85}= 9.3568 D_{60}= 2.8565
D_{50}= 1.4206 D_{30}= 0.1654 D_{15}= 0.0084
D_{10}= 0.0032 C_u= 894.95 C_c= 3.00

Classification

USCS= SM AASHTO=

Remarks

F.M.=3.35

Source of Sample: HEN-B032 **Depth:** 20.0'-21.5'
Sample Number: S-7 **Date:** 12-15-15

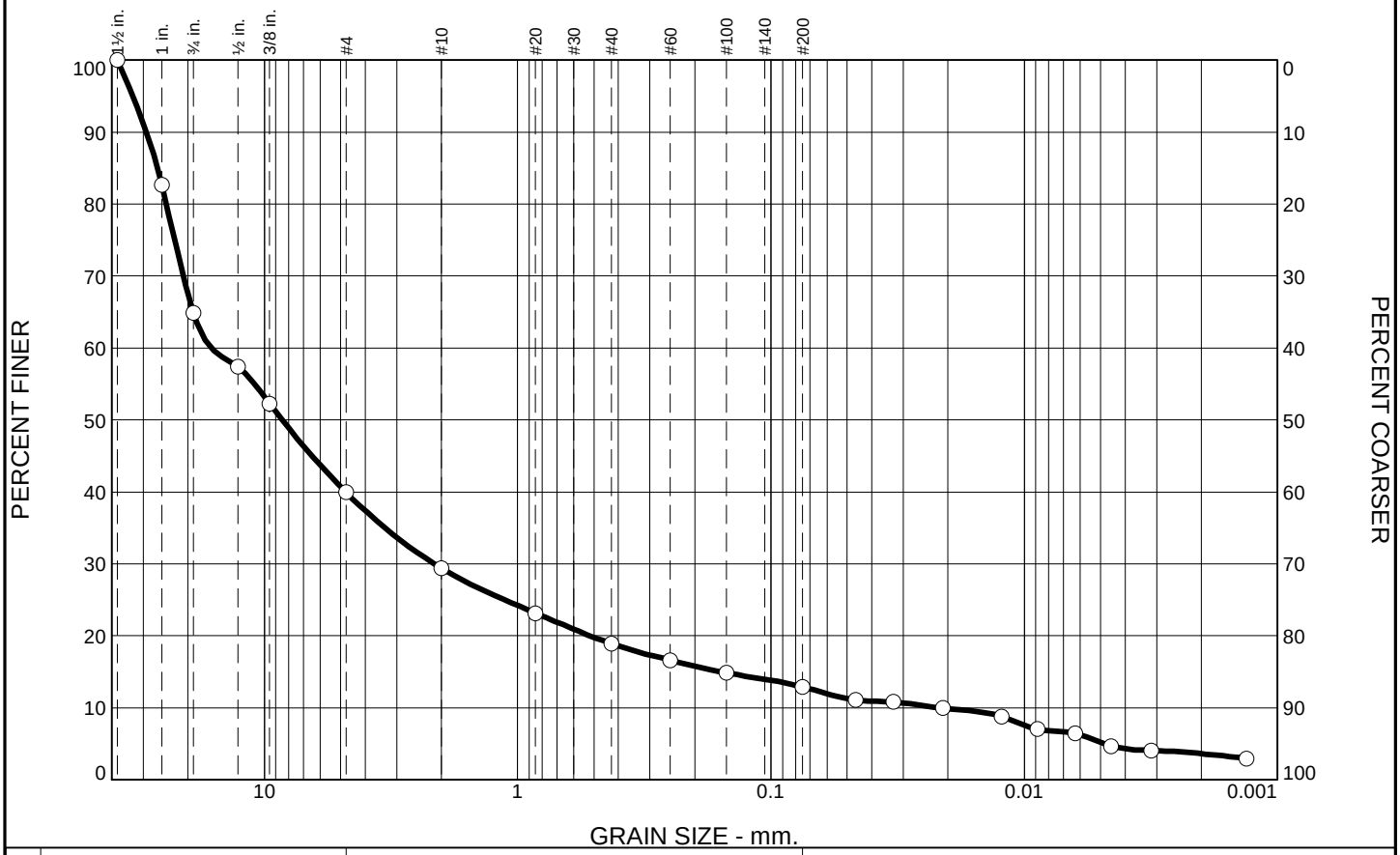
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	35.1	25.0	10.5	10.5	6.0	7.7	5.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	82.7		
.75	64.9		
.5	57.4		
.375	52.3		
#4	39.9		
#10	29.4		
#20	23.2		
#40	18.9		
#60	16.6		
#100	14.8		
#200	12.9		

* (no specification provided)

BROWN AND LIGHT BROWN POORLY GRADED GRAVEL WITH SILT AND SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 29.2016 D_{85}= 26.4297 D_{60}= 16.1803
D_{50}= 8.4958 D_{30}= 2.1337 D_{15}= 0.1581
D_{10}= 0.0218 C_u= 742.74 C_c= 12.92

Classification

USCS= GP-GM AASHTO=

Remarks

F.M.=5.34

Source of Sample: HEN-B034 **Depth:** 10.0'-11.5'
Sample Number: S-5 **Date:** 12-17-15

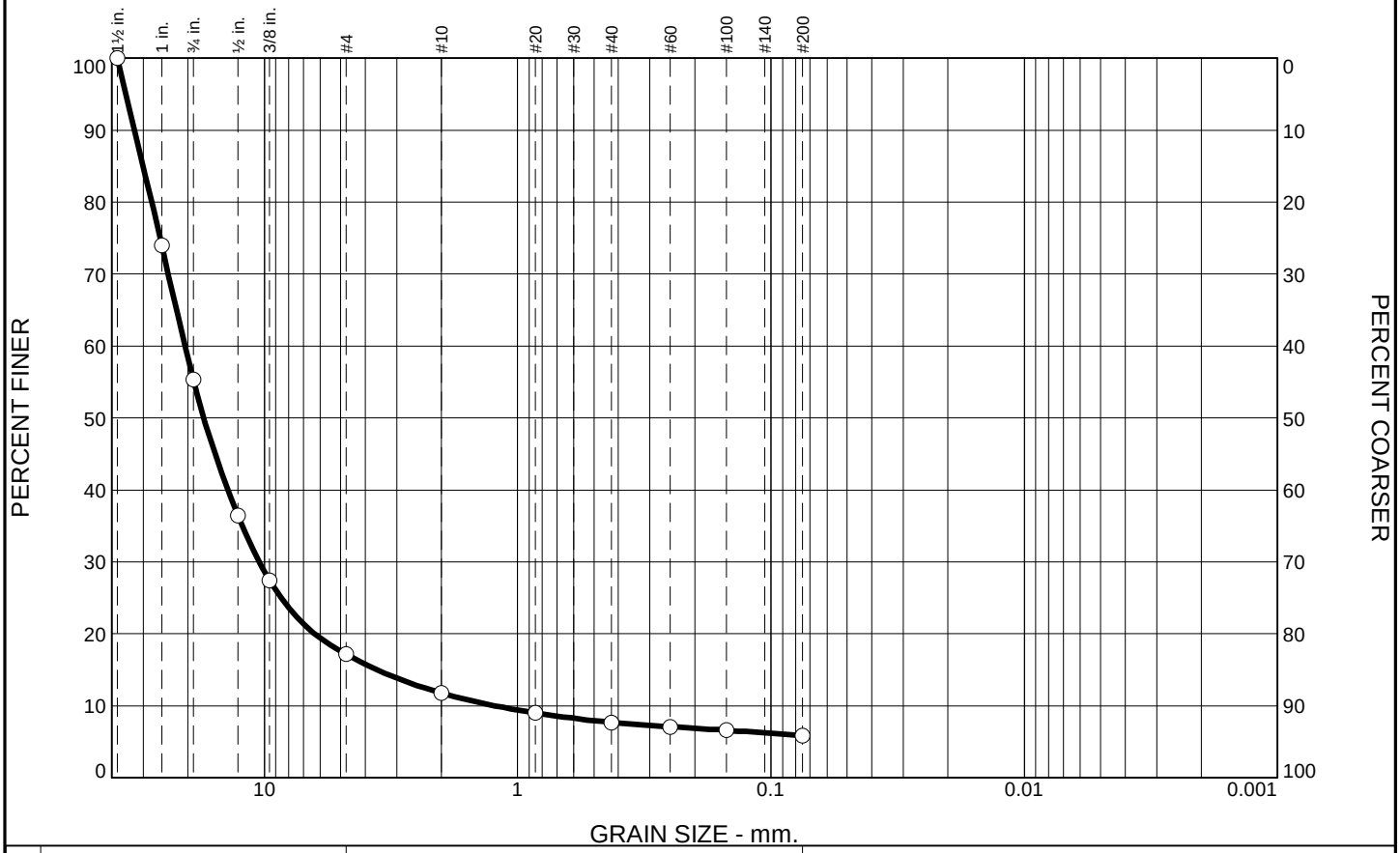
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	44.7	38.1	5.4	4.1	1.8	5.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	74.0		
.75	55.3		
.5	36.4		
.375	27.4		
#4	17.2		
#10	11.8		
#20	9.0		
#40	7.7		
#60	7.1		
#100	6.6		
#200	5.9		

* (no specification provided)

LIGHT BROWN AND TAN POORLY GRADED GRAVEL WITH SAND AND SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 32.5083 D_{85}= 30.0560 D_{60}= 20.5658
D_{50}= 17.3171 D_{30}= 10.4646 D_{15}= 3.5815
D_{10}= 1.2300 C_u= 16.72 C_c= 4.33

Classification

USCS= GP-GM AASHTO=

Remarks

F.M.=6.56

Source of Sample: HEN-B034 **Depth:** 35.0'-36.5'
Sample Number: S-10 **Date:** 12-10-15

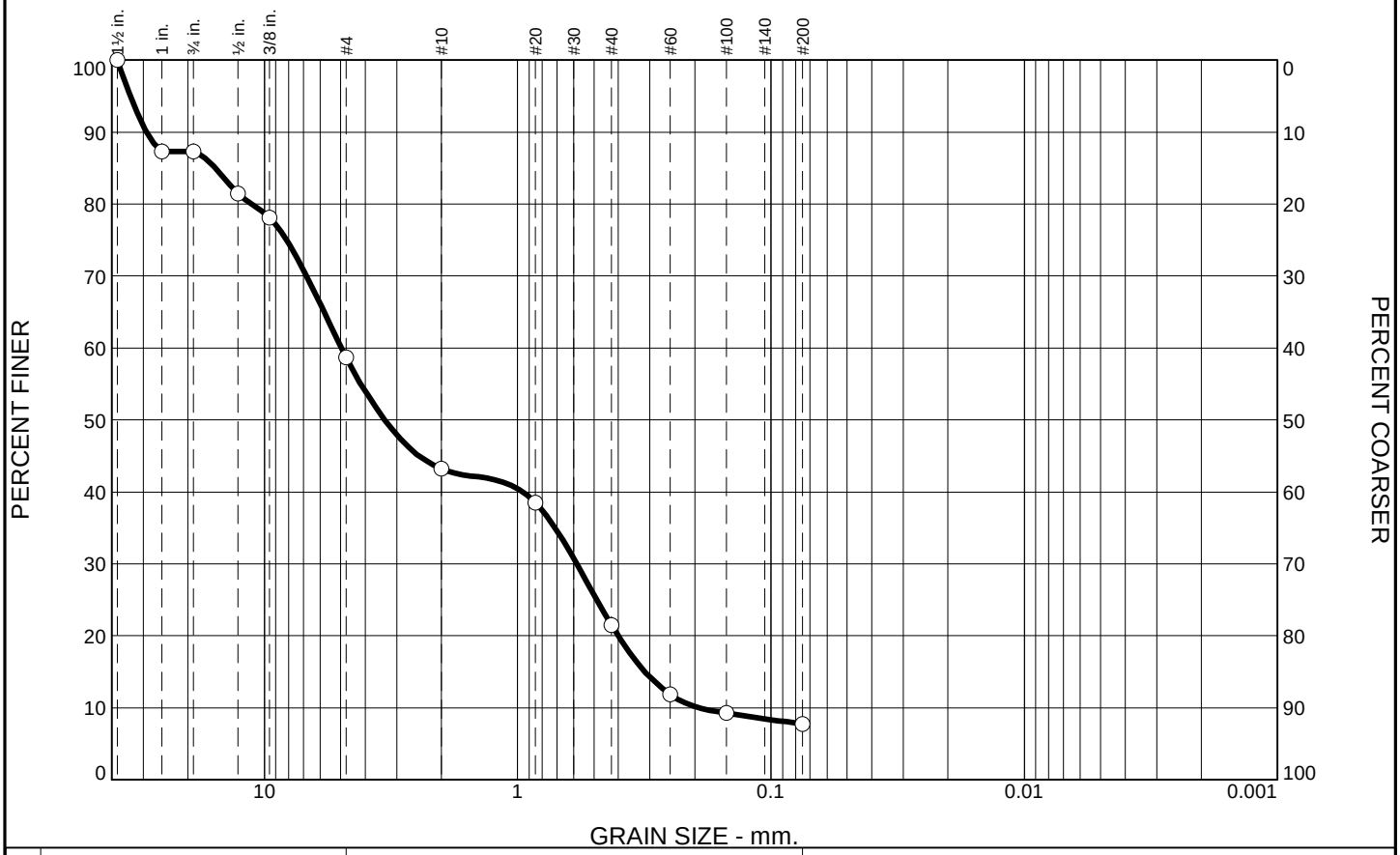
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	12.7	28.6	15.5	21.8	13.7	7.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	87.3		
.75	87.3		
.5	81.5		
.375	78.1		
#4	58.7		
#10	43.2		
#20	38.5		
#40	21.4		
#60	11.8		
#100	9.2		
#200	7.7		

* (no specification provided)

BROWN AND DARK BROWN SILTY SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 29.1386 D_{85}= 15.6078 D_{60}= 4.9602
D_{50}= 3.3485 D_{30}= 0.5840 D_{15}= 0.3138
D_{10}= 0.1928 C_u= 25.73 C_c= 0.36

Classification

USCS= SM AASHTO=

Remarks

F.M.=4.36

Source of Sample: HEN-B037 **Depth:** 5.0'-6.5'
Sample Number: S-3 **Date:** 12-10-15

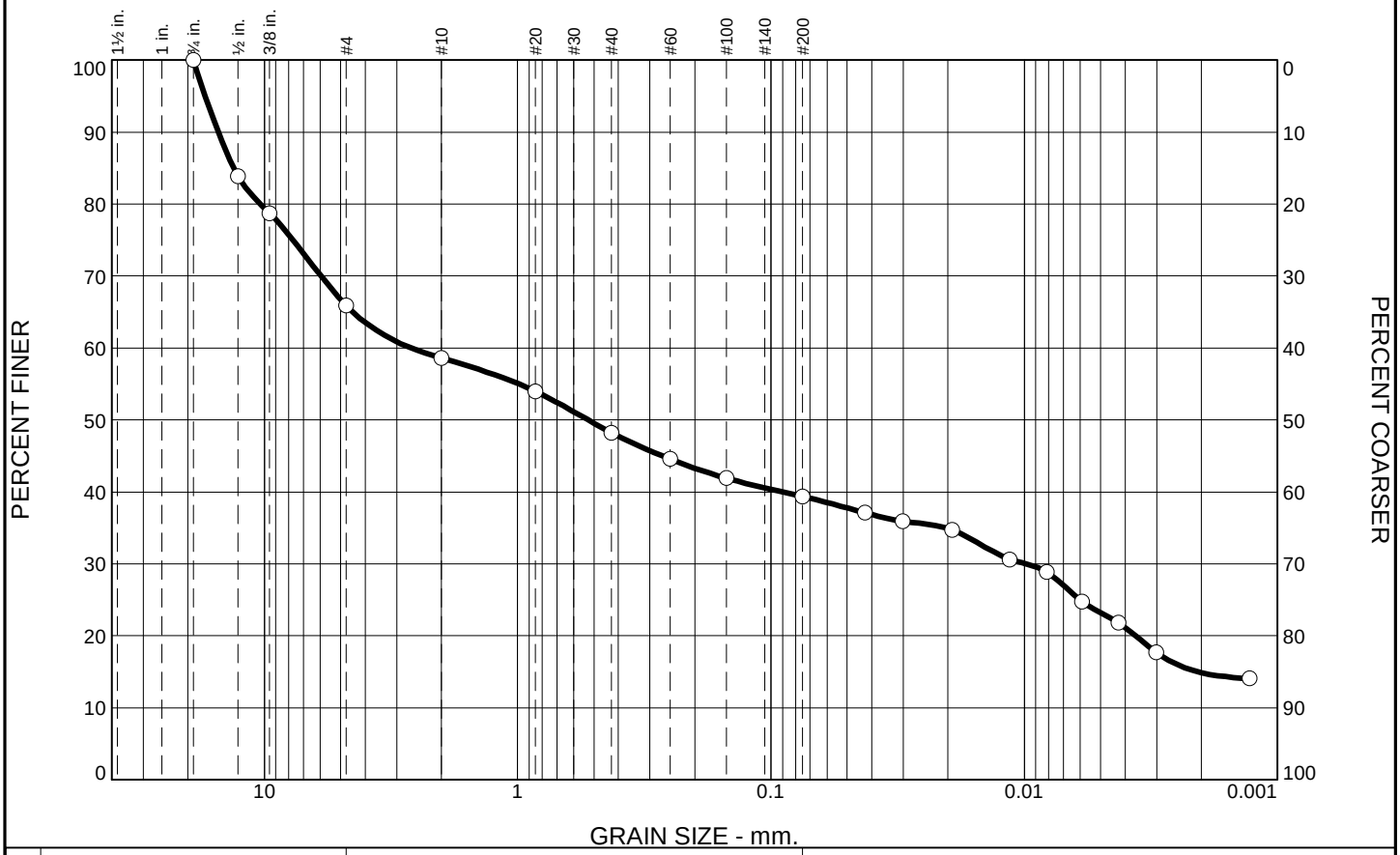
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	34.1	7.3	10.4	8.8	16.2	23.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	83.9		
.375	78.7		
#4	65.9		
#10	58.6		
#20	54.0		
#40	48.2		
#60	44.6		
#100	41.9		
#200	39.4		

* (no specification provided)

BROWN AND LIGHT BROWN CLAYEY GRAVEL WIRTH SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 15.2090 D_{85}= 13.2128 D_{60}= 2.6302
D_{50}= 0.5271 D_{30}= 0.0099 D_{15}= 0.0021
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO=

Remarks

F.M.=3.01

Source of Sample: HEN-B037 **Depth:** 15.0'-16.5'
Sample Number: S-6 **Date:** 12-15-15

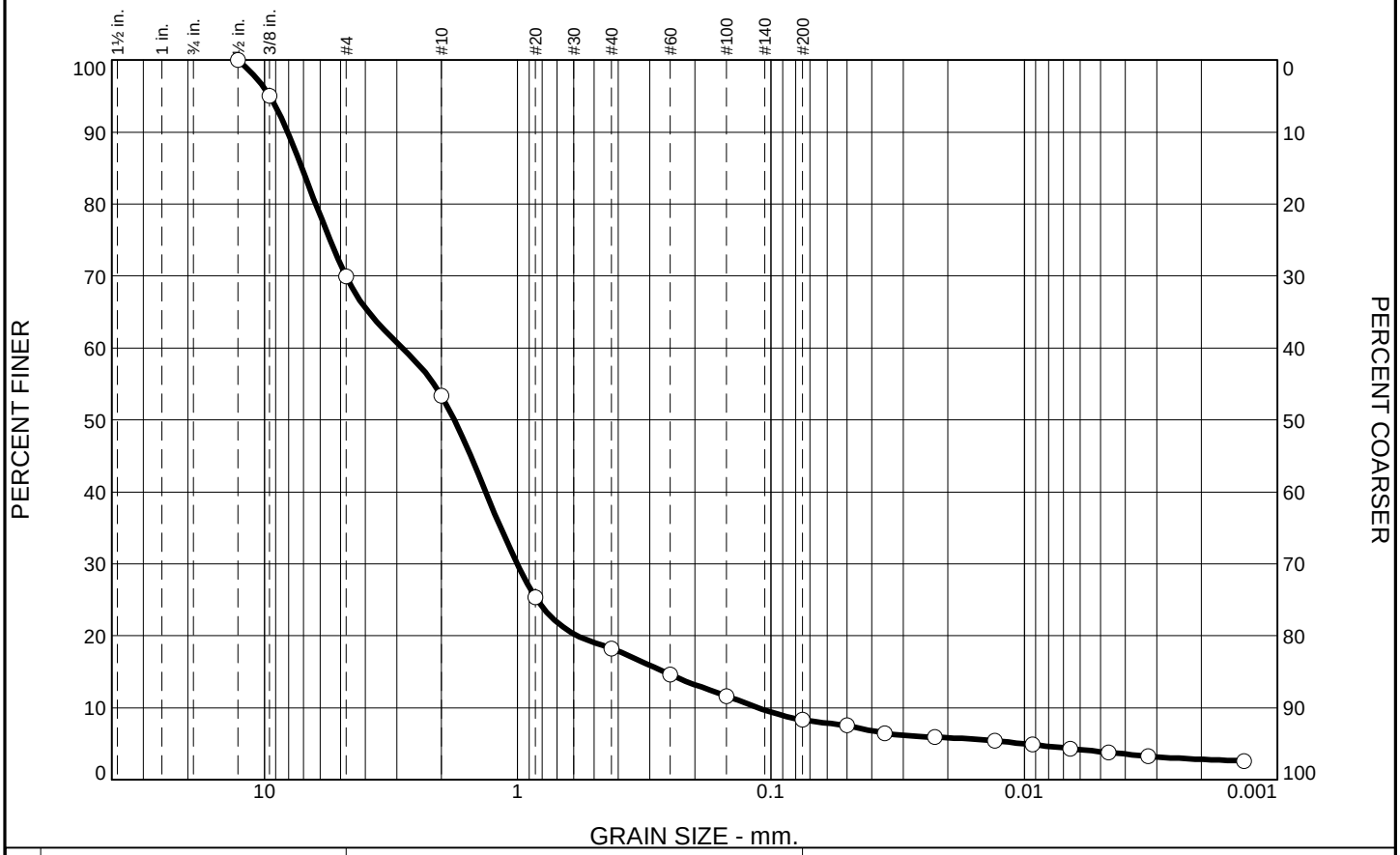
Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	30.1	16.5	35.2	9.9	4.4	3.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.50	100.0		
.375	95.0		
#4	69.9		
#10	53.4		
#20	25.4		
#40	18.2		
#60	14.6		
#100	11.6		
#200	8.3		

* (no specification provided)

TAN POORLY GRADED SAND WITH GRAVEL AND SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 8.0898 D_{85}= 7.0874 D_{60}= 2.8508
D_{50}= 1.7783 D_{30}= 1.0044 D_{15}= 0.2652
D_{10}= 0.1120 C_u= 25.46 C_c= 3.16

Classification

USCS= SP-SM AASHTO=

Remarks

F.M.=3.95

Source of Sample: HEN-B038 **Depth:** 5.0'-5.9'
Sample Number: S-3 **Date:** 12-15-15

Terracon

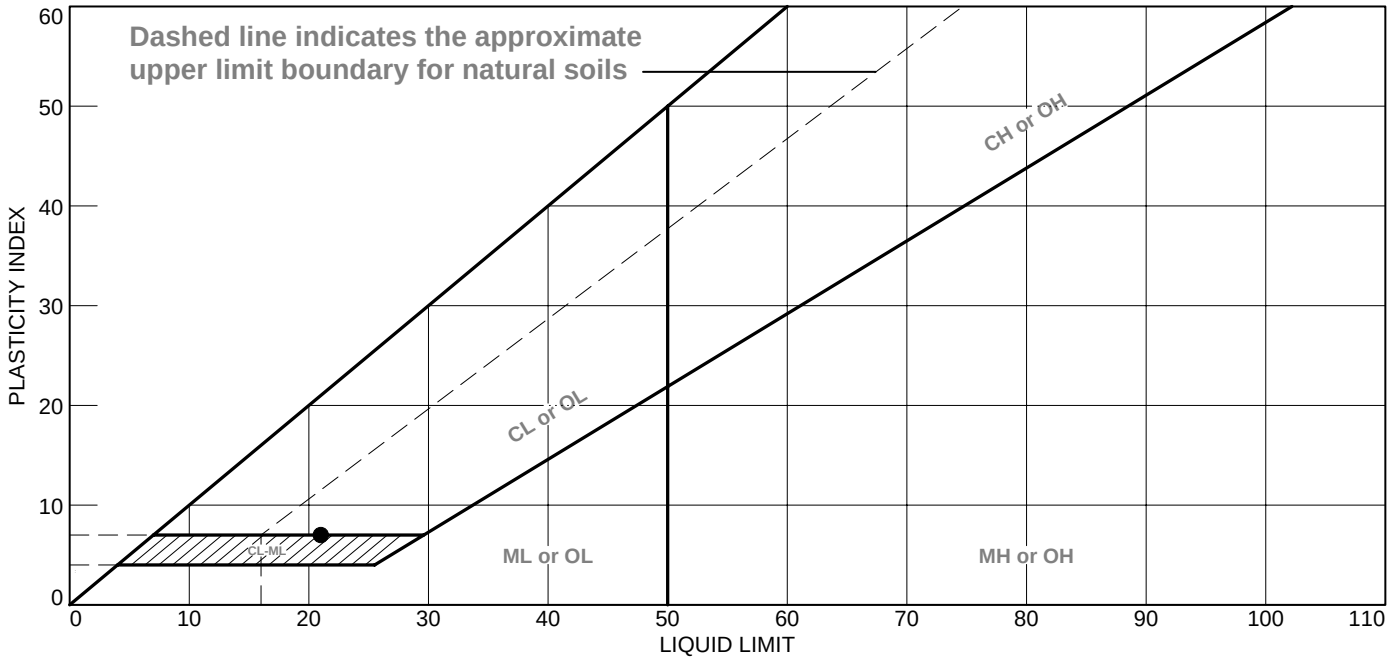
Client: AECOM
Project: DYNERGY - HENNEPIN

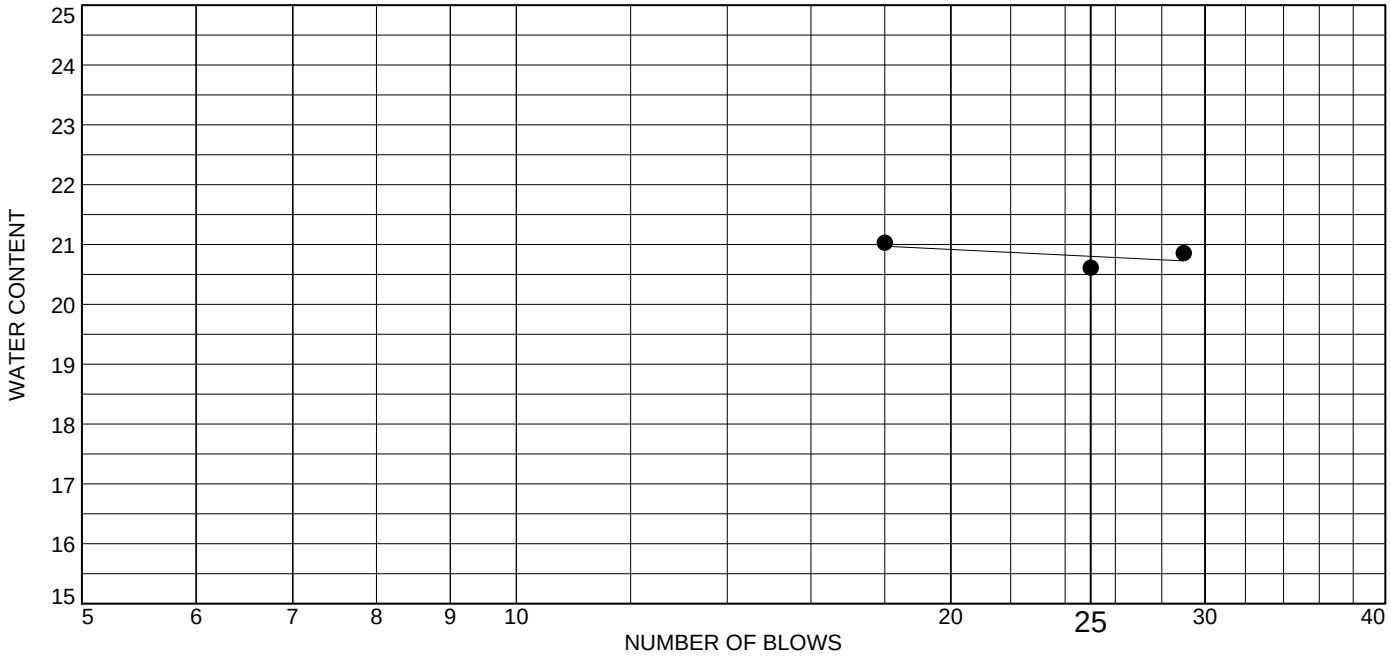
Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

Liquid Limit, Plastic Limit and Plasticity Index of Soils ASTM D 4318

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY LEAN CLAY WITH SAND - SAND SEAMS NOTED	21	14	7			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B001 **Depth:** 7.5'-9.5'
Sample Number: S-4

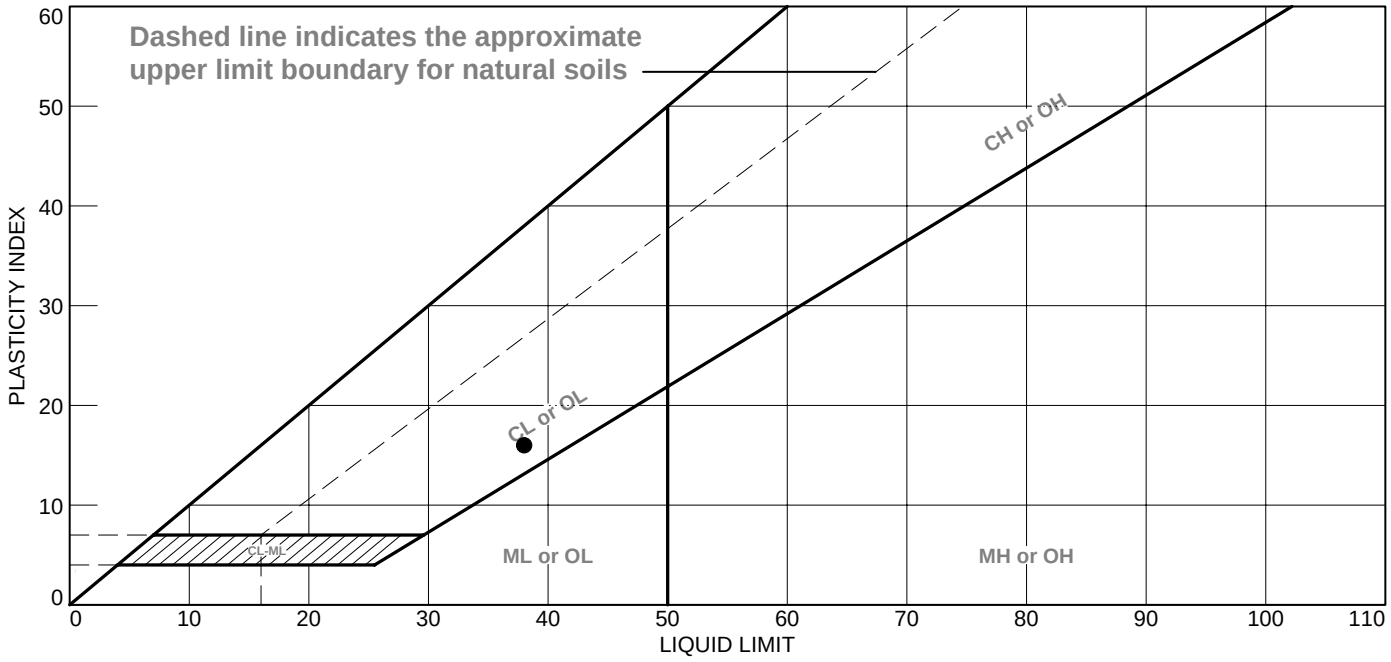
Remarks:

Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY ORGANIC LEAN CLAY - SHELL NOTED	38	22	16			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B001 **Depth:** 20.0'-22.0'
Sample Number: S-7

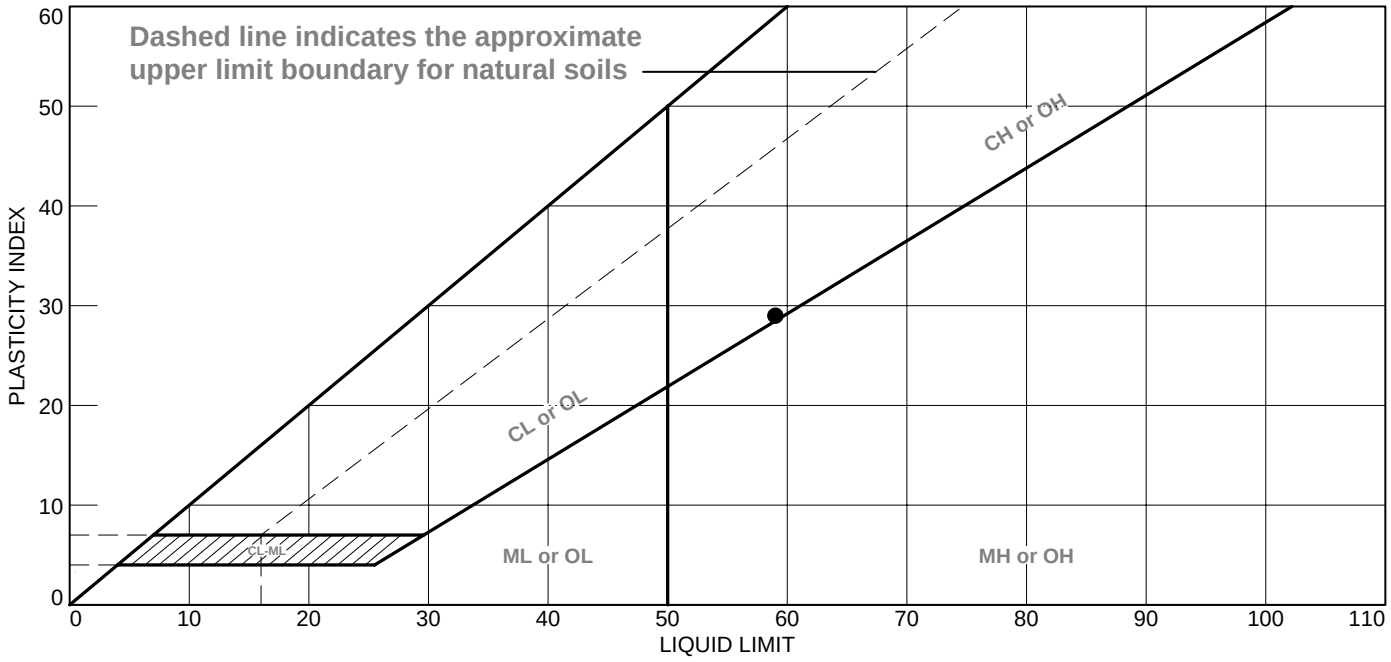
Remarks:

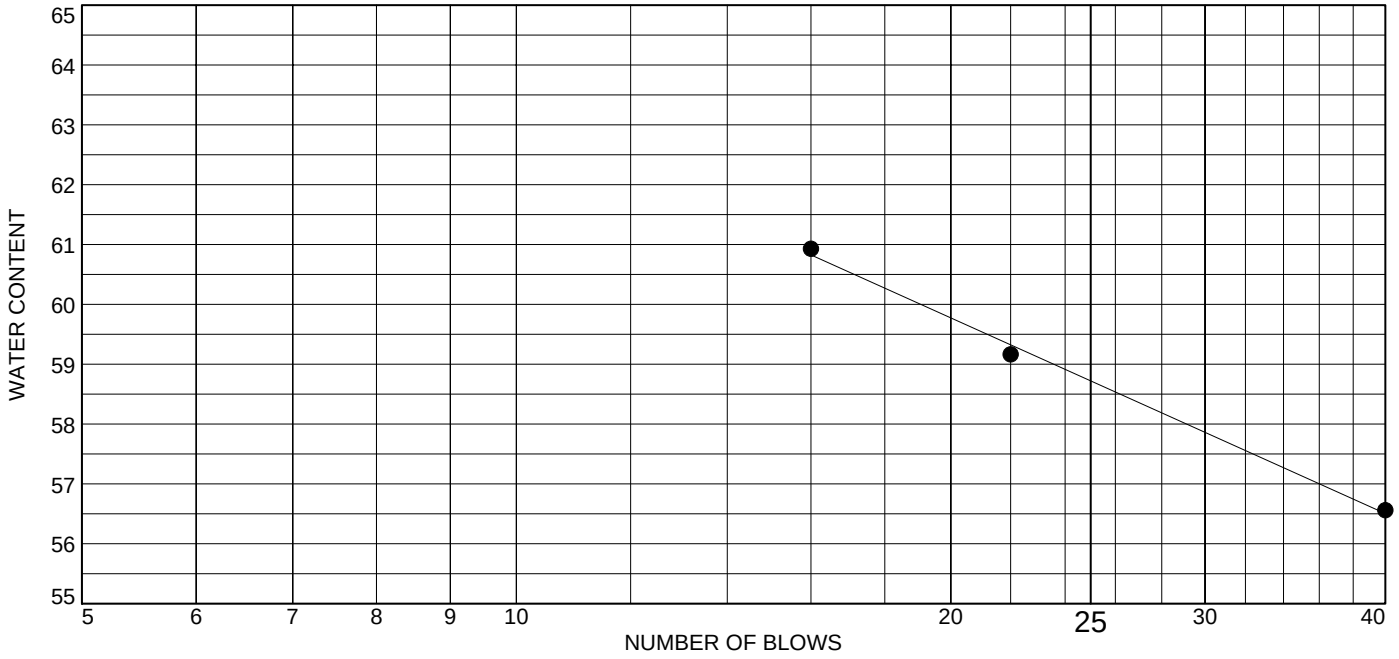
Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK GRAY FAT CLAY	59	30	29			CH

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B001 **Depth:** 40.0'-41.5'
Sample Number: S-11

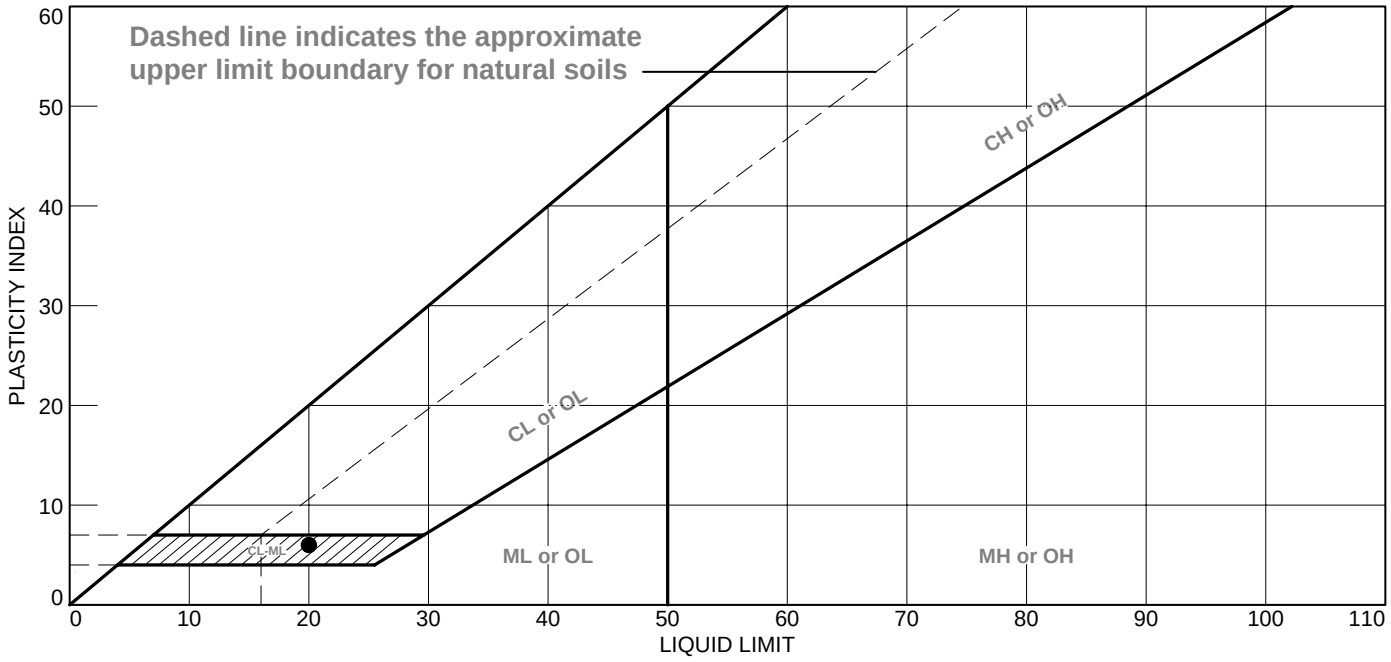
Remarks:

Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN SILT WITH CLAY	20	14	6			ML

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B002 **Depth:** 7.5'-9.0'
Sample Number: S-4

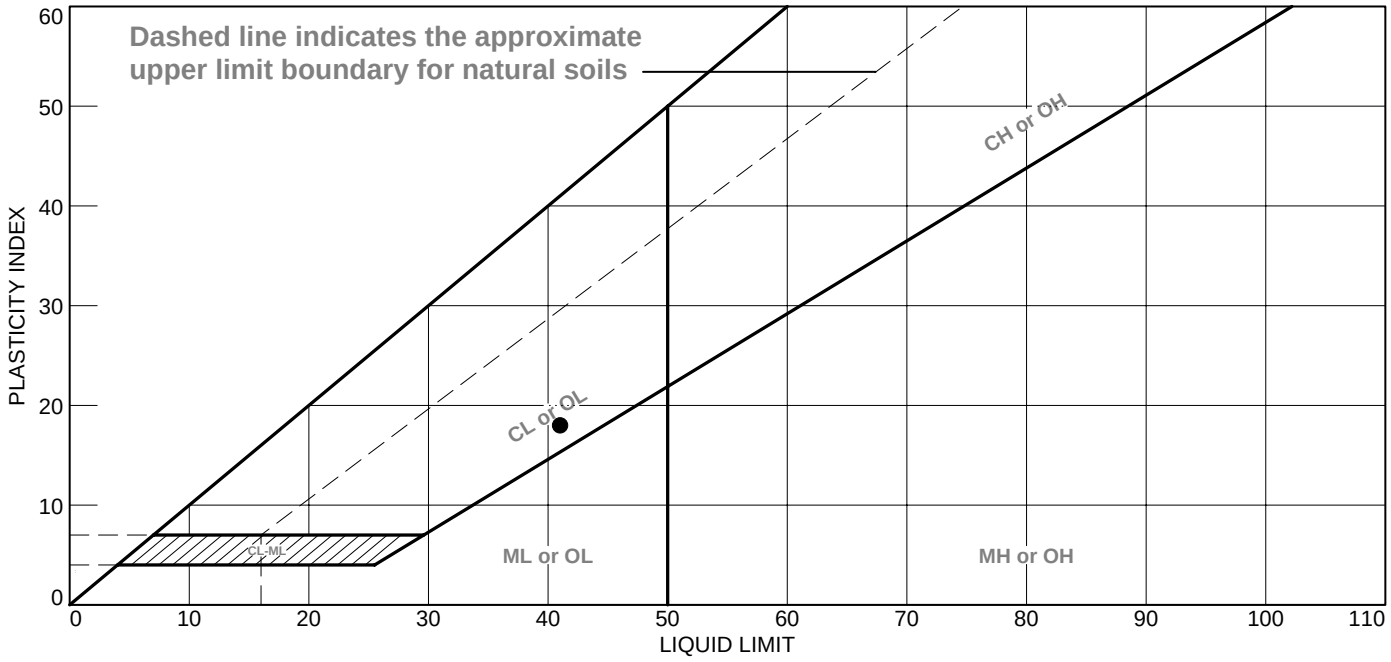
Terracon

Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK GRAY LEAN CLAY WITH SAND AND GRAVEL - FLY ASH NOTED	41	23	18			OL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B002 **Depth:** 25.0'-27.0'
Sample Number: S-8

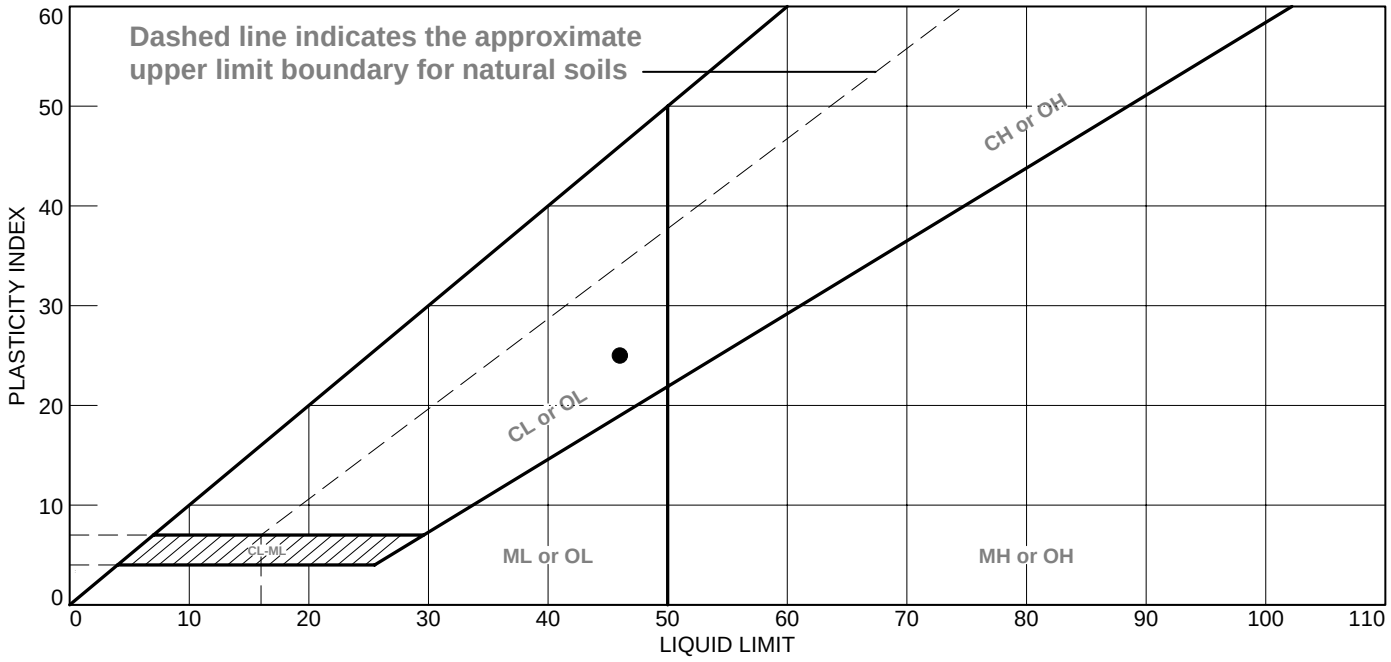
Remarks:

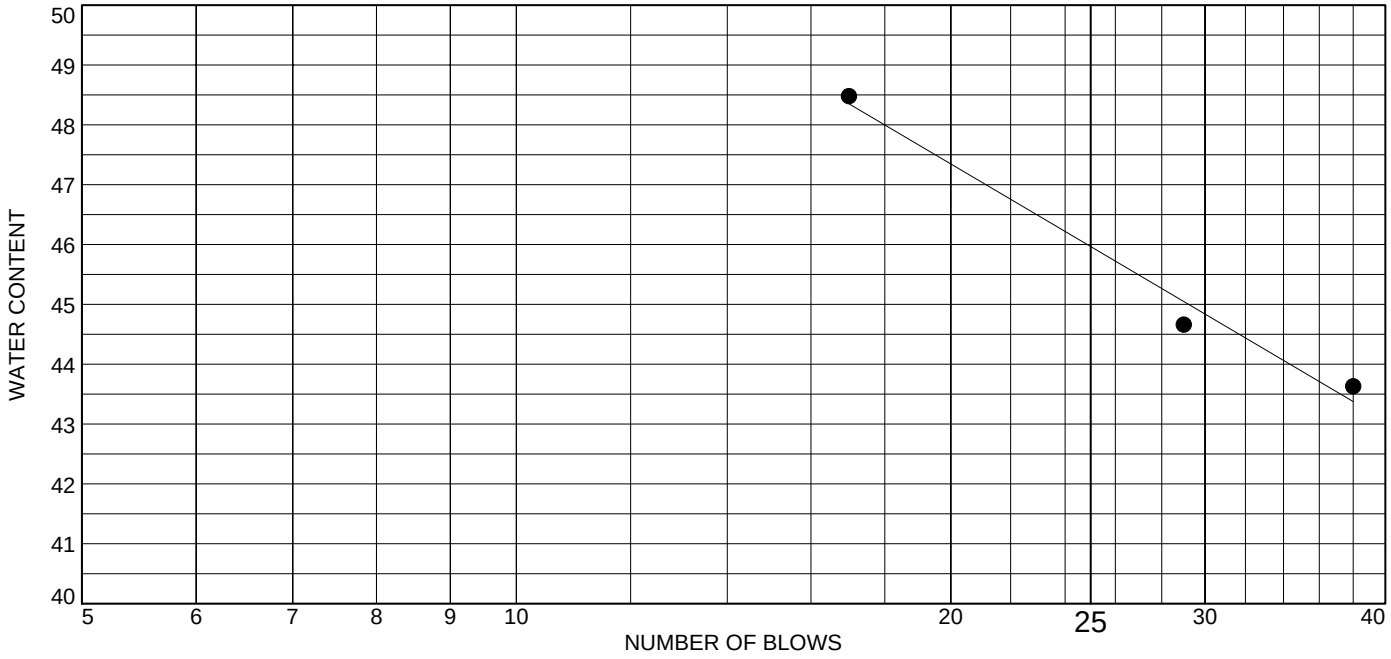
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY LEAN CLAY	46	21	25			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B002 **Depth:** 35.0'-37.0'
Sample Number: S-10

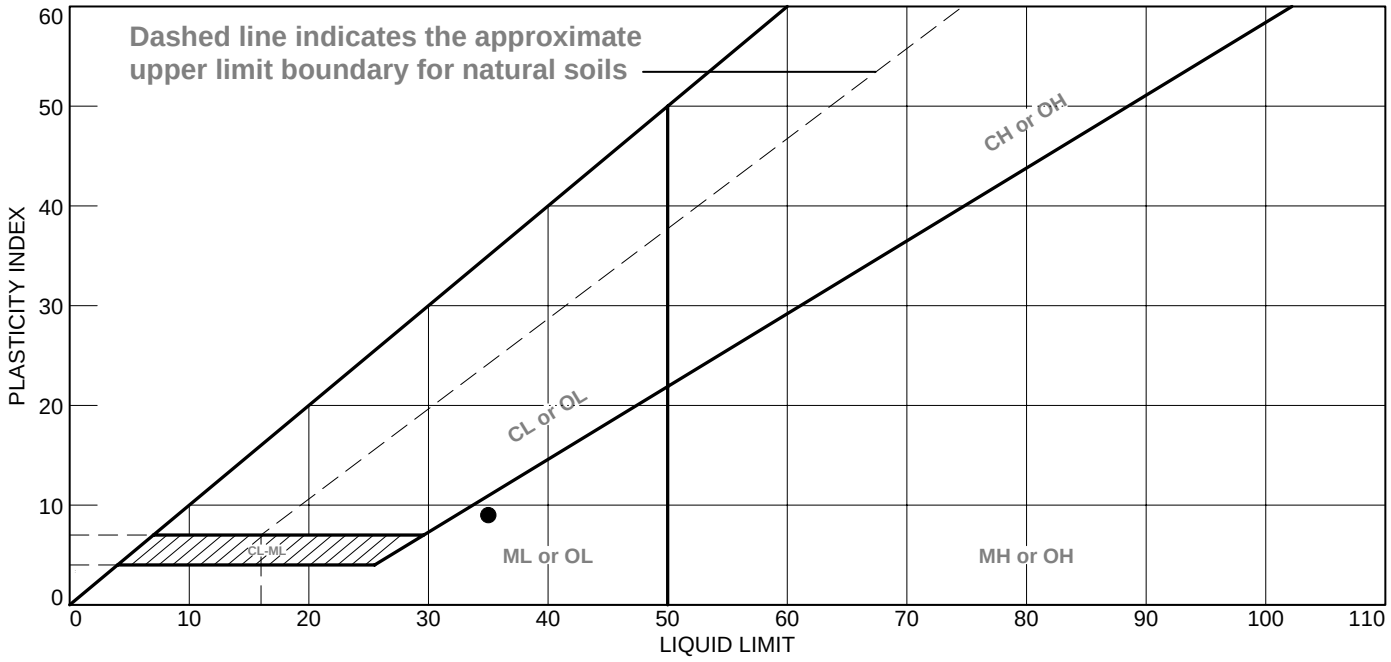
Terracon

Remarks:

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BLACK ORGANIC CLAY WITH SAND - WOOD NOTED	35	26	9			OL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B003 **Depth:** 10.0'-12.0'
Sample Number: S-5

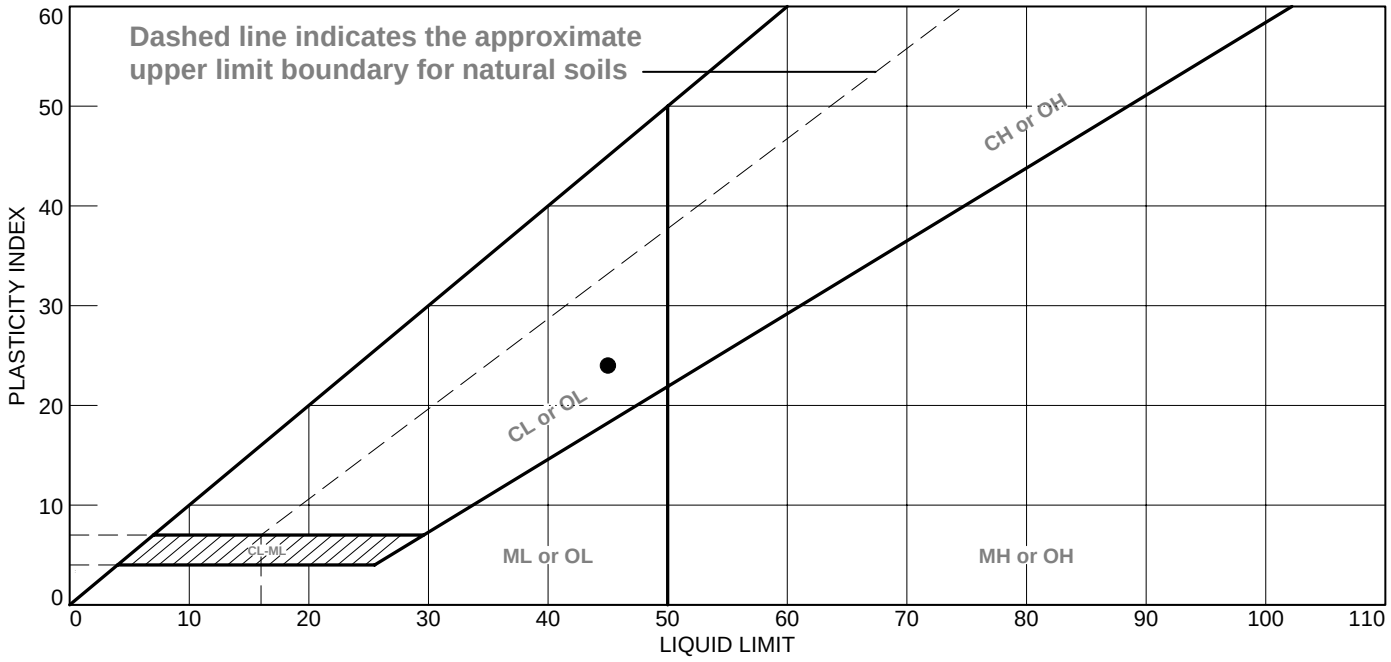
Remarks:

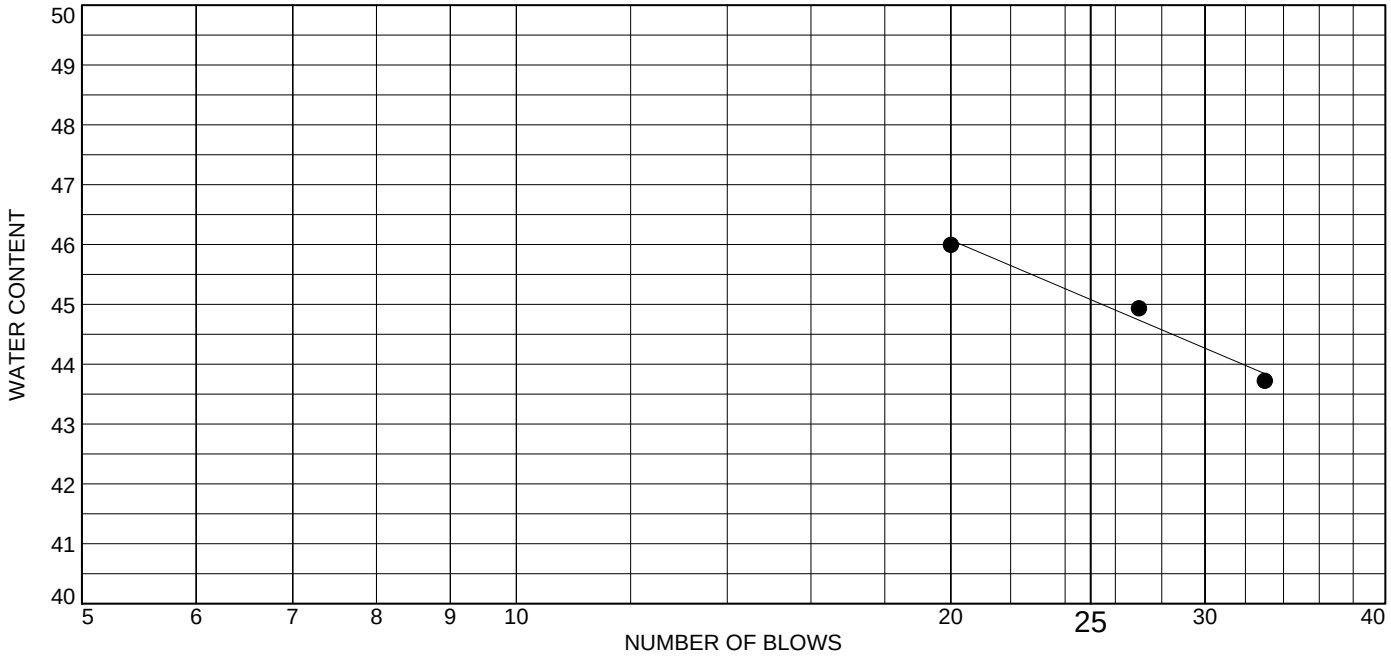
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK GRAY LEAN CLAY	45	21	24			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B003 **Depth:** 25.0'-27.5'
Sample Number: S-8

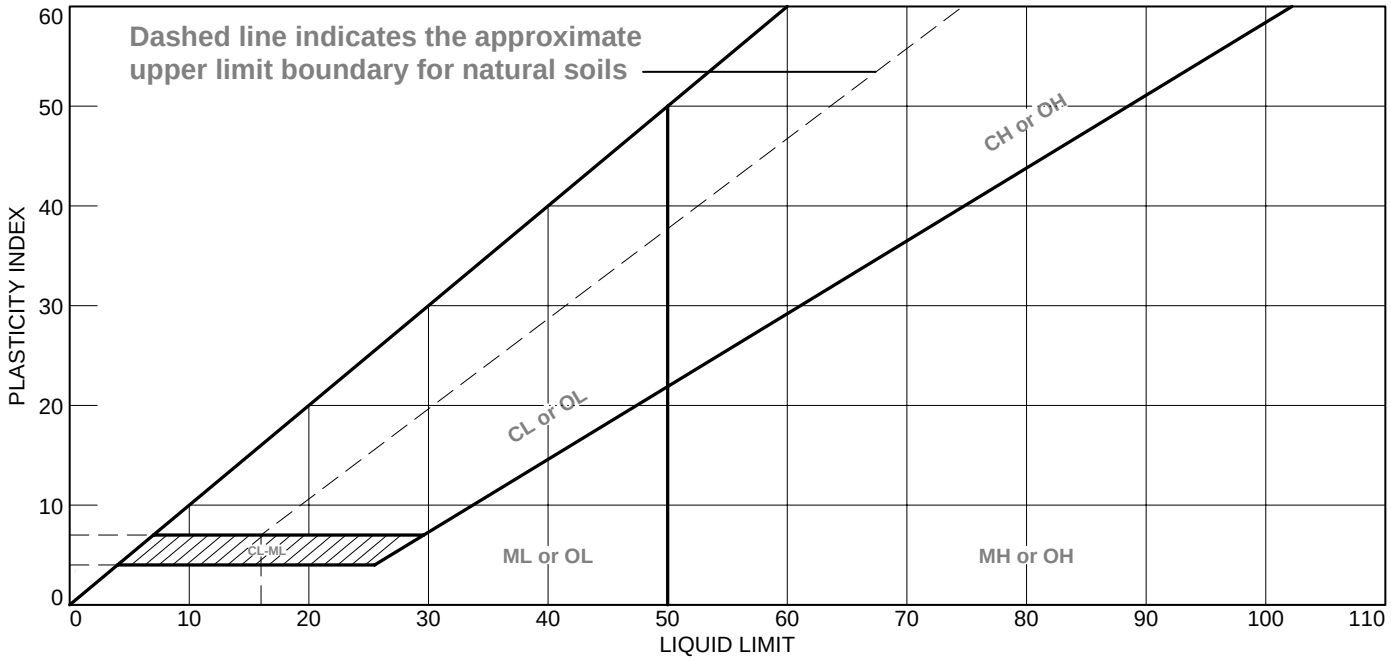
Remarks:

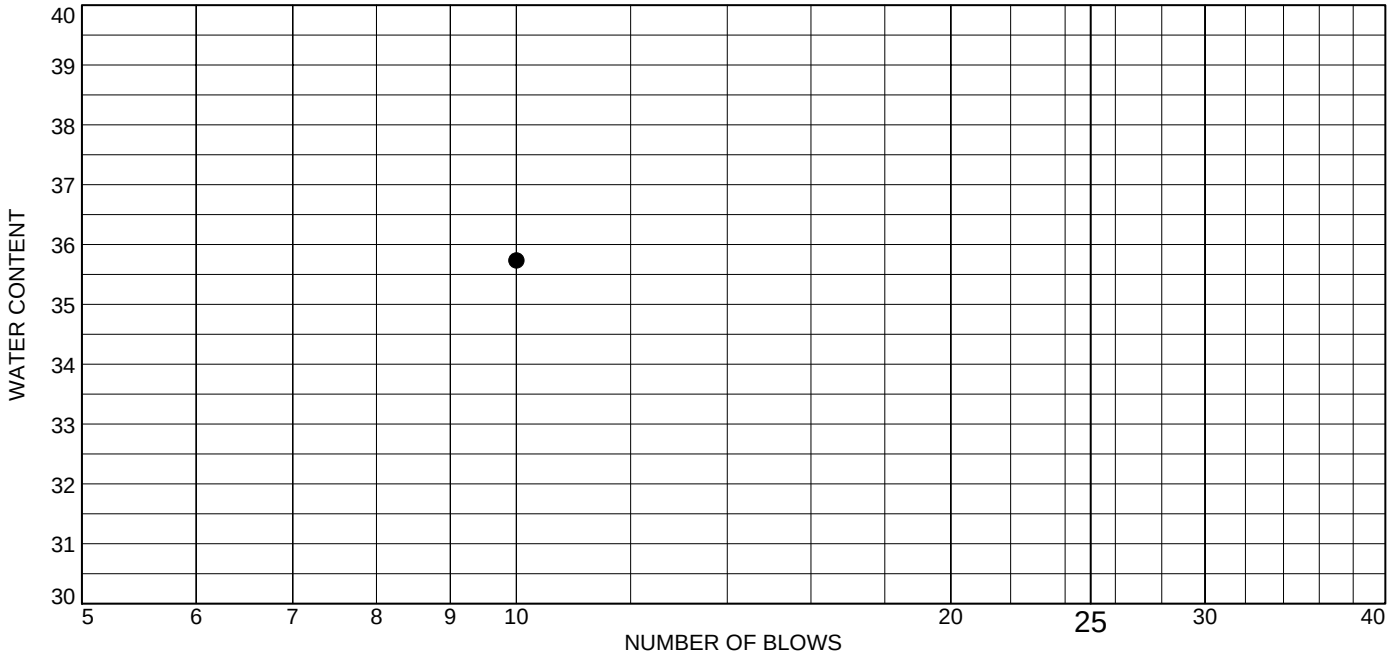
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN BLACK AND GRAY SANDY SILT WITH GRAVEL	32	35	NP			ML

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B004 **Depth:** 10.0'-12.0'
Sample Number: S-5

Terracon

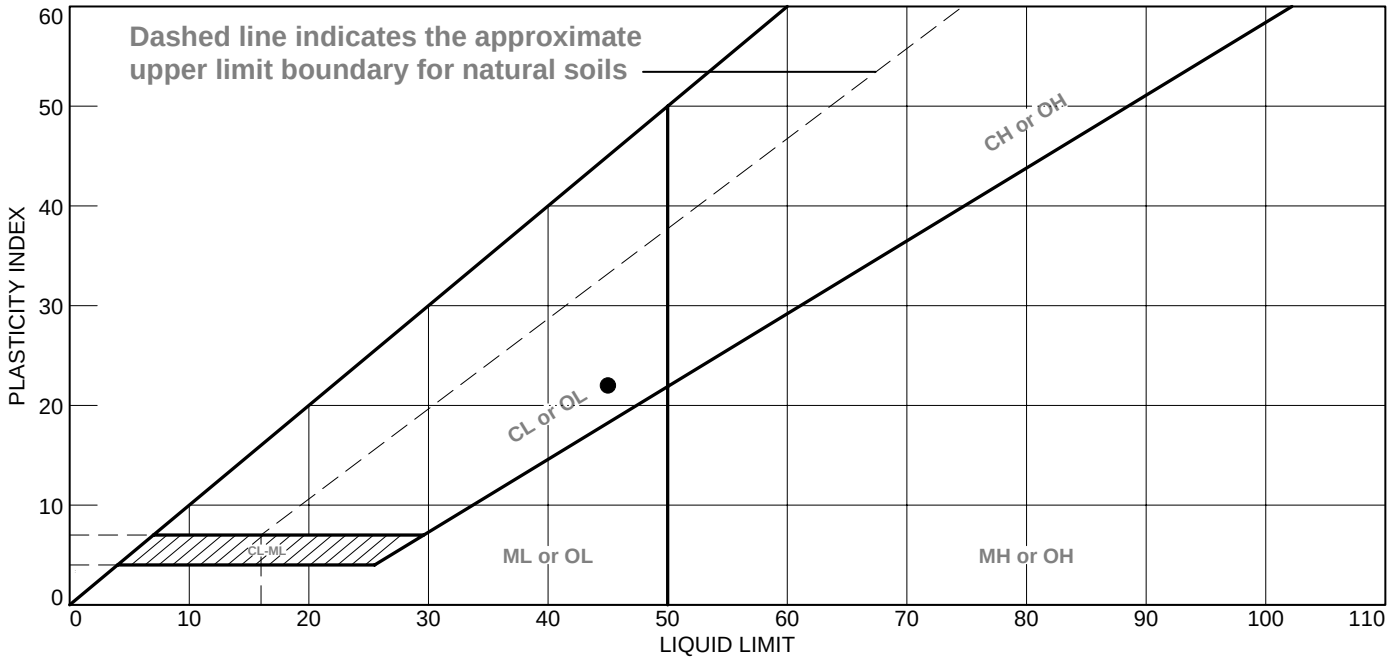
Remarks:

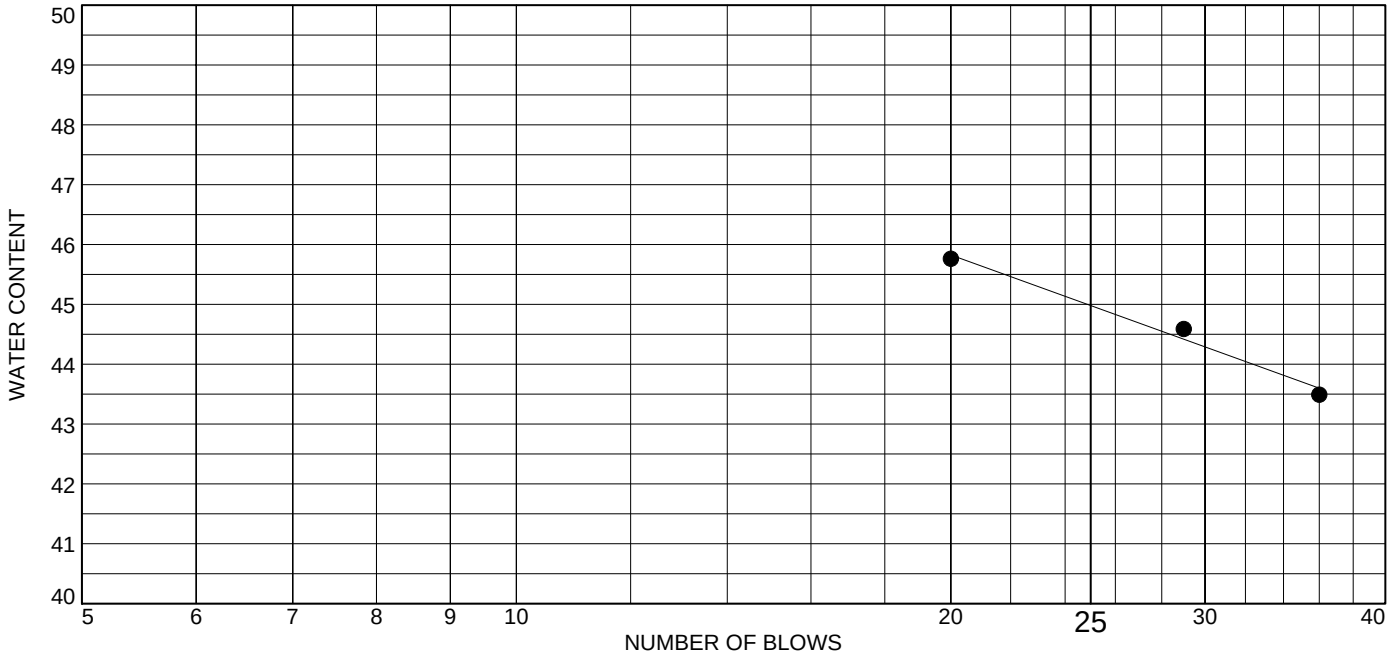
● A single point test was performed because of difficultly obtaining high blow counts due to type of material.

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK GRAY LEAN CLAY - ORGANICS NOTED	45	23	22			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B004 **Depth:** 20.0'-22.0'
Sample Number: S-7

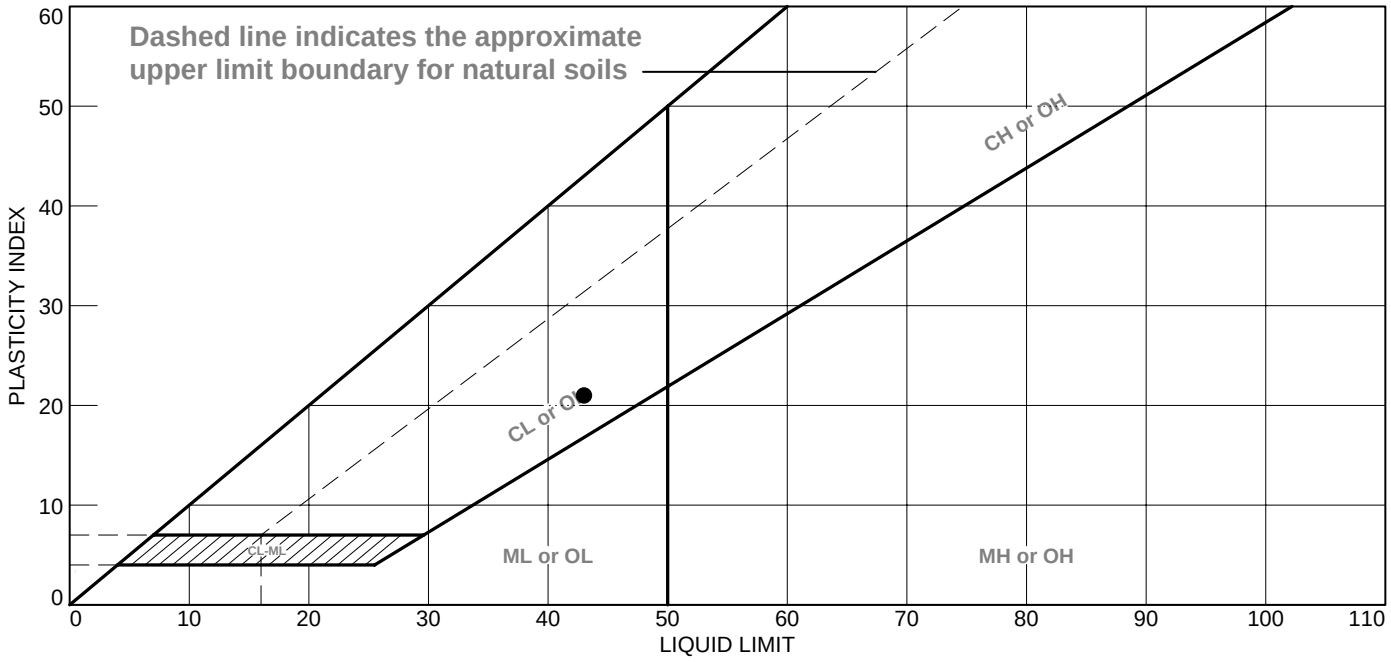
Remarks:

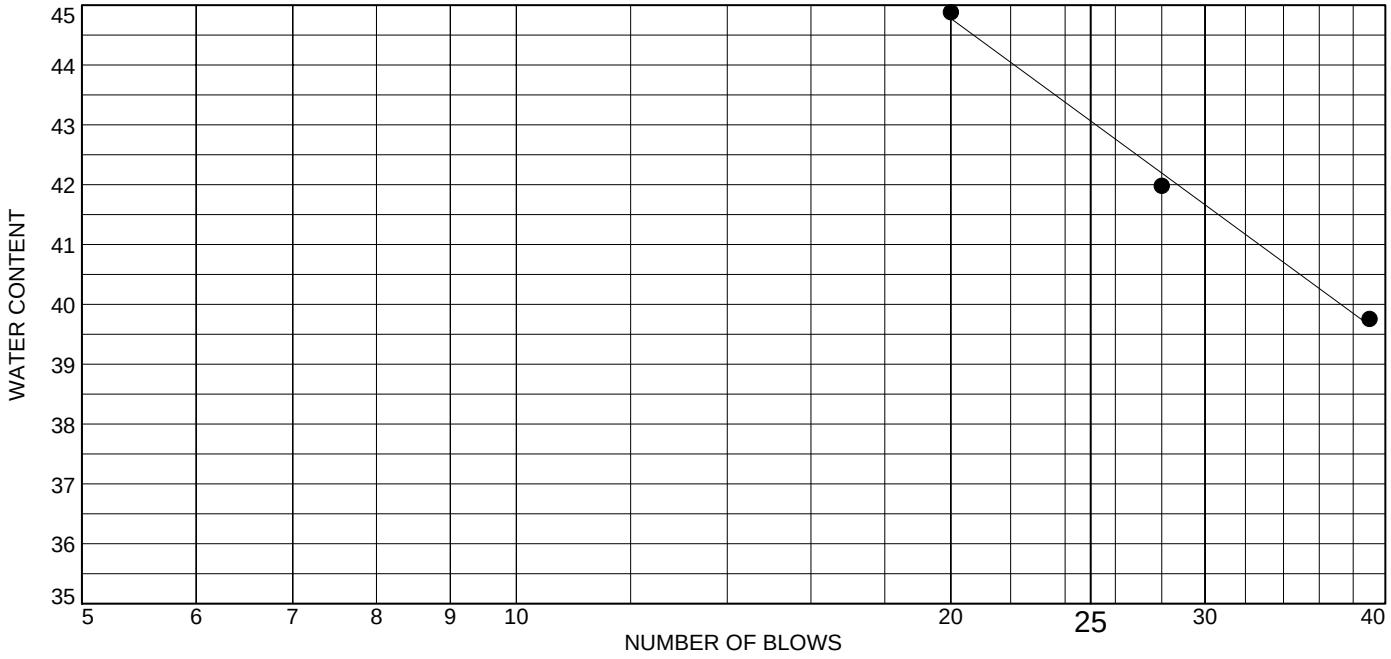
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY LEAN CLAY	43	22	21			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B004 **Depth:** 30.0'-32.0'
Sample Number: S-9

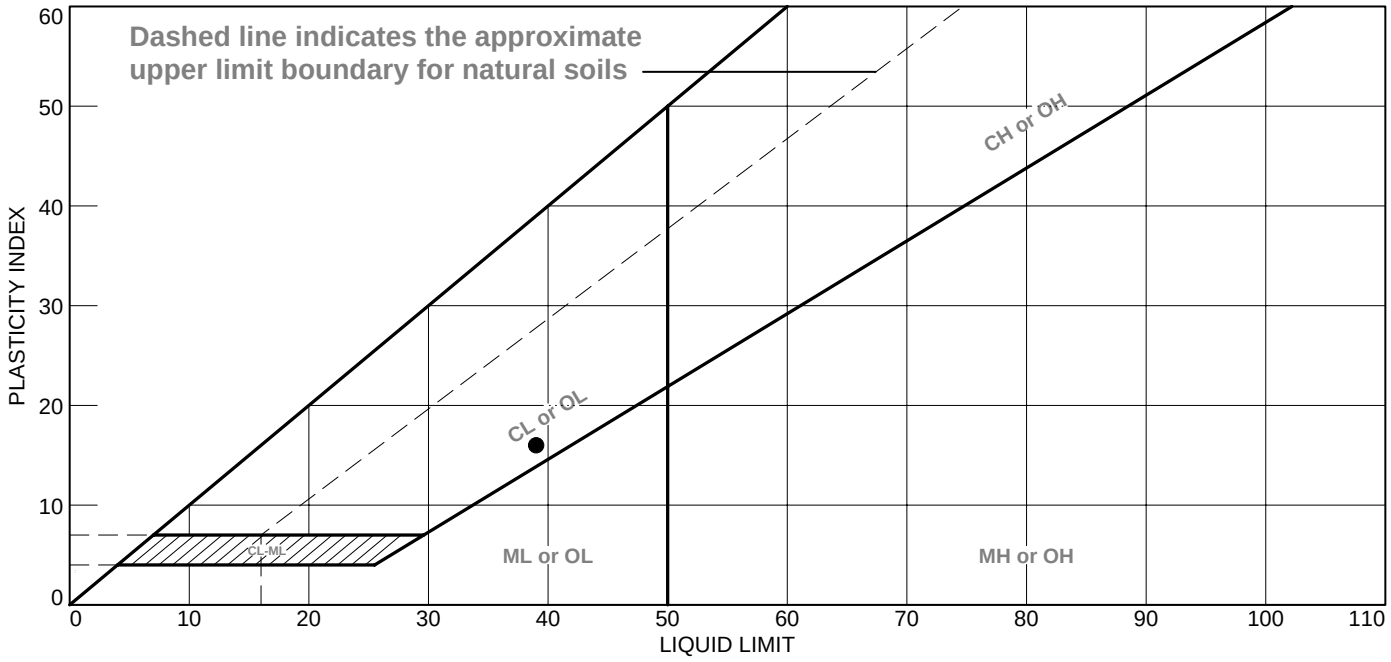
Remarks:

Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BLACK TO VERY DARK GRAY ORGANIC CLAY	39	23	16			OL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B005 **Depth:** 7.5'-9.5'
Sample Number: S-2

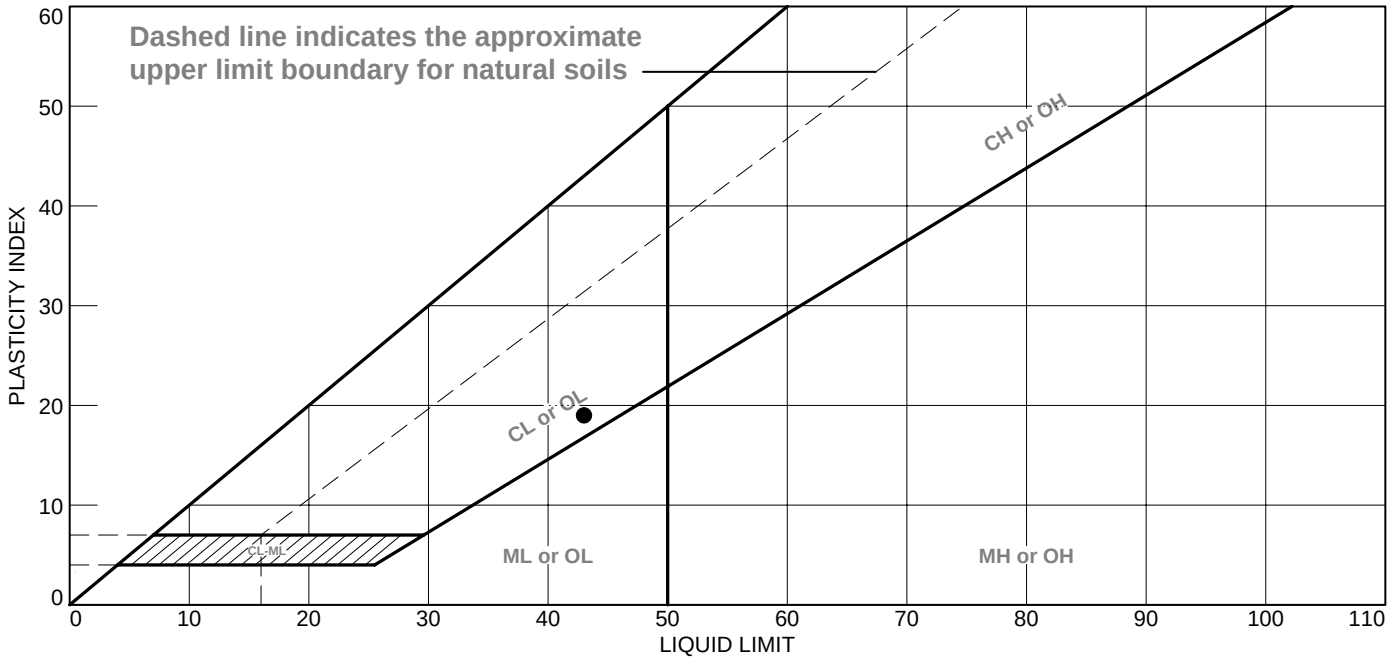
Remarks:

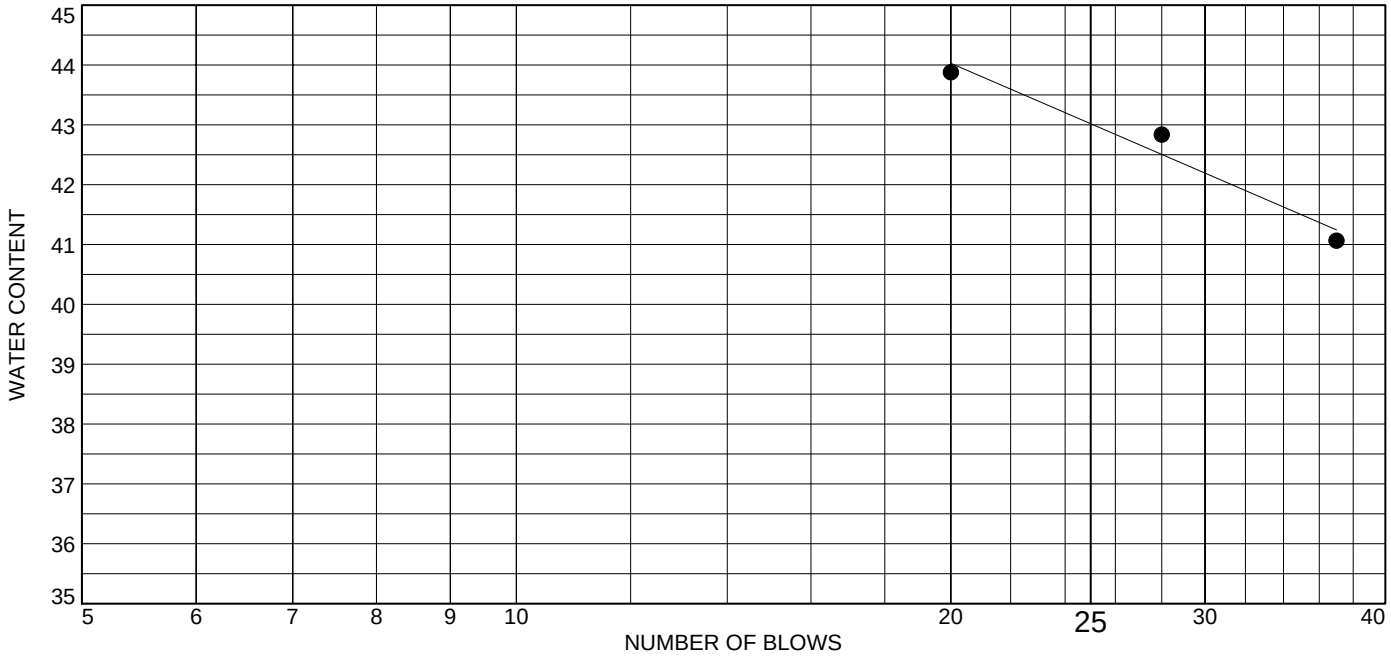
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK GRAY LEAN CLAY WITH SAND AND FLY ASH	43	24	19	100.0	83.8	CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B005 **Depth:** 12.5'-14.5'
Sample Number: S-4

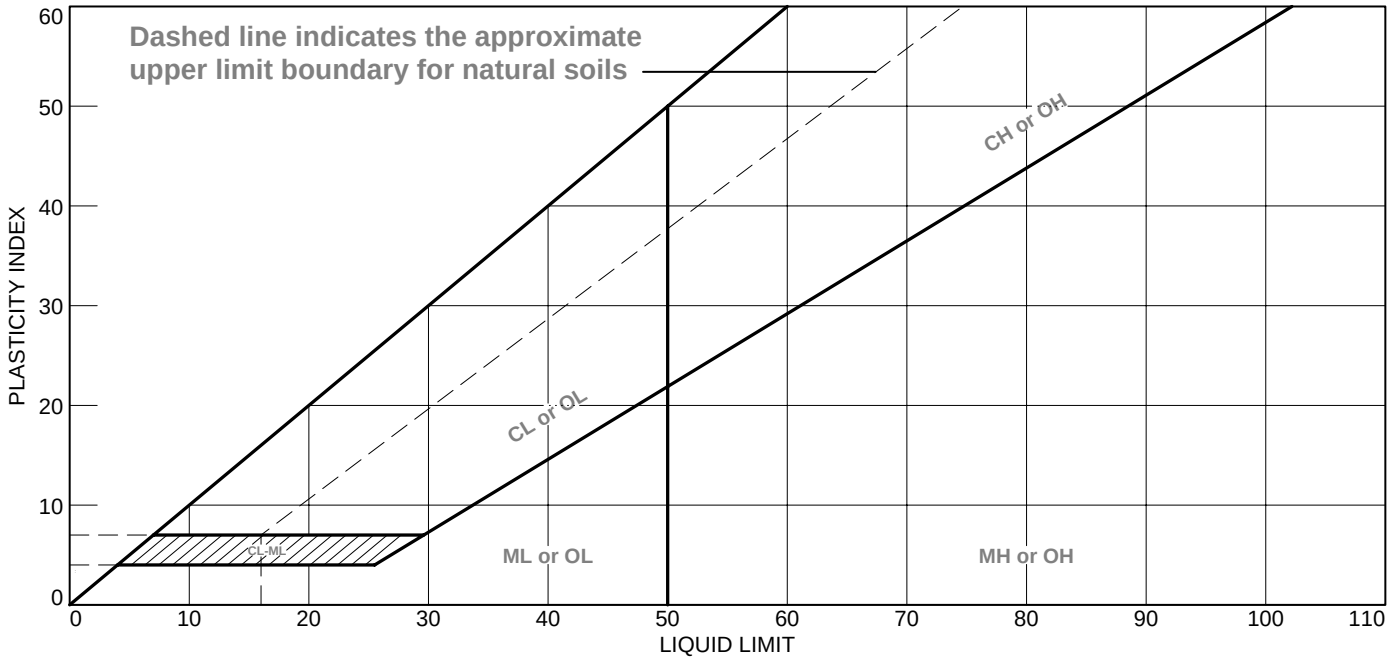
Remarks:

Terracon

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	MULTI STRATA SAMPLE: TOP, FLY ASH - MIDDLE, FLY ASH LEAN CLAY WITH SAND MIX - BOTTOM, BROWN SANDY CLAY	25	28	NP			

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B008 **Depth:** 7.5'-9.5'
Sample Number: S-4

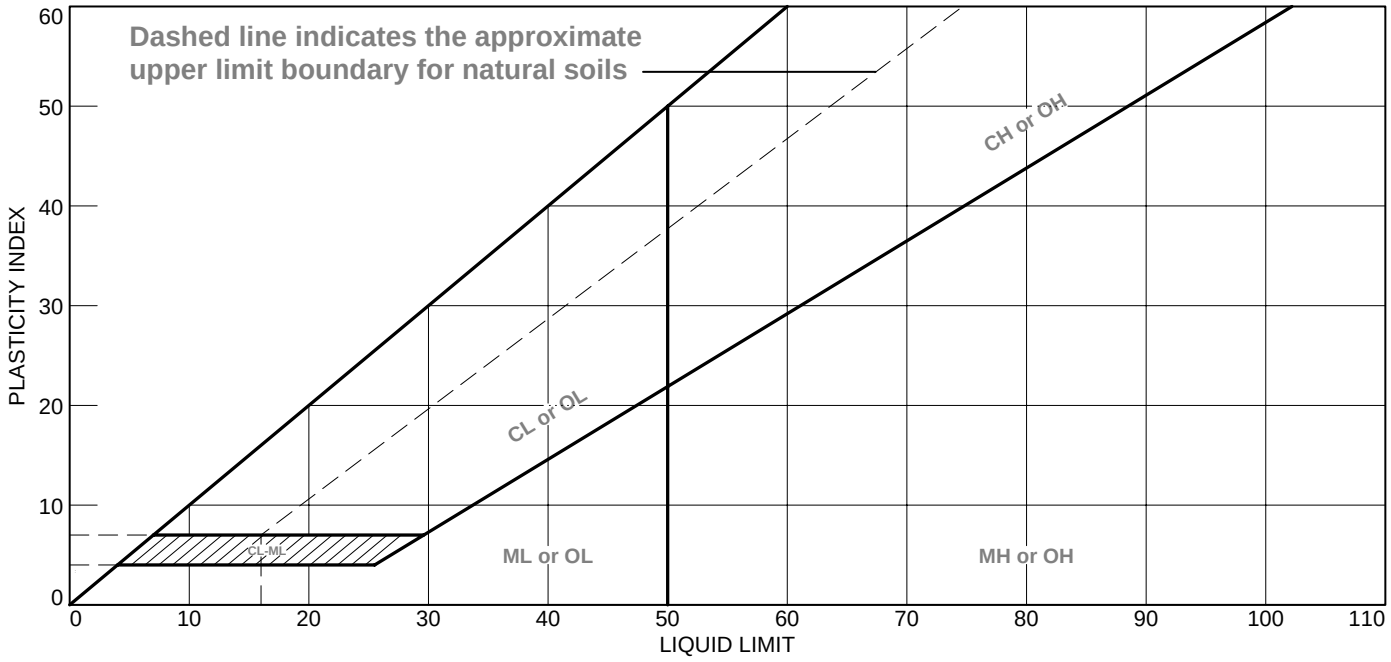
Remarks:

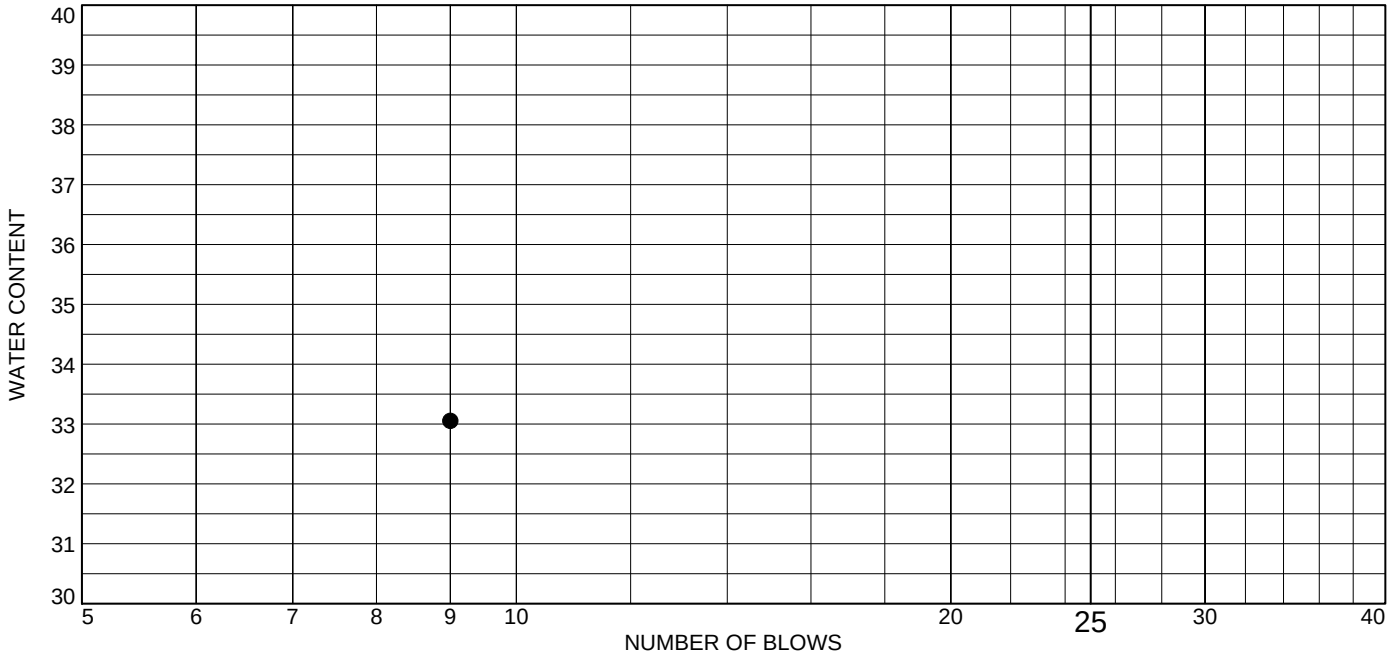
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK GRAY FLY ASH WITH SAND AND GRAVEL	29	33	NP			

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B010 **Depth:** 10.0'-11.5'
Sample Number: S-5

Terracon

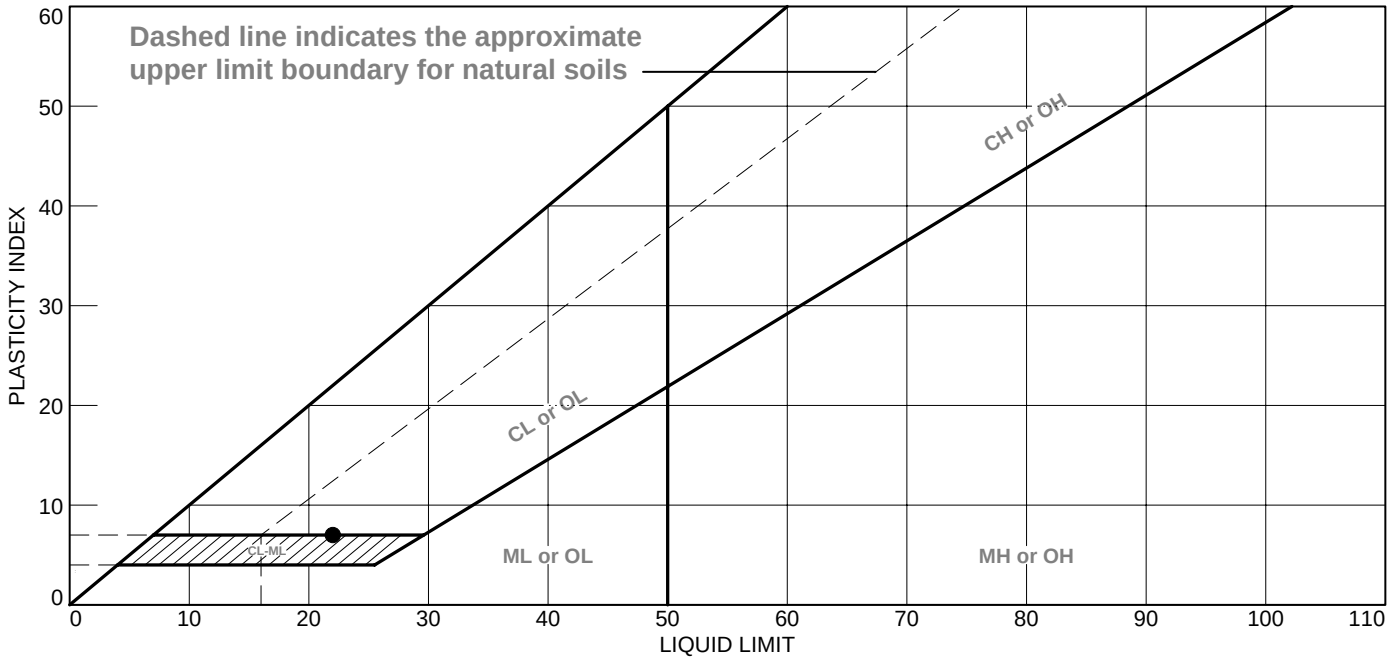
Remarks:

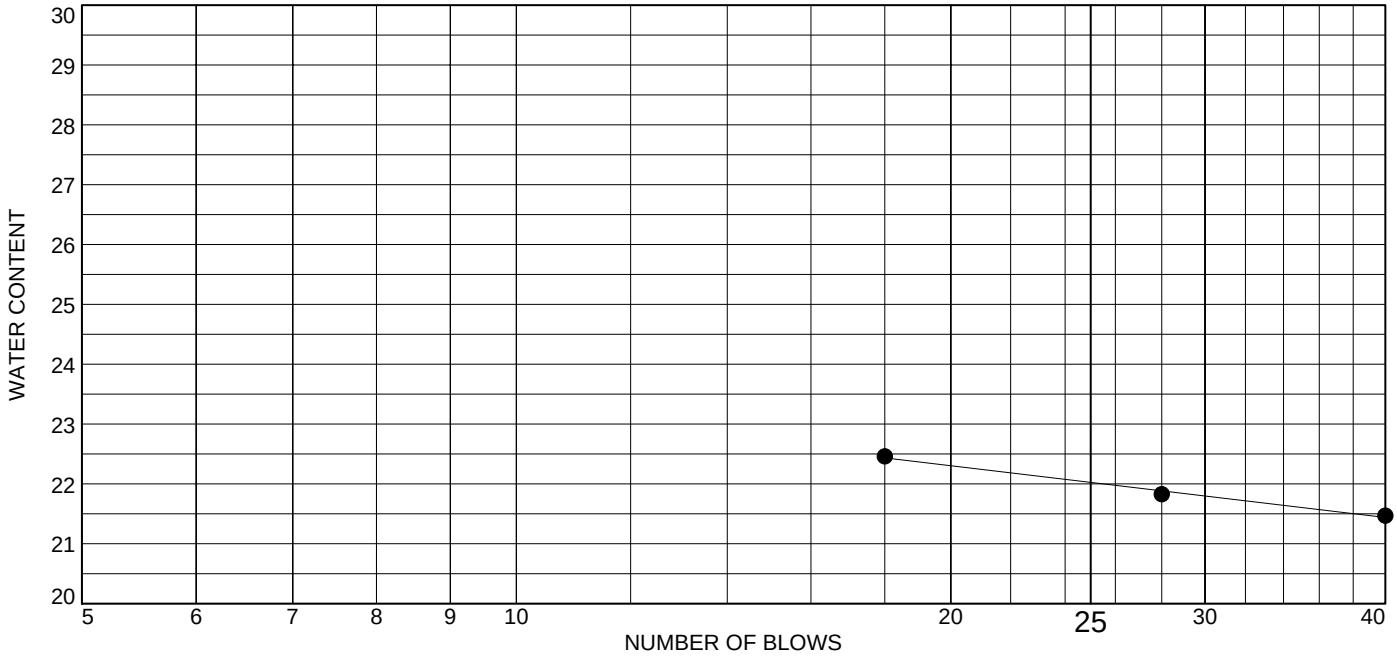
● A single point test was performed because of difficultly obtaining high blow counts due to type of material.

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	RUST BROWN SANDY LEAN CLAY	22	15	7			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B011 **Depth:** 2.5'-4.0'
Sample Number: S-2

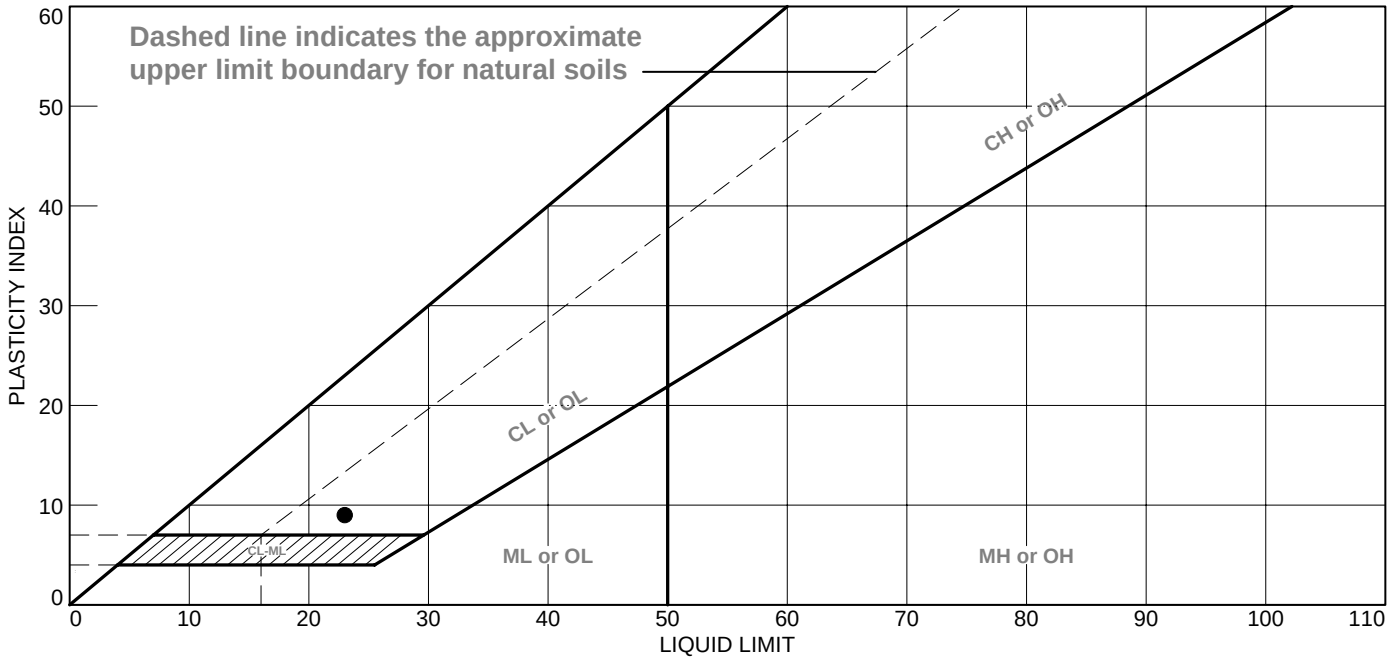
Remarks:

Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWN LEAN CLAY WITH SILT AND SAND - SILT AND SAND SEAM NOTED	23	14	9			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B012 **Depth:** 10.0'-11.5'
Sample Number: S-5

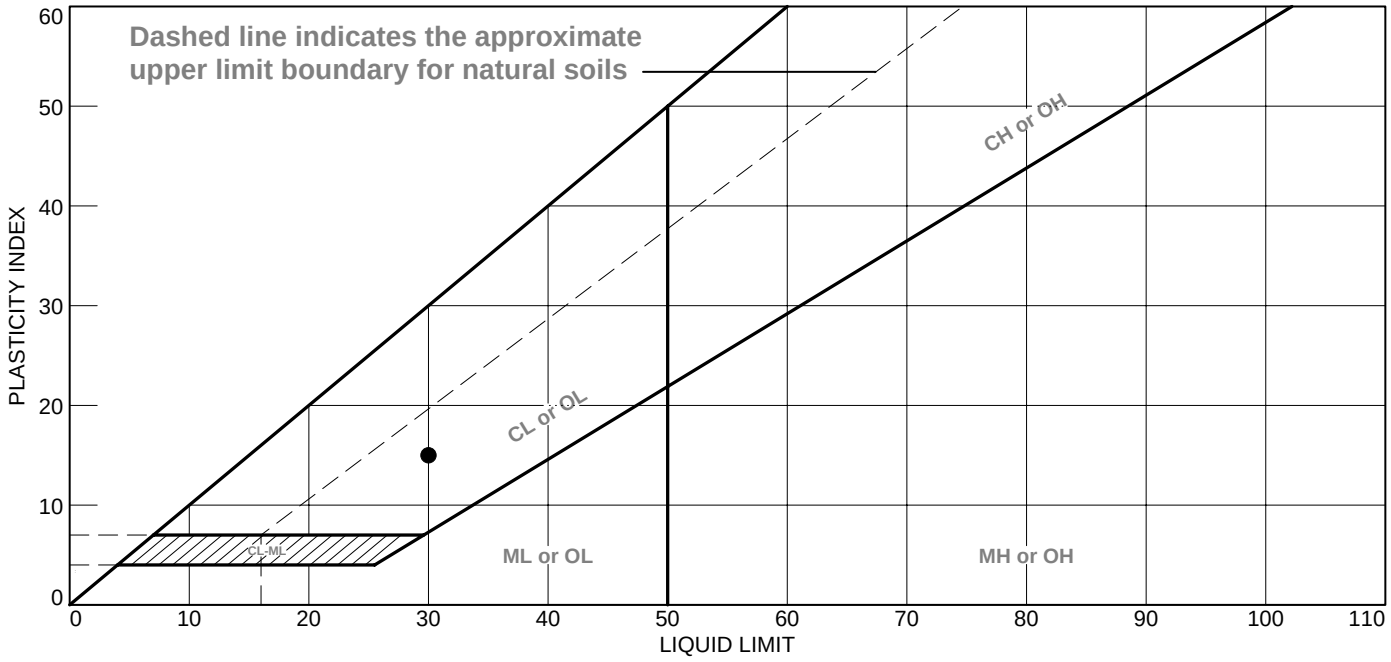
Remarks:

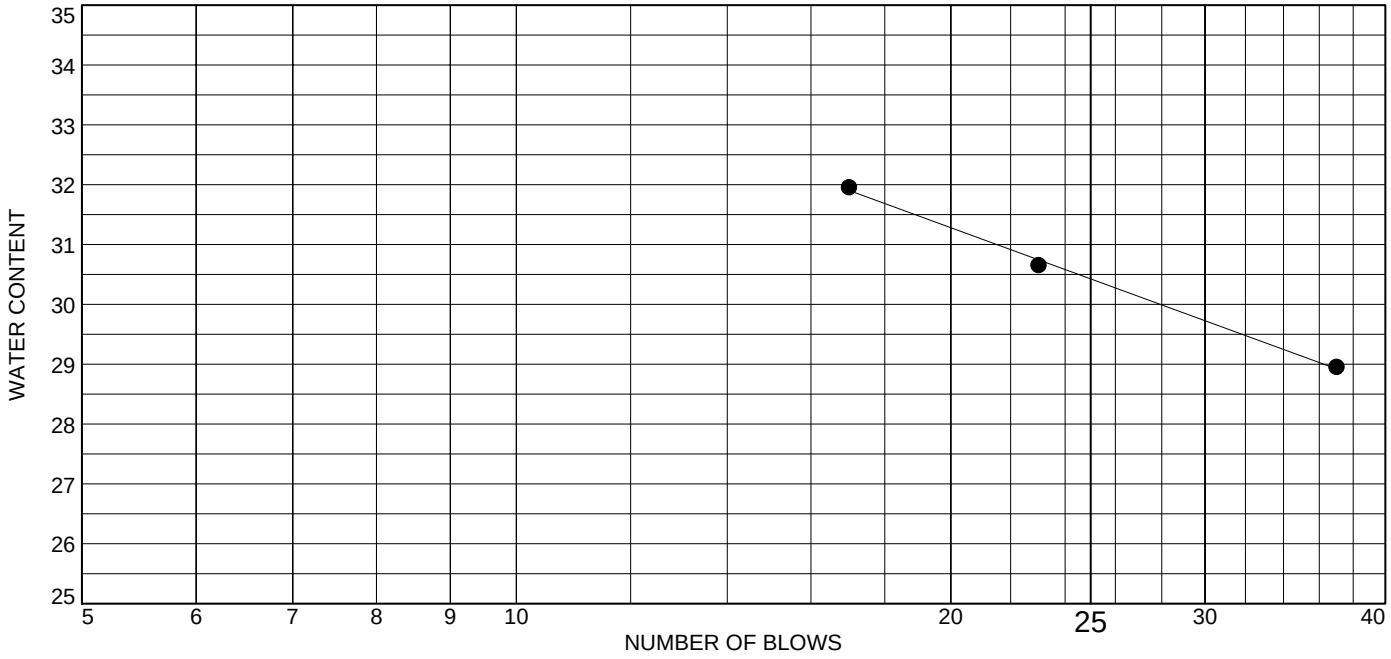
Terracon

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAYISH BROWN LEAN CLAY WITH SAND	30	15	15			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B012 **Depth:** 30.0'-32.0'
Sample Number: S-9

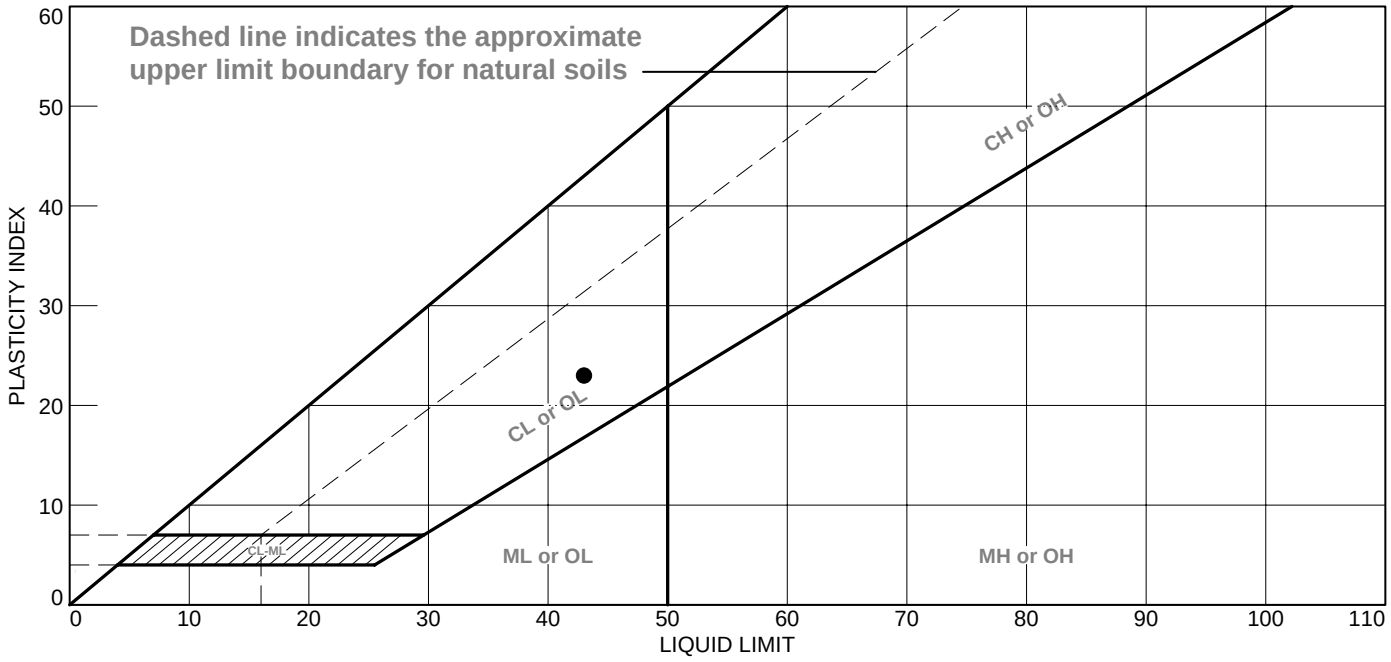
Remarks:

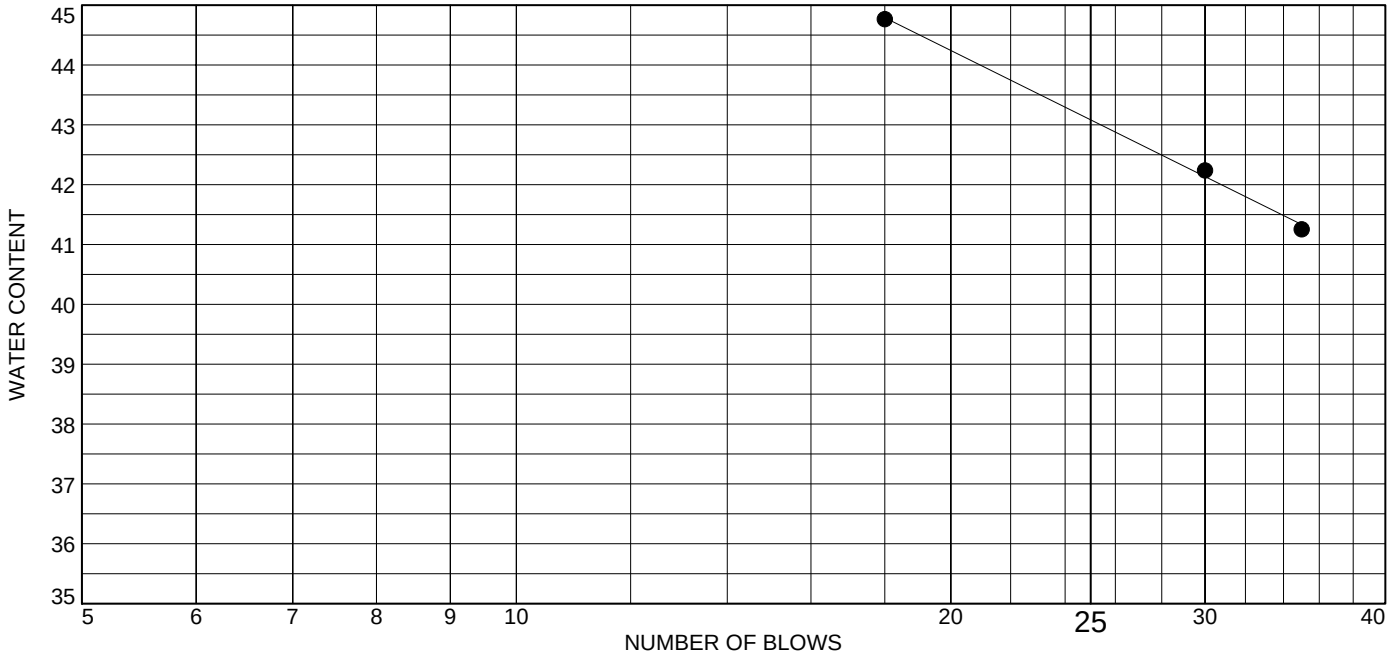
Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY LEAN CLAY	43	20	23			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B014 **Depth:** 25.0'-27.0'
Sample Number: S-8

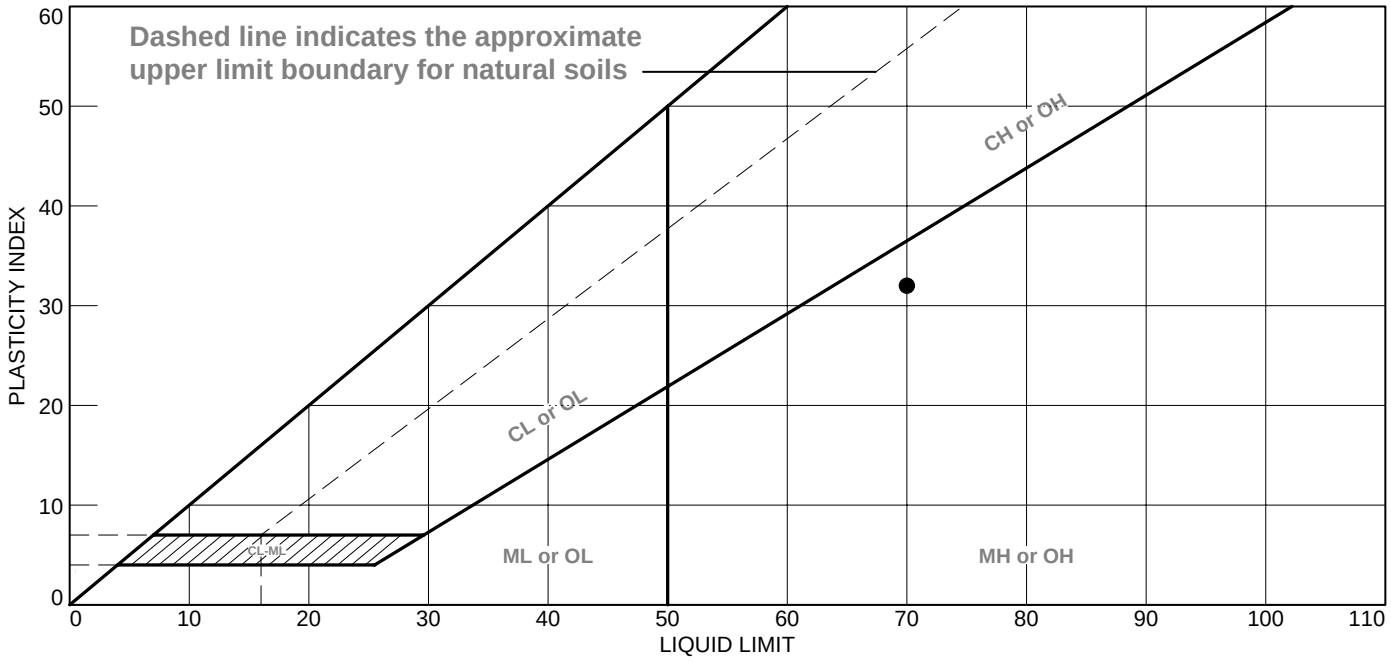
Remarks:

Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK BROWNISH GRAY ORGANIC SILT	70	38	32			OH

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B014 **Depth:** 35.0'-37.0'
Sample Number: S-10

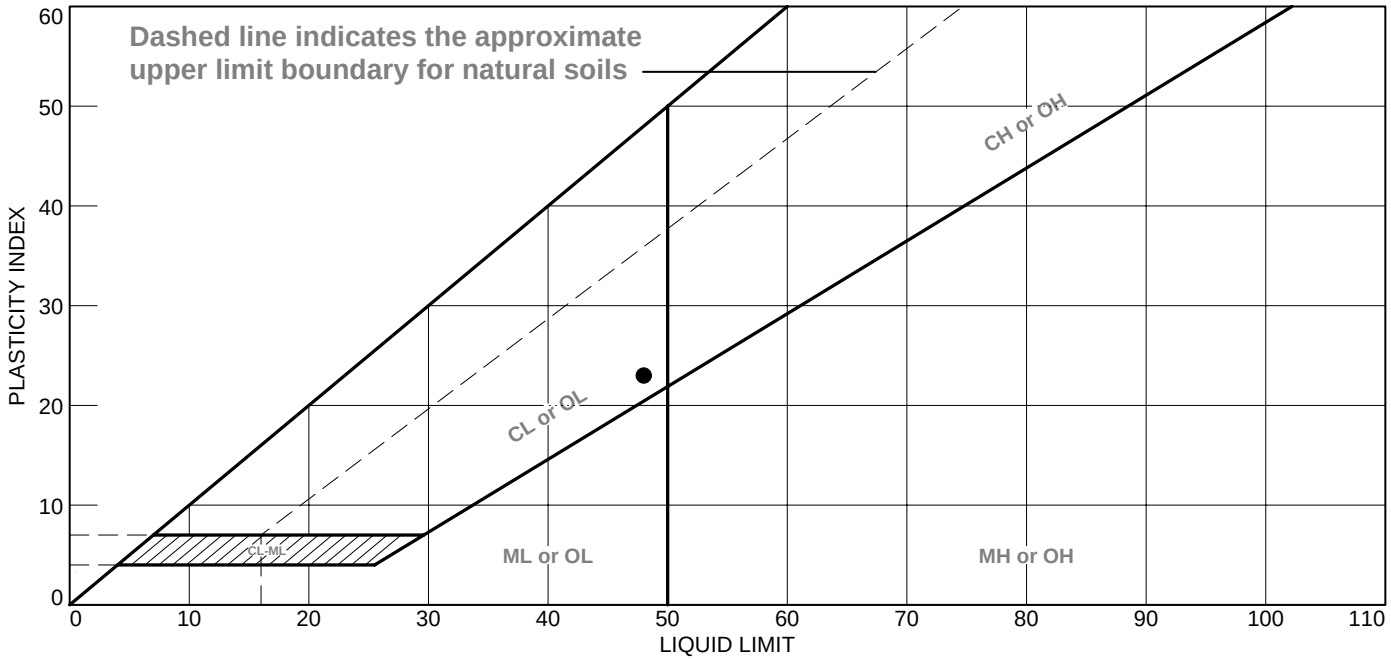
Remarks:

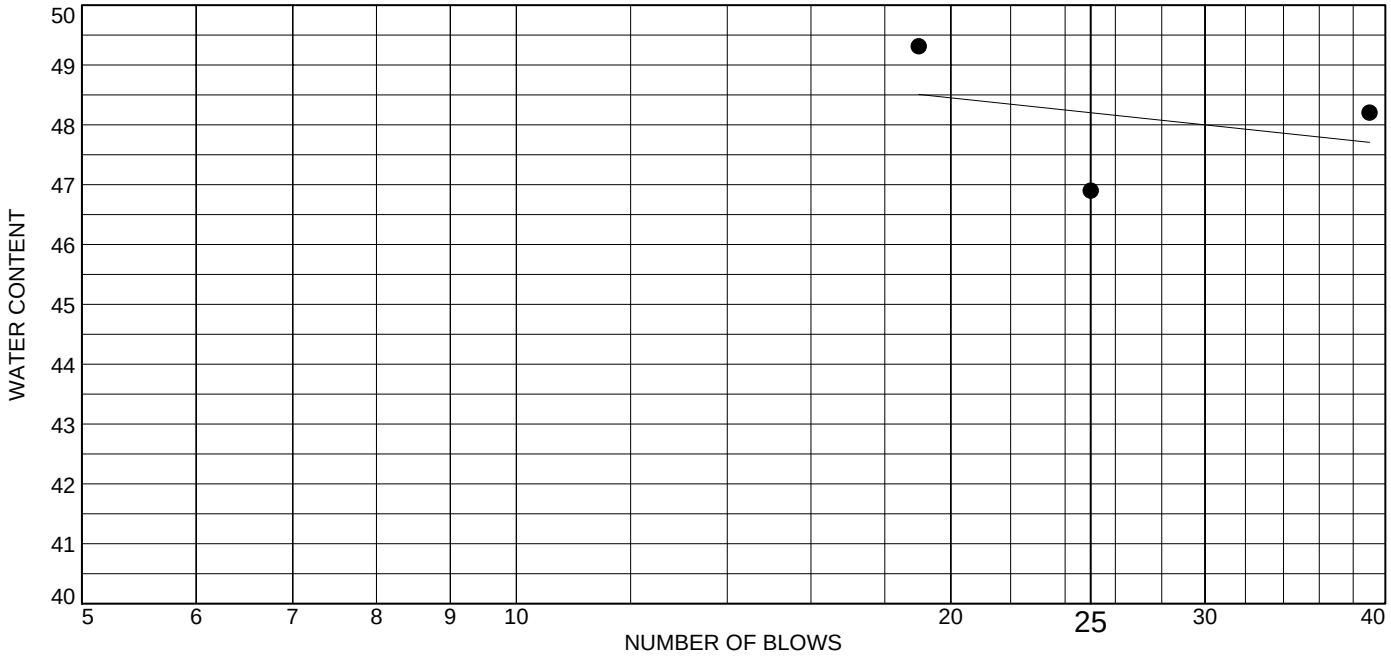
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BLACK AND DARK GRAY ORGANIC LEAN CLAY WITH SAND AND GRAVEL	48	25	23			OL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B015 **Depth:** 7.5'-9.5'
Sample Number: S-4

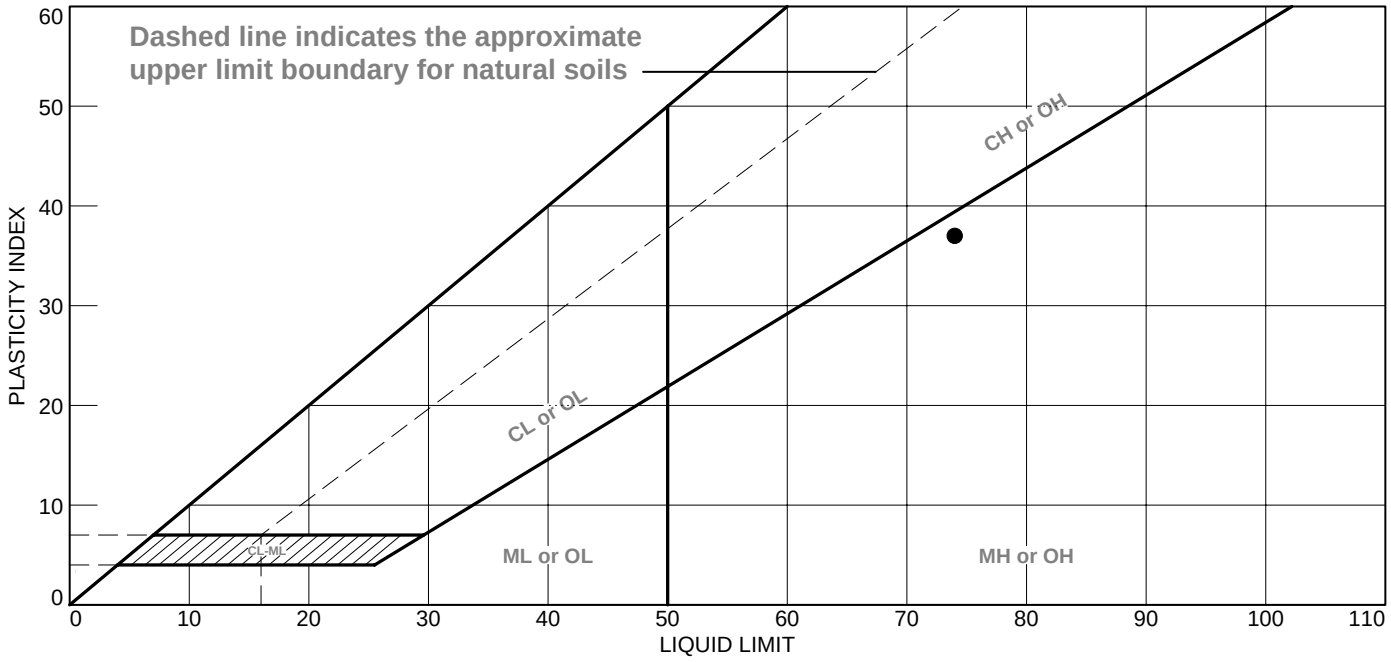
Remarks:

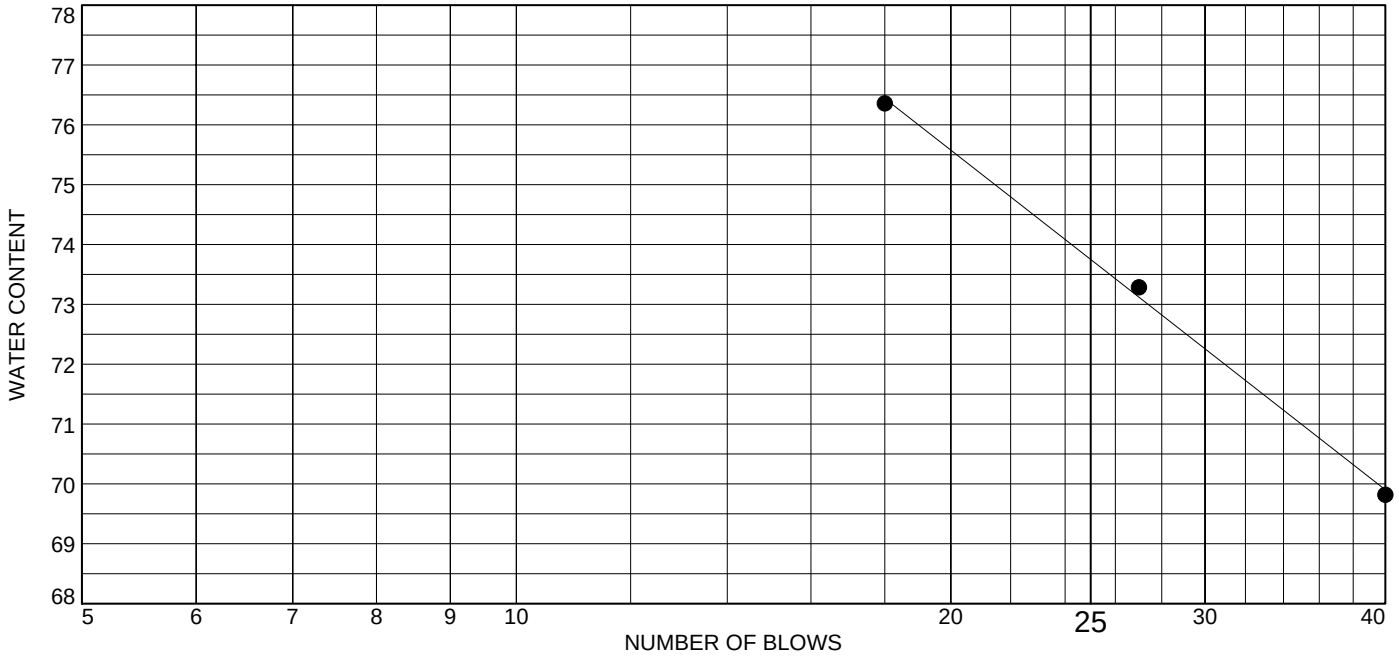
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BLACK ORGANIC SILT WITH SAND	74	37	37			OH

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B015 **Depth:** 25.0'-27.0'
Sample Number: S-8

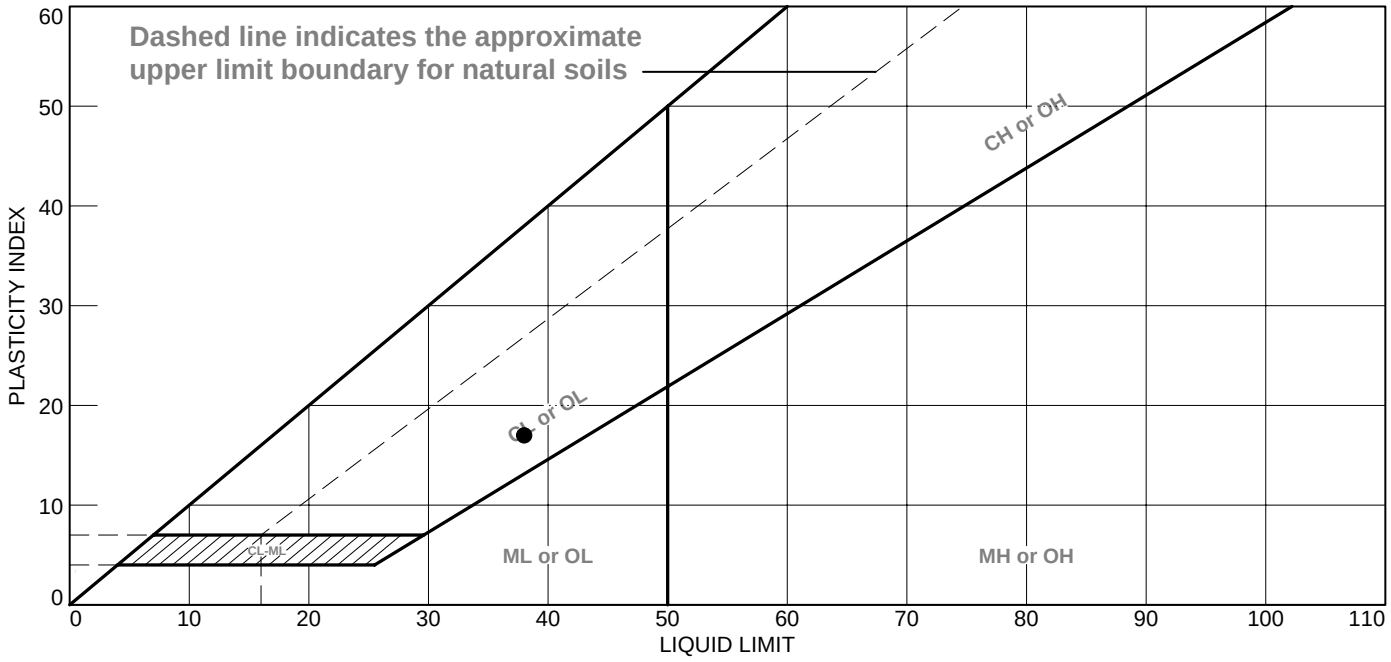
Terracon

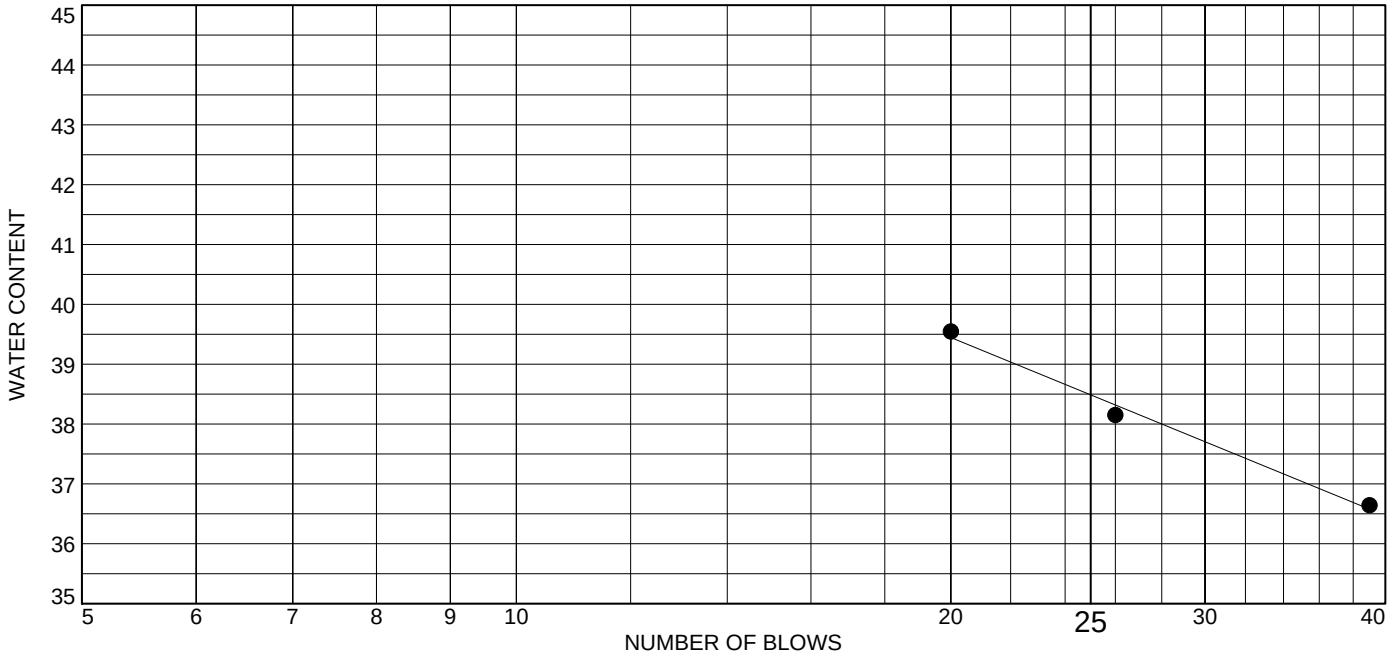
Remarks:

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK GRAY CLAY WITH SAND AND GRAVEL - ORGANICS AND ASH NOTED	38	21	17			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B016 **Depth:** 20.0'-22.0'
Sample Number: S-7

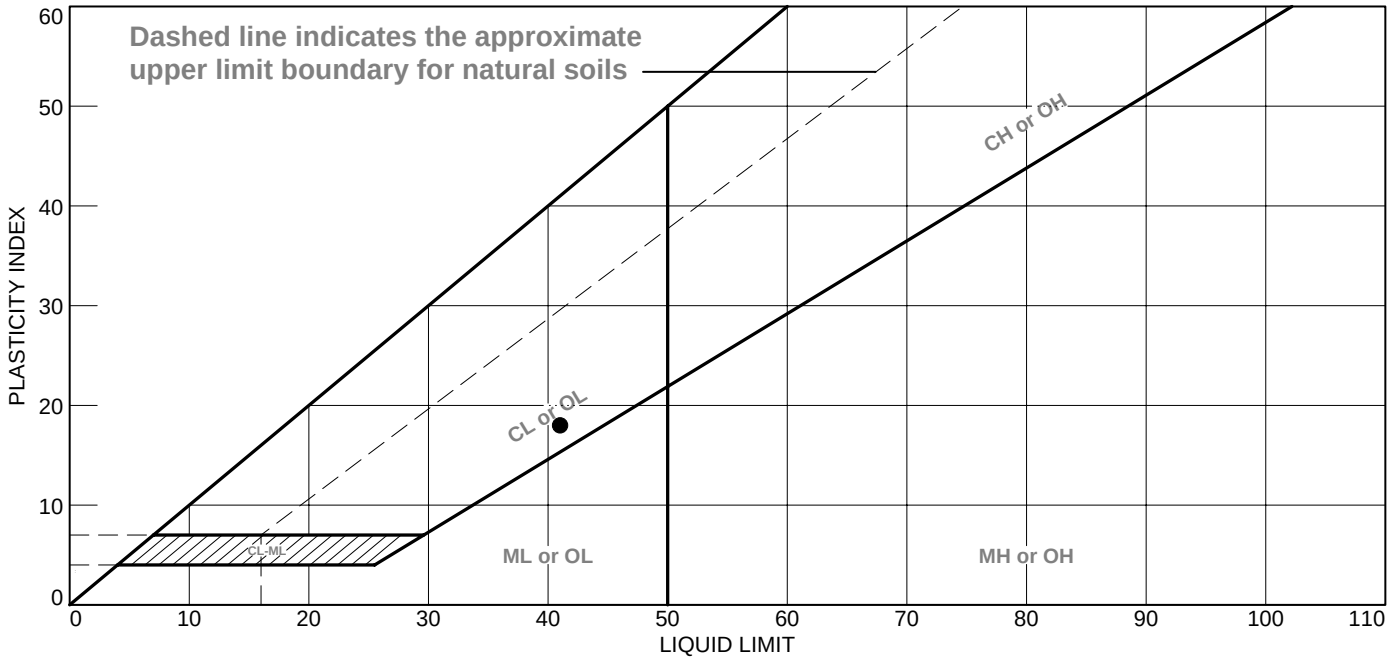
Remarks:

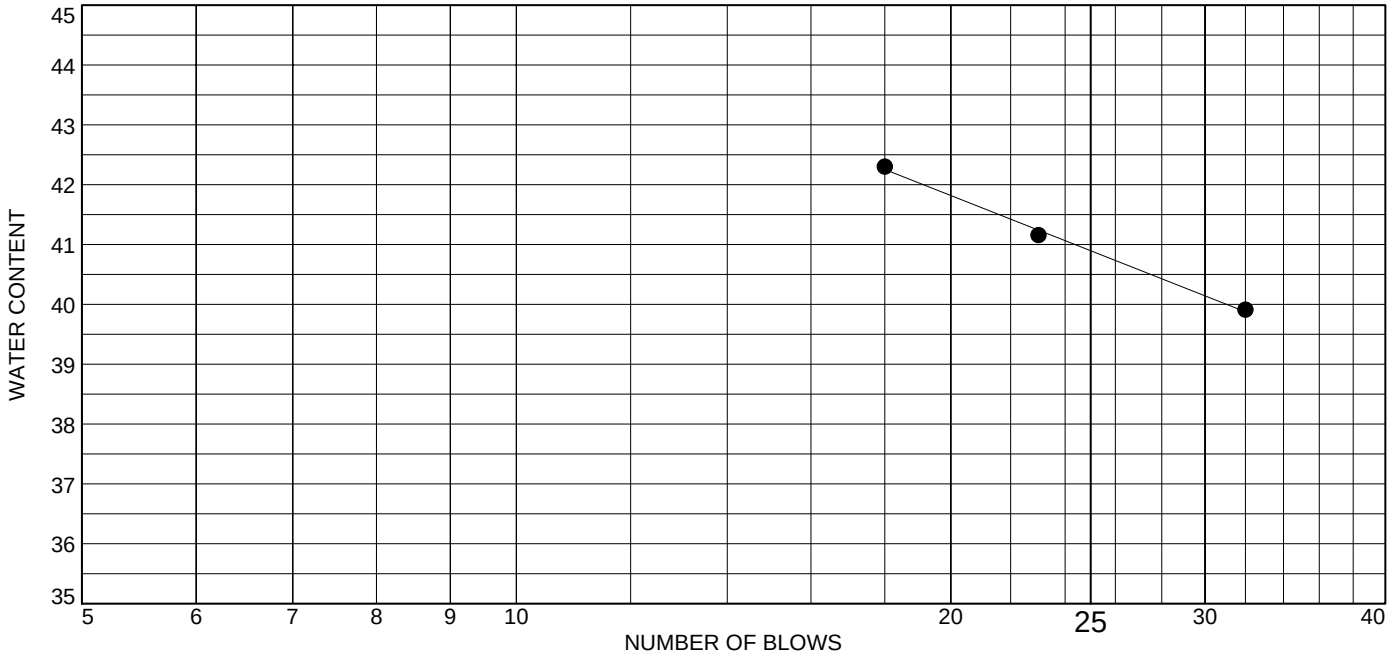
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK GRAY LEAN CLAY WITH SAND - FLY ASH AND ORGANICS NOTED	41	23	18			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B016 **Depth:** 35.0'-37.0'
Sample Number: S-10

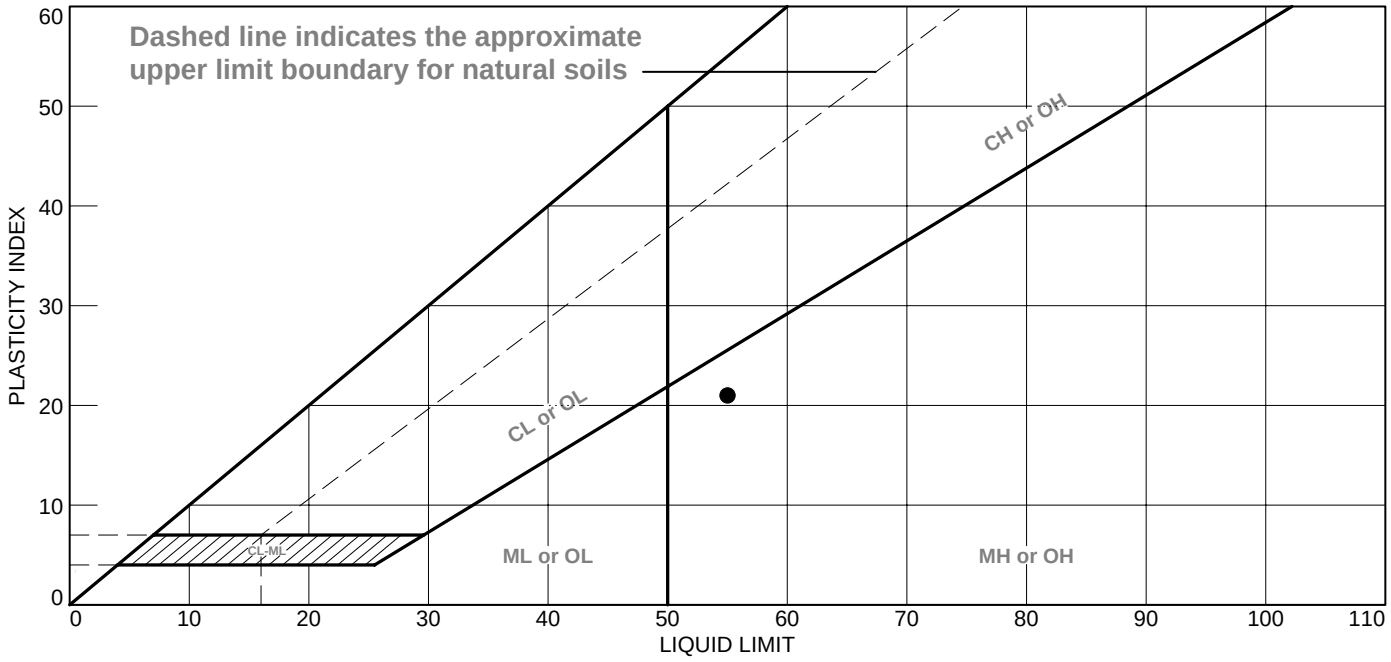
Remarks:

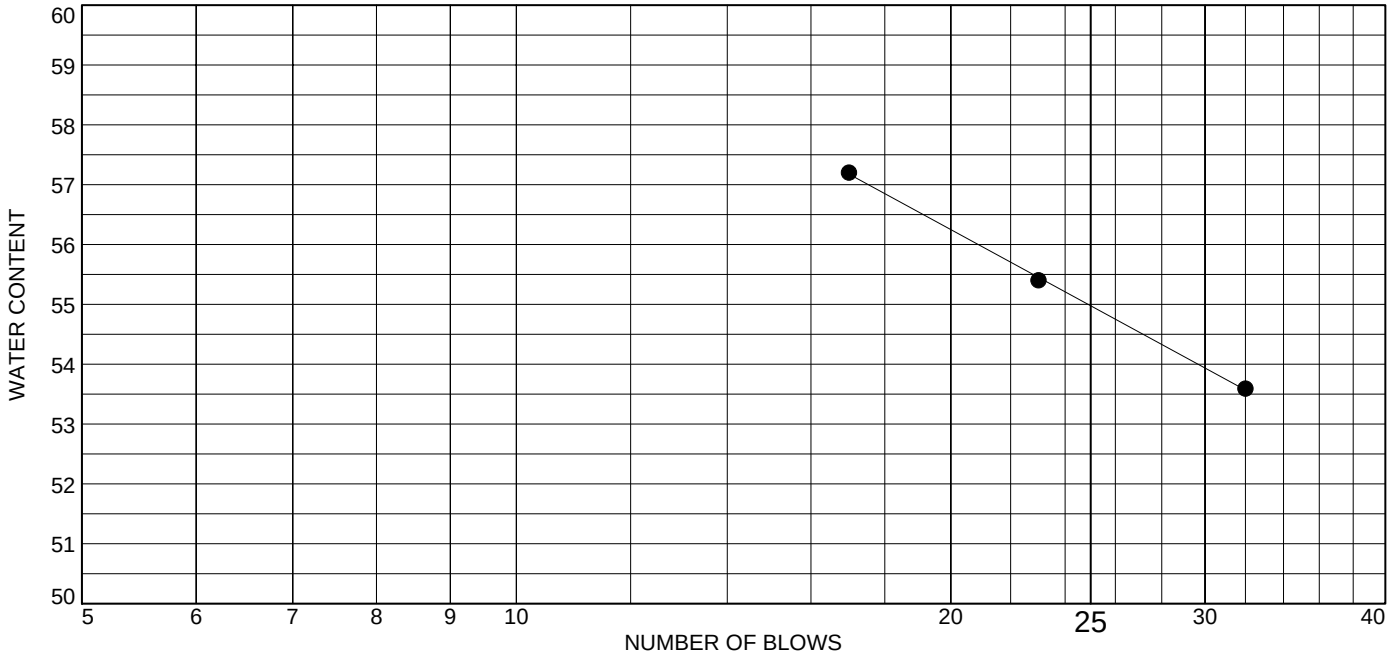
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK GRAY LEAN CLAY WITH SILT	55	34	21			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B016 **Depth:** 60.0'-61.5'
Sample Number: S-15

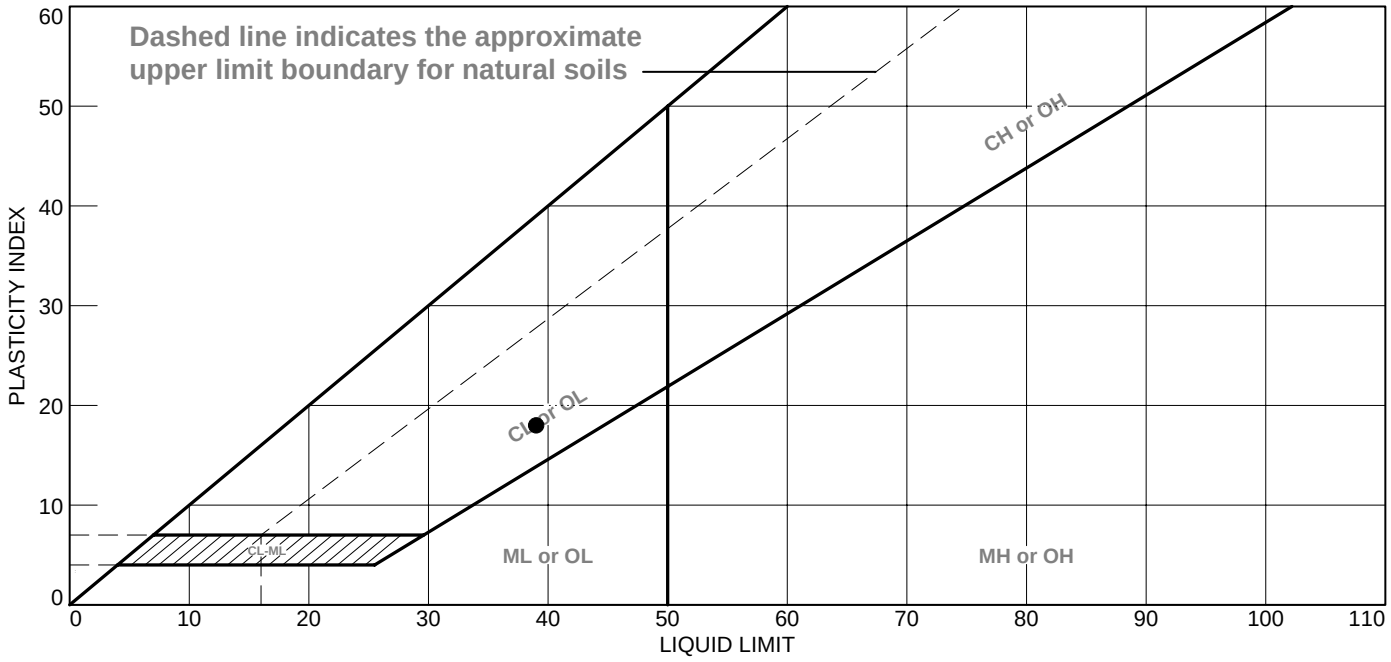
Remarks:

Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK GRAY LEAN CLAY WITH SAND	39	21	18			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B017 **Depth:** 5.0'-7.0'
Sample Number: S-3

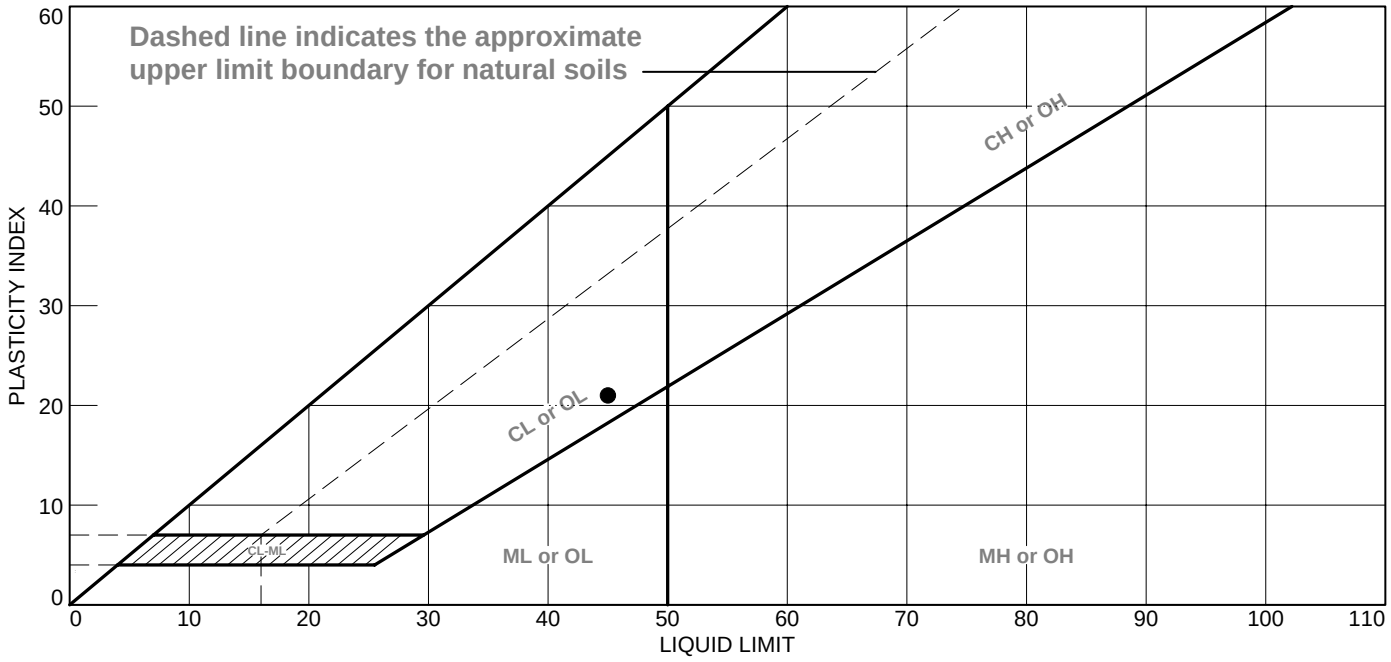
Remarks:

Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY LEAN CLAY	45	24	21			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B017 **Depth:** 15.0'-17.0'
Sample Number: S-6

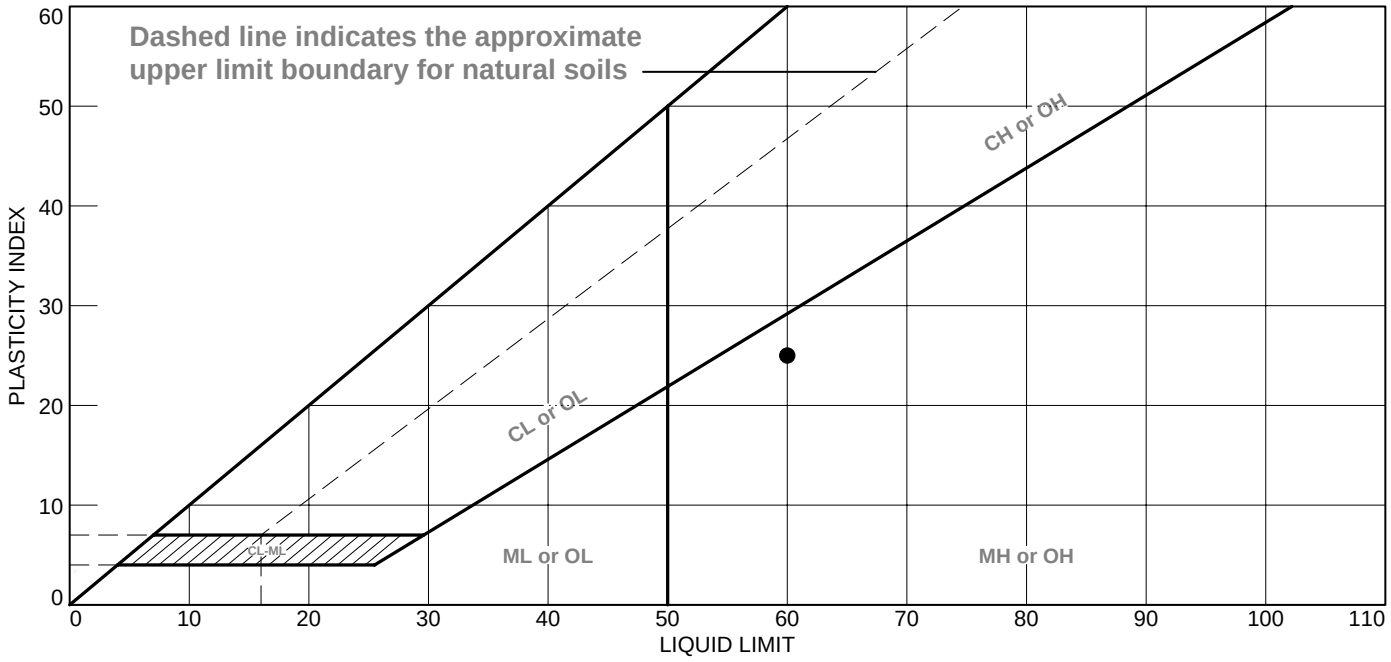
Remarks:

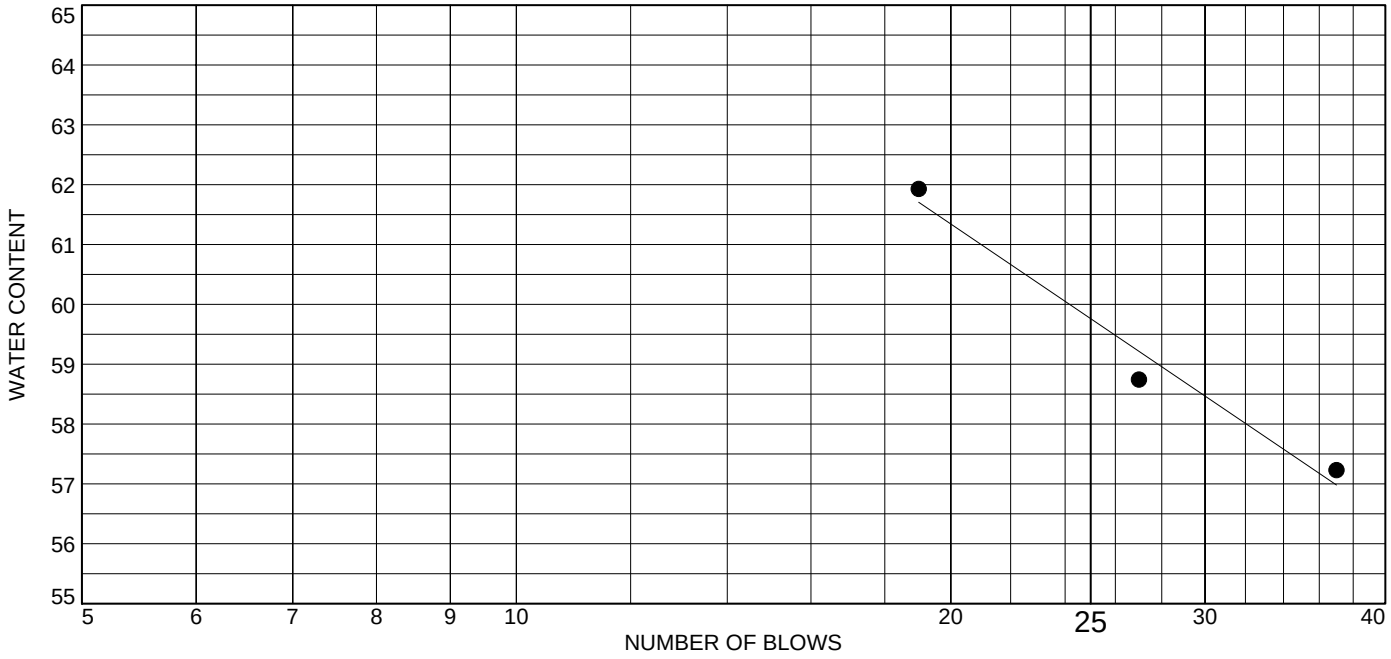
Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWNISH GRAY ORGANIC CLAY WITH SAND - SAND SEAMS AND SHELL NOTED	60	35	25			OL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B017 **Depth:** 30.0'-32.0'
Sample Number: S-9

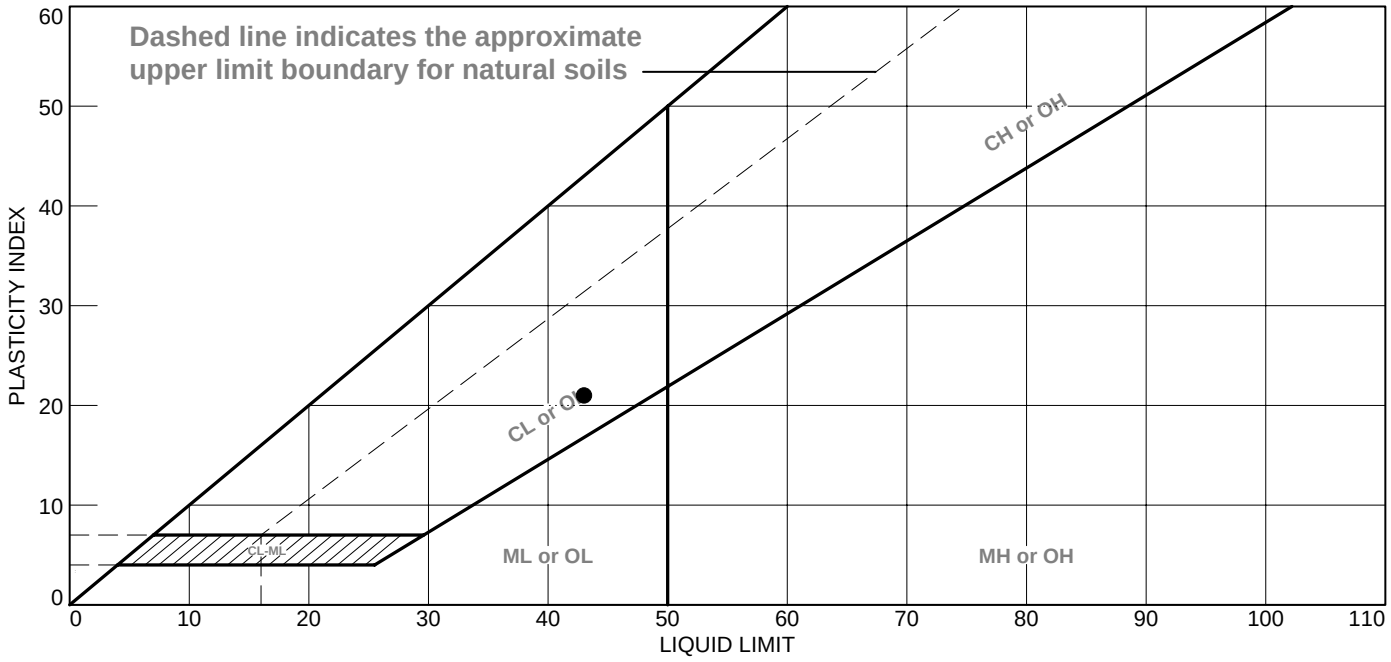
Remarks:

Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWNISH GRAY LEAN CLAY	43	22	21			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B018 **Depth:** 25.0'-27.0'
Sample Number: S-8

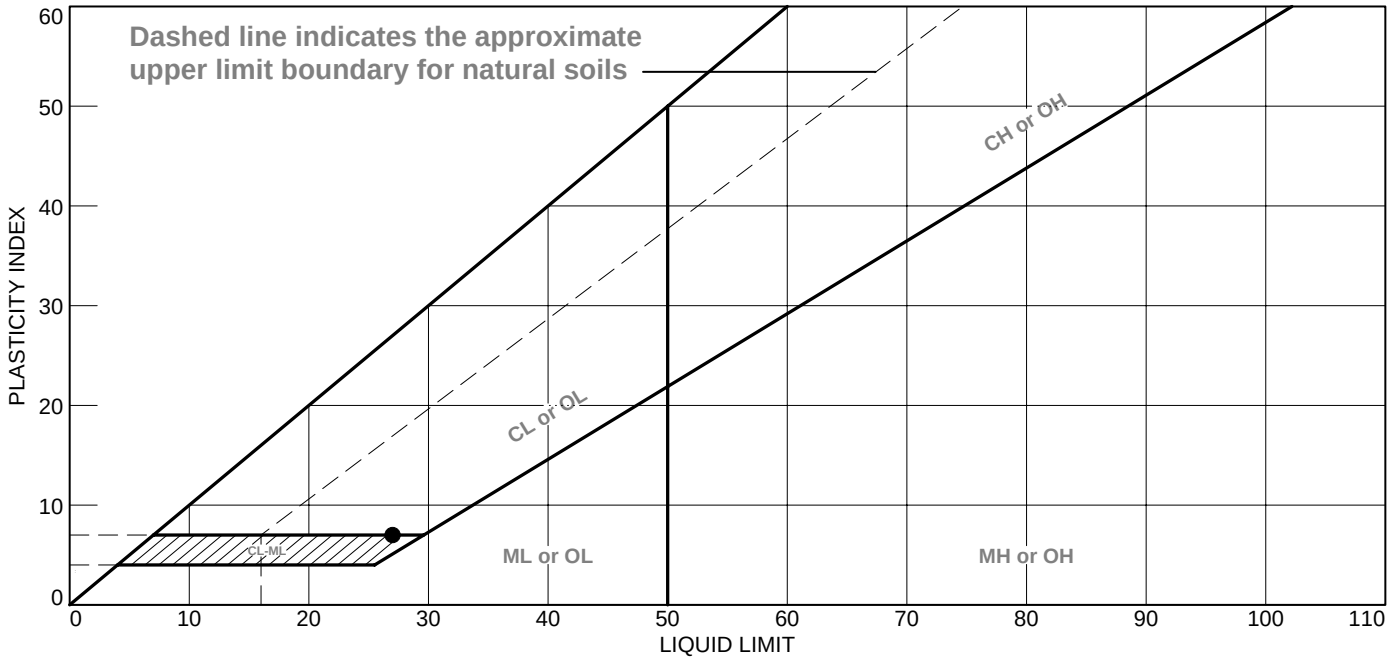
Remarks:

Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWN AND GRAY ORGANIC CLAY WITH SAND - SAND SEAMS AND SHELL NOTED	27	20	7			OL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B018 **Depth:** 40.0'-42.0'
Sample Number: S-11

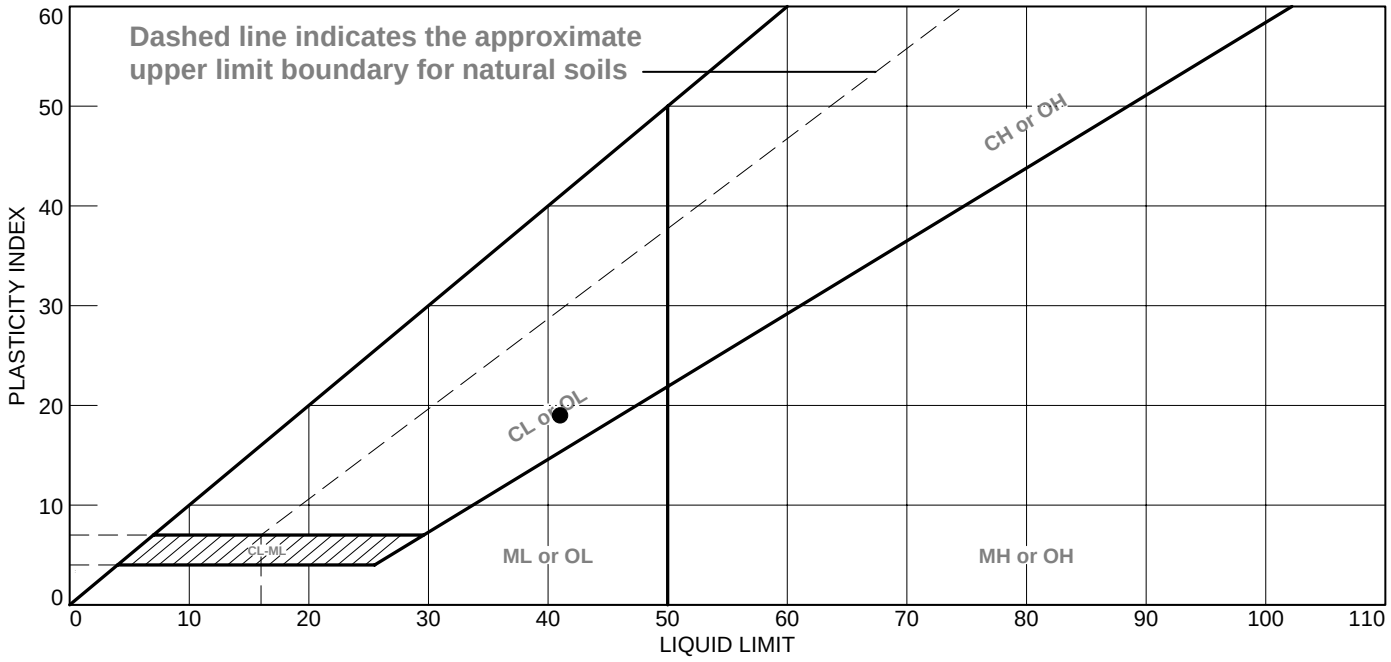
Remarks:

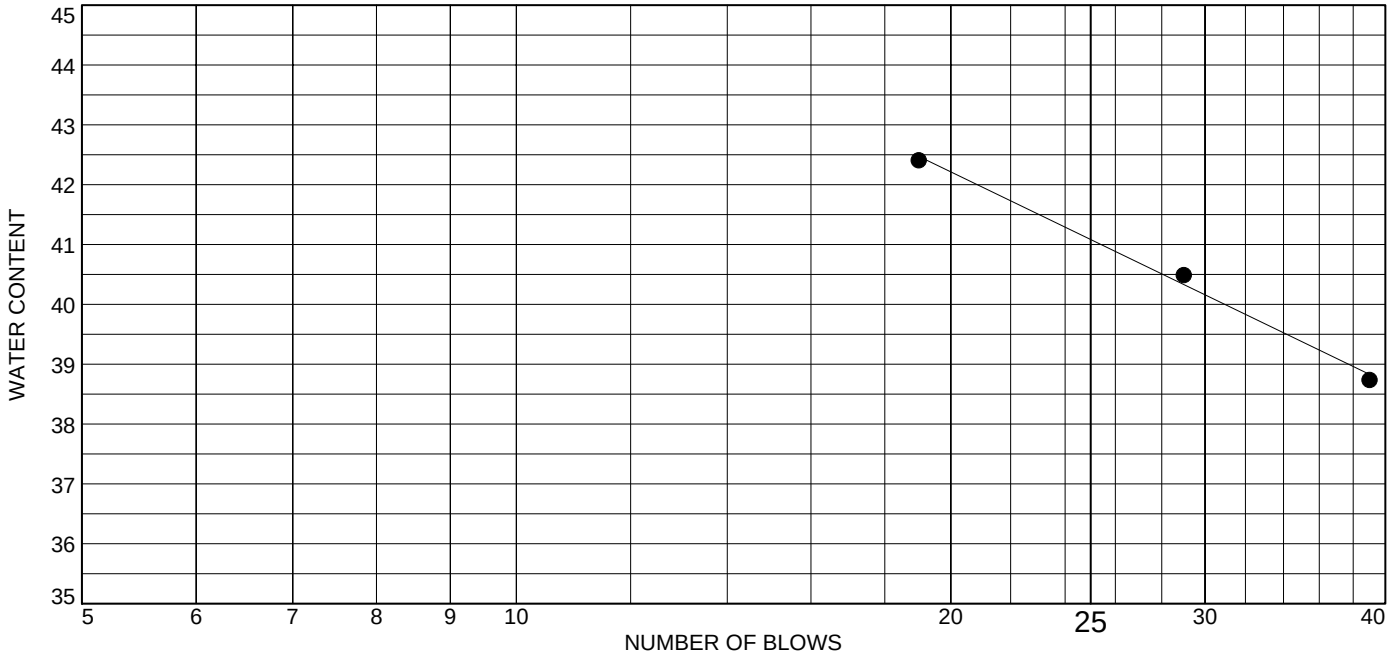
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWN LEAN CLAY WITH SAND	41	22	19			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B019 **Depth:** 7.5'-9.5'
Sample Number: S-2

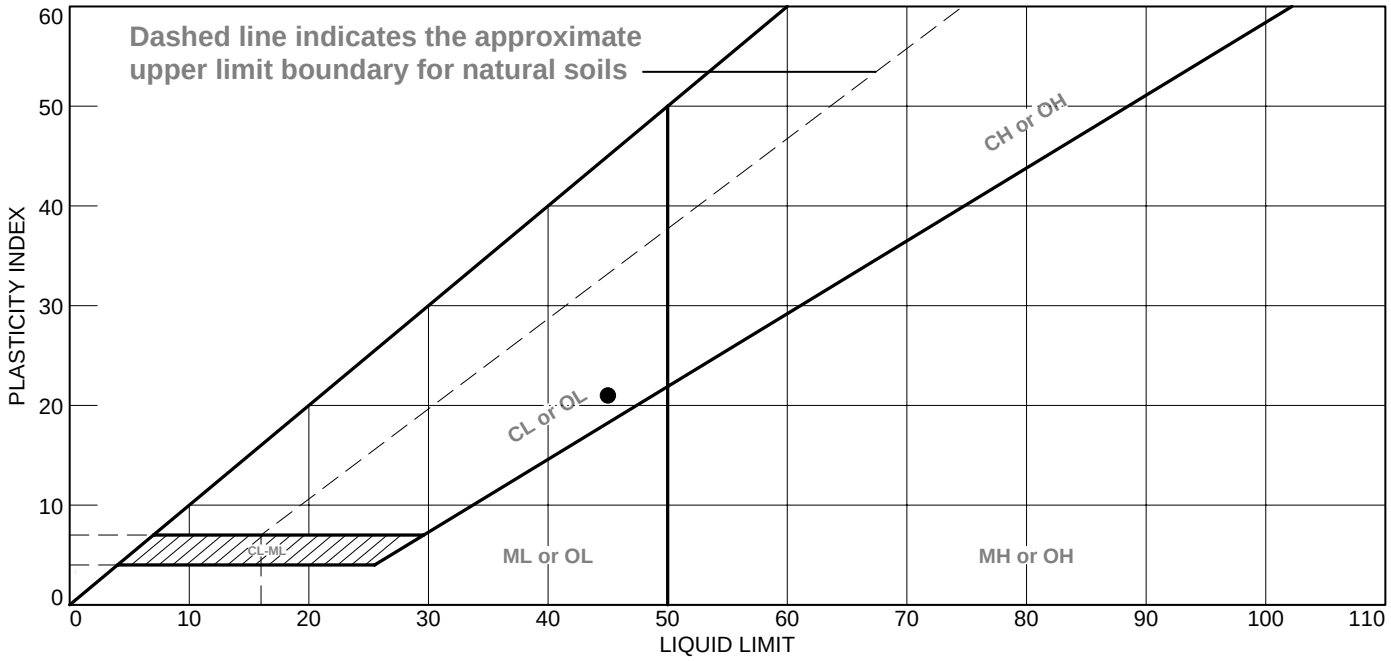
Remarks:

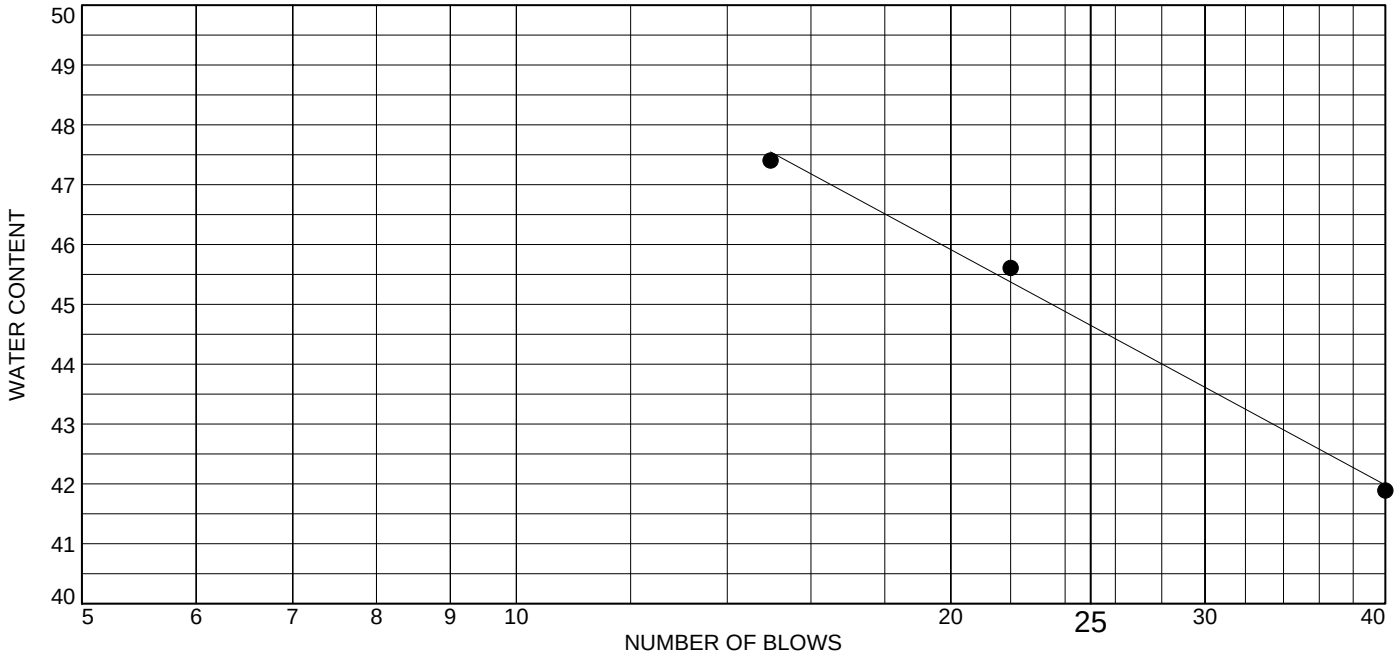
Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY AND BROWN LEAN CLAY	45	24	21			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B019 **Depth:** 12.5'-14.5'
Sample Number: S-4

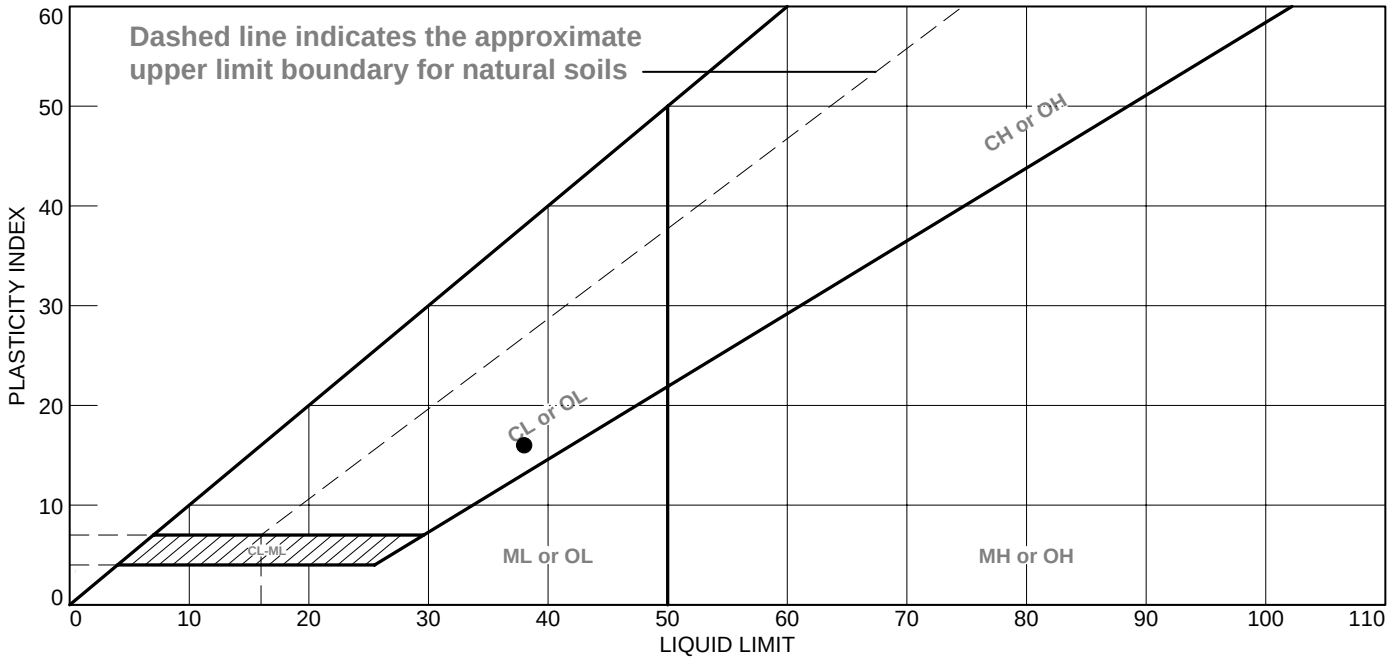
Remarks:

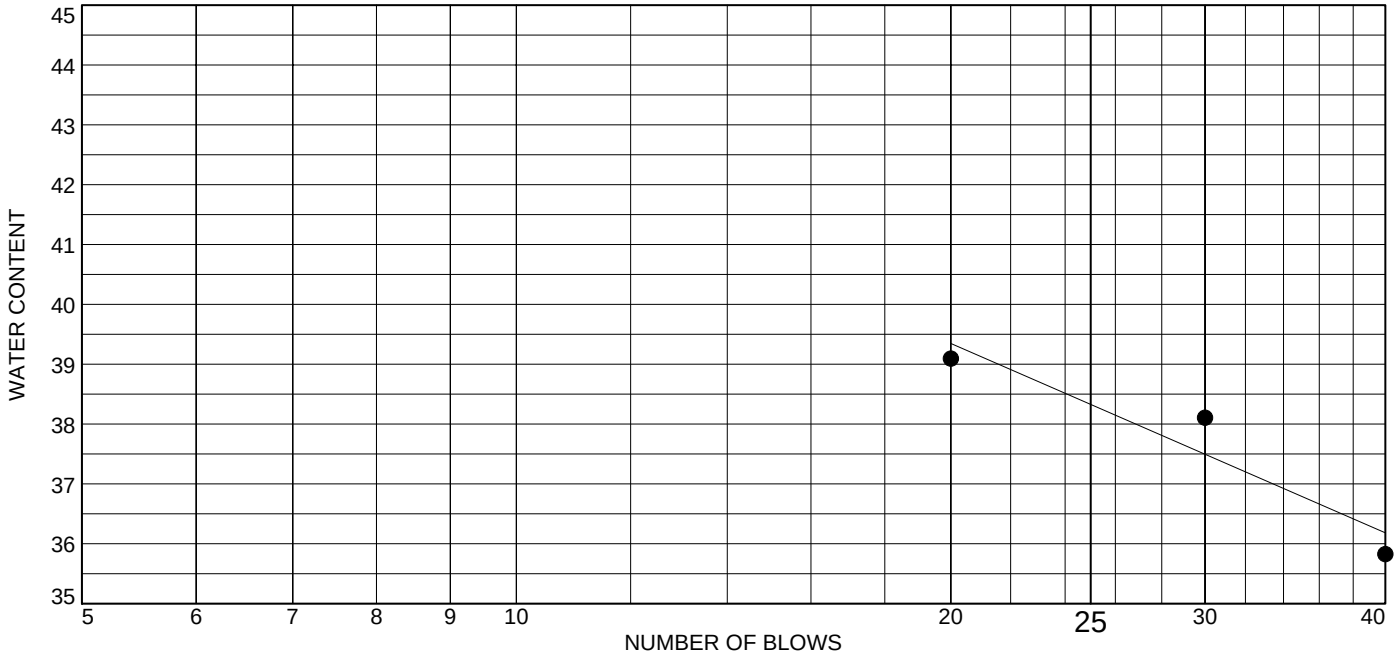
Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY LEAN CLAY	38	22	16			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B019 **Depth:** 20.0'-22.0'
Sample Number: S-6

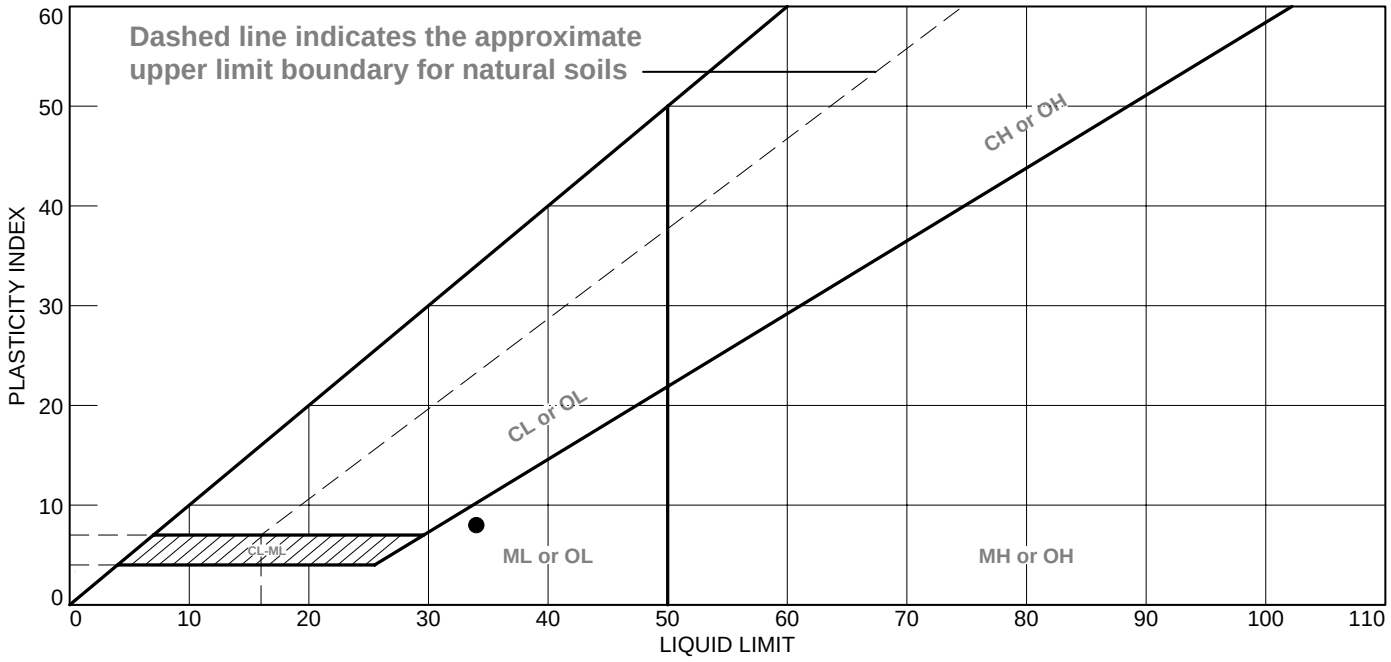
Remarks:

Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK GRAY ORGANIC SILT WITH SAND - SHELL NOTED	34	26	8			ML

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B019 **Depth:** 25.0'-27.0'
Sample Number: S-7

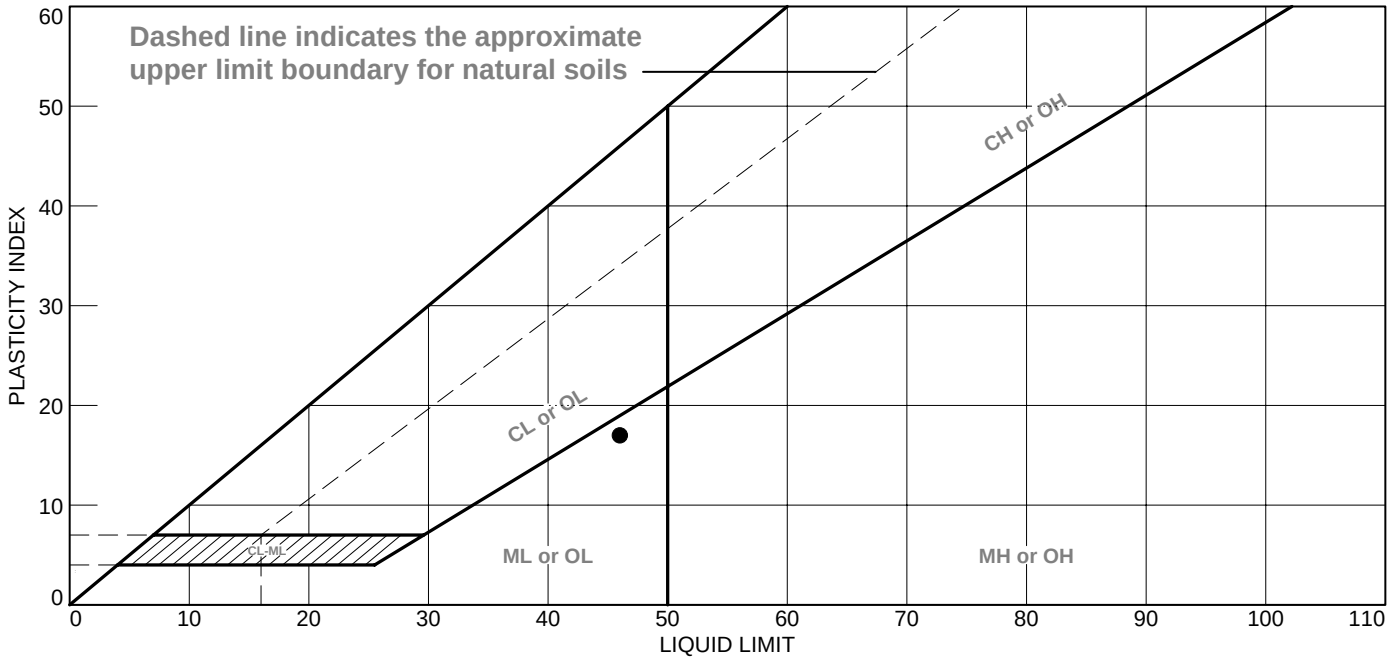
Terracon

Remarks:

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY LEAN CLAY WITH SILT	46	29	17			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B019 **Depth:** 50.0'-51.5'
Sample Number: S-12

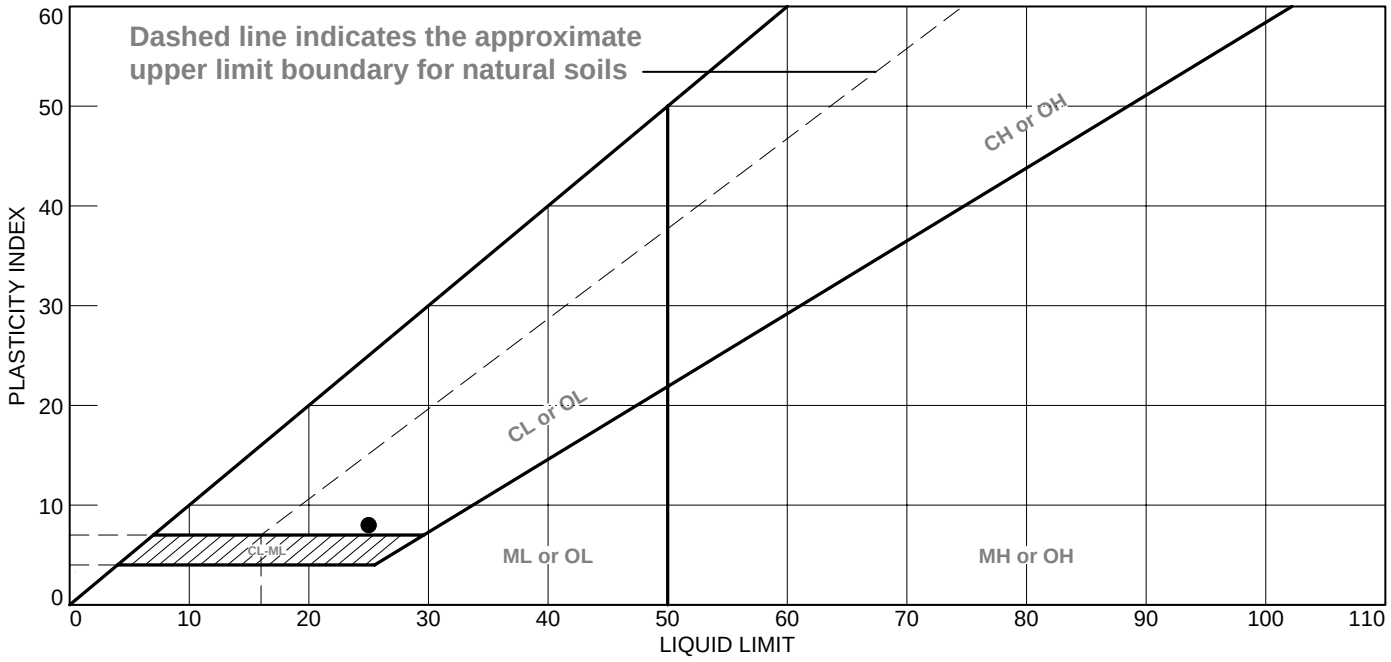
Remarks:

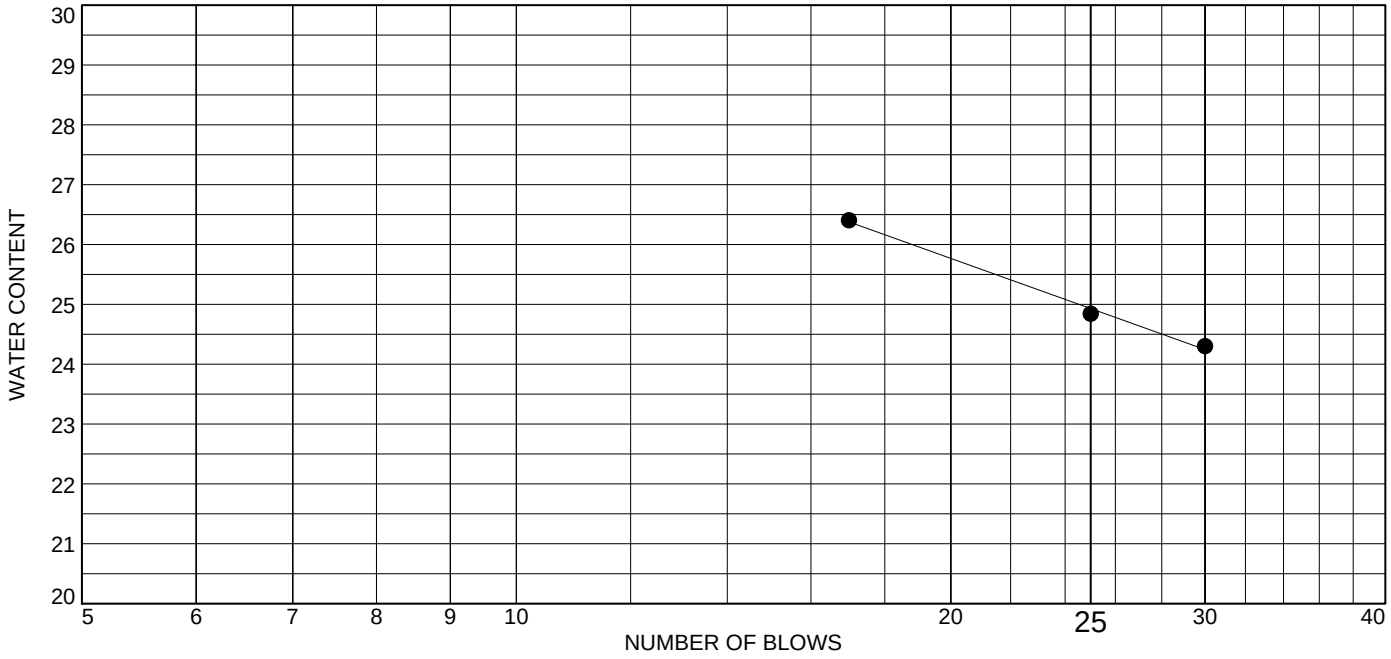
Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND DARK BROWN LEAN CLAY WITH SILT AND GRAVEL	25	17	8			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B020 **Depth:** 0.0'-1.5'
Sample Number: S-1

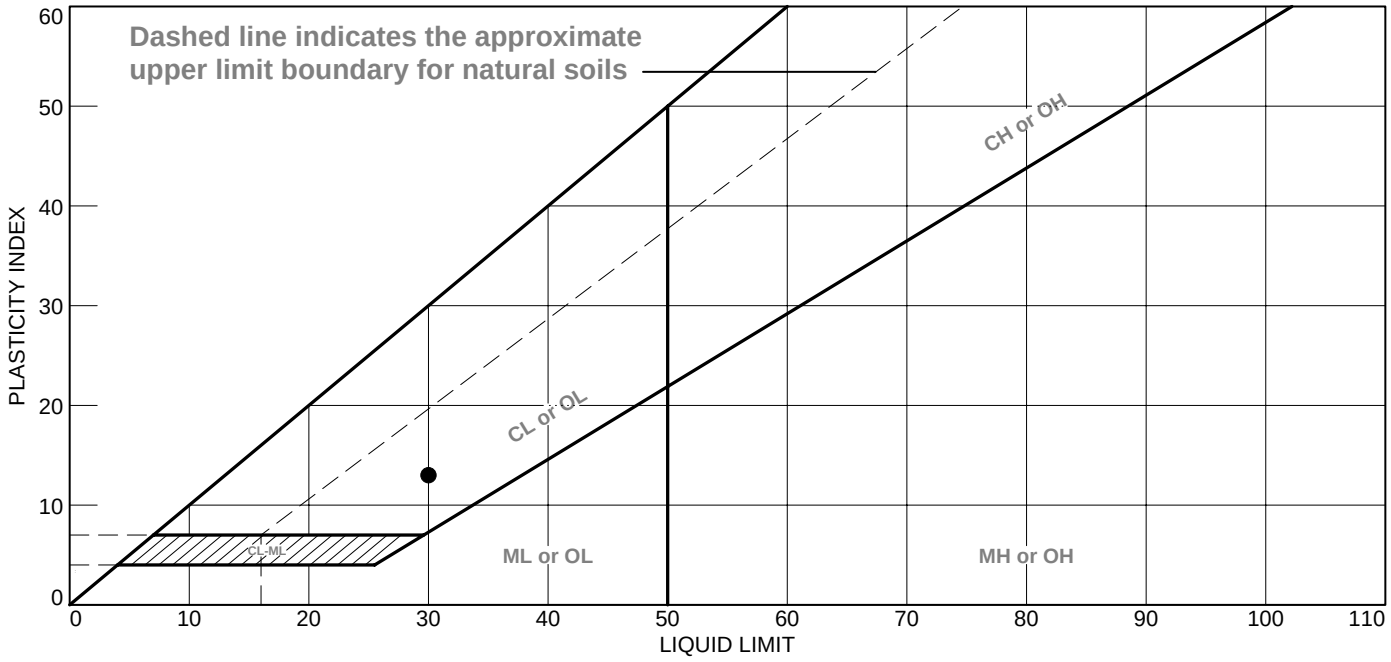
Remarks:

Terracon

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN SANDY LEAN CLAY WITH GRAVEL	30	17	13			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B020 **Depth:** 9.5'-11.5
Sample Number: S-5

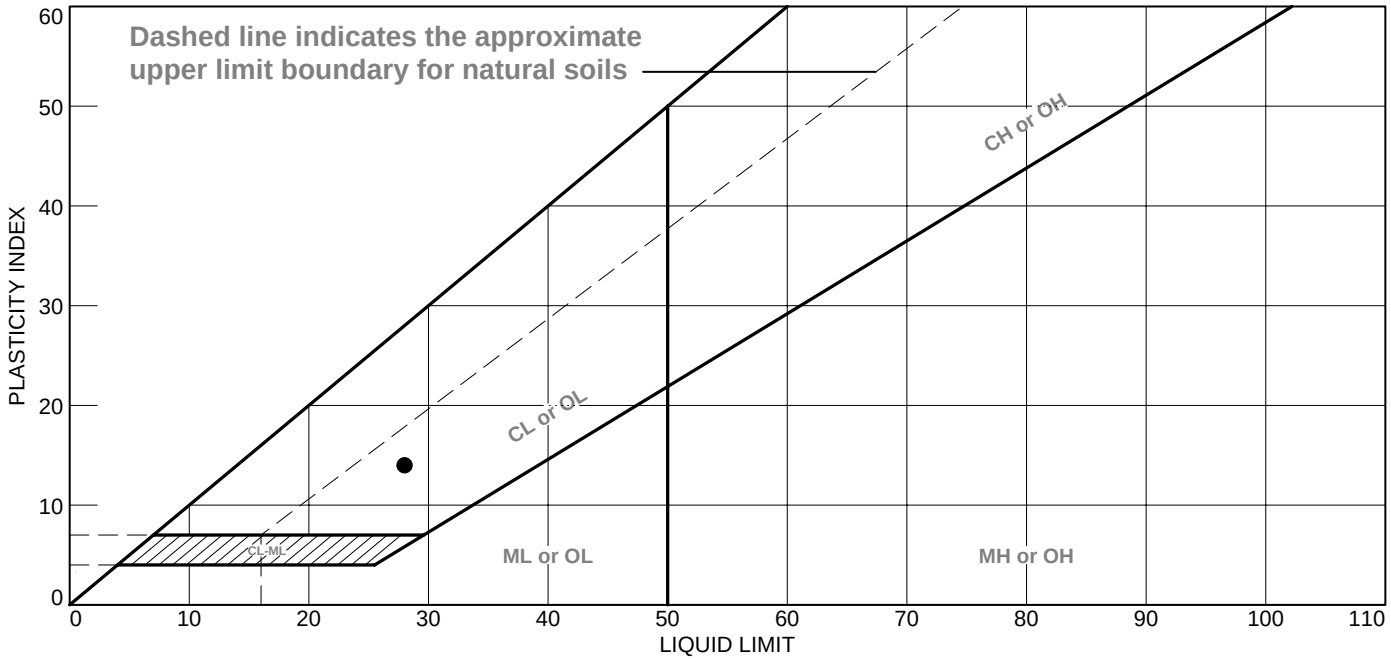
Remarks:

Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN LEAN CLAY WITH SAND AND GRAVEL	28	14	14			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B021 **Depth:** 5.0'-6.0'
Sample Number: S-3

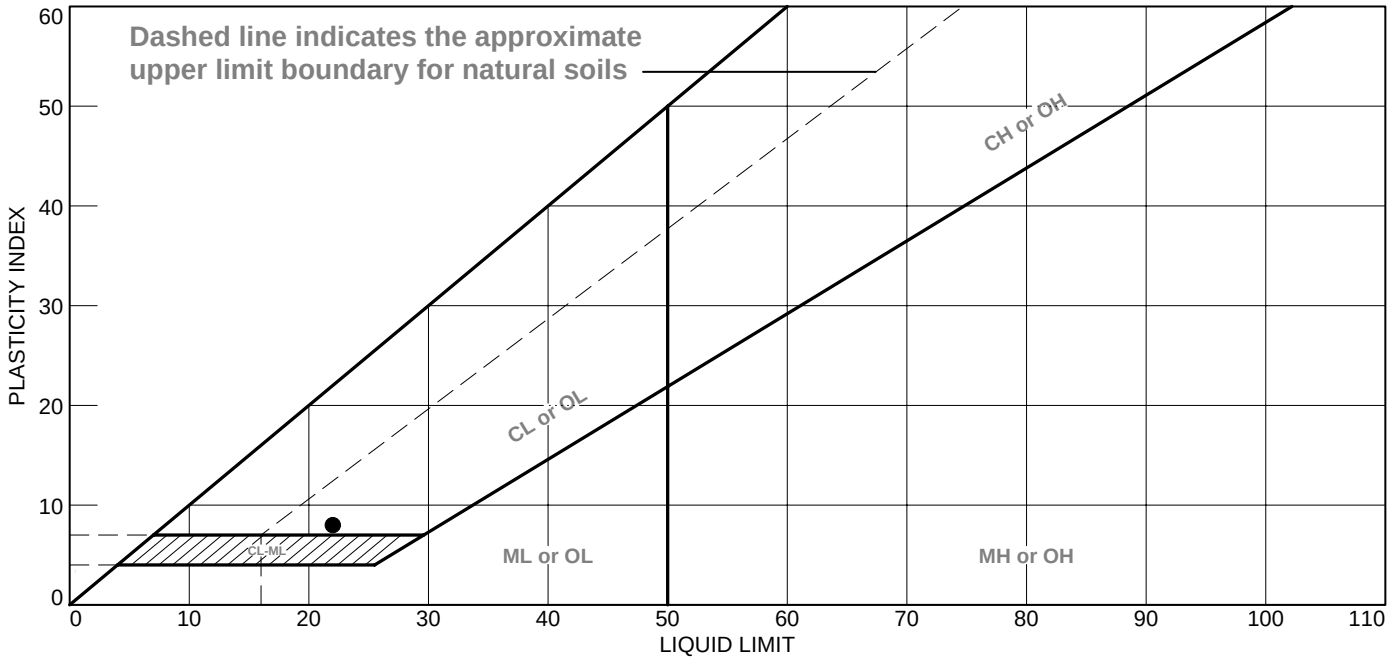
Terracon

Remarks:

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN LEAN CLAY WITH SAND - ROOTS NOTED	22	14	8			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B021 **Depth:** 15.0'-16.5'
Sample Number: S-6

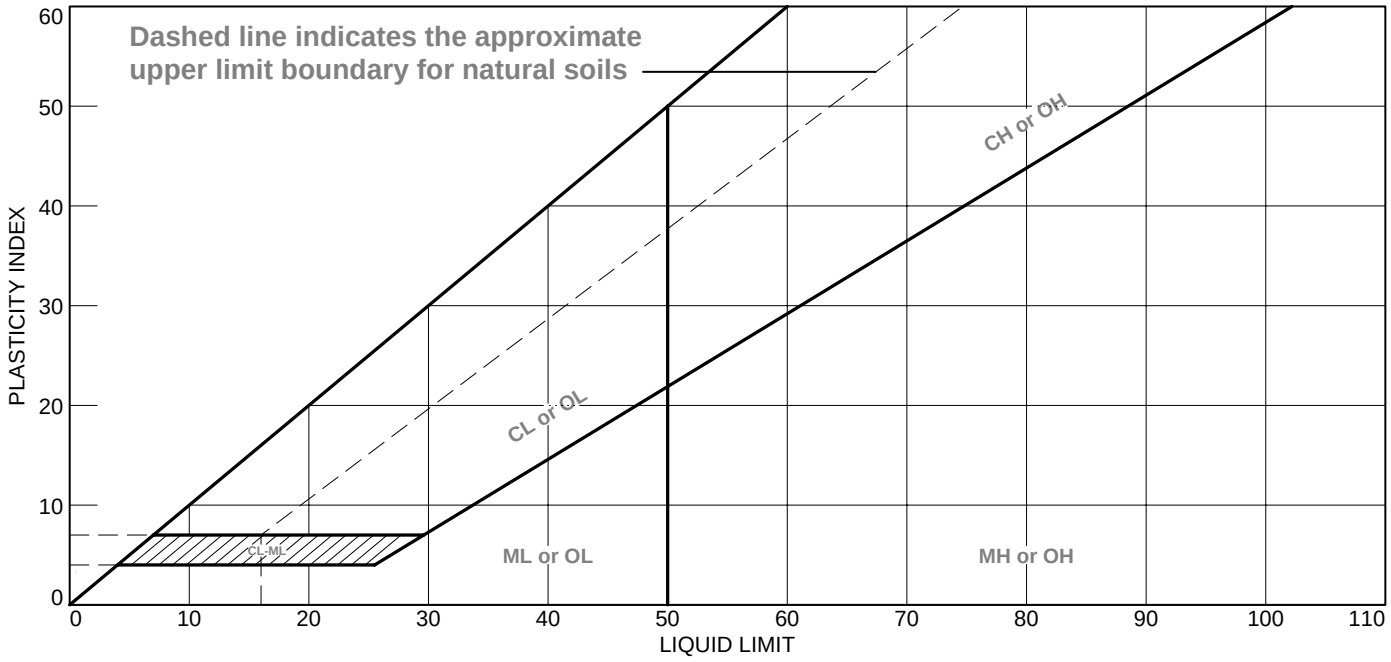
Remarks:

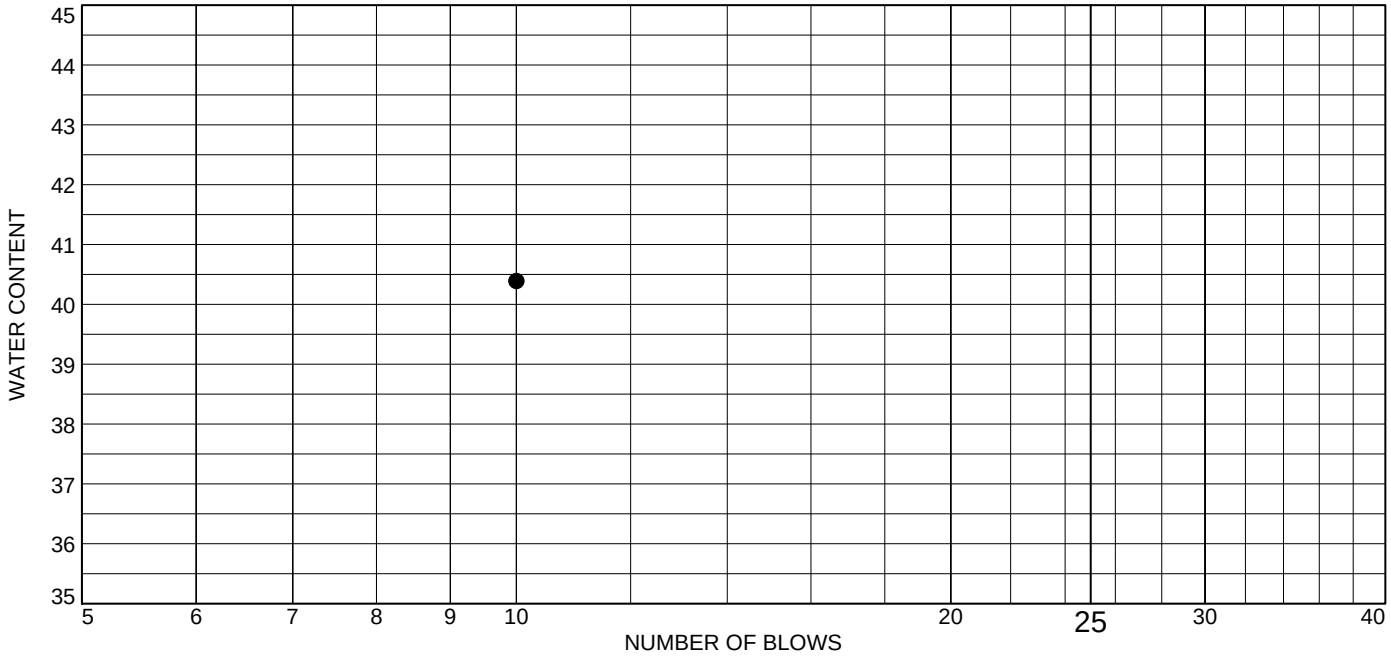
Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK GRAY VARVED FLY ASH	36	42	NP			

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B022 **Depth:** 2.5'-4.5'
Sample Number: S-2

Terracon

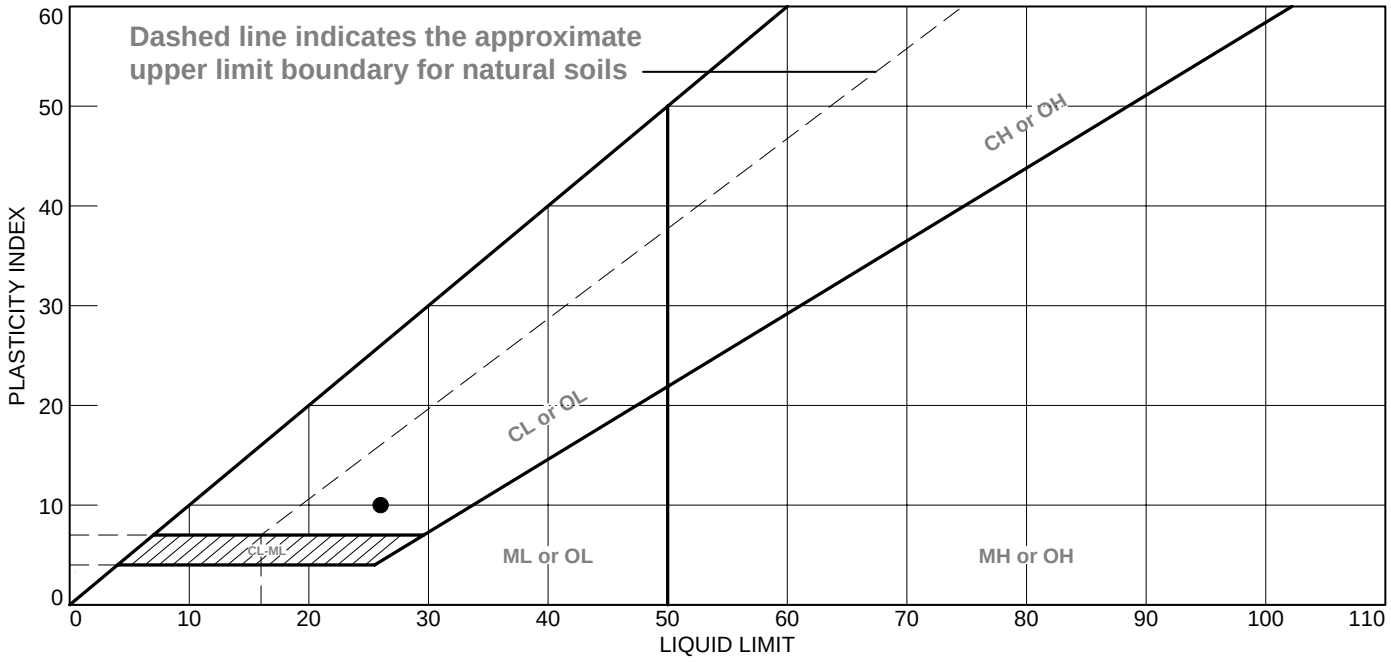
Remarks:

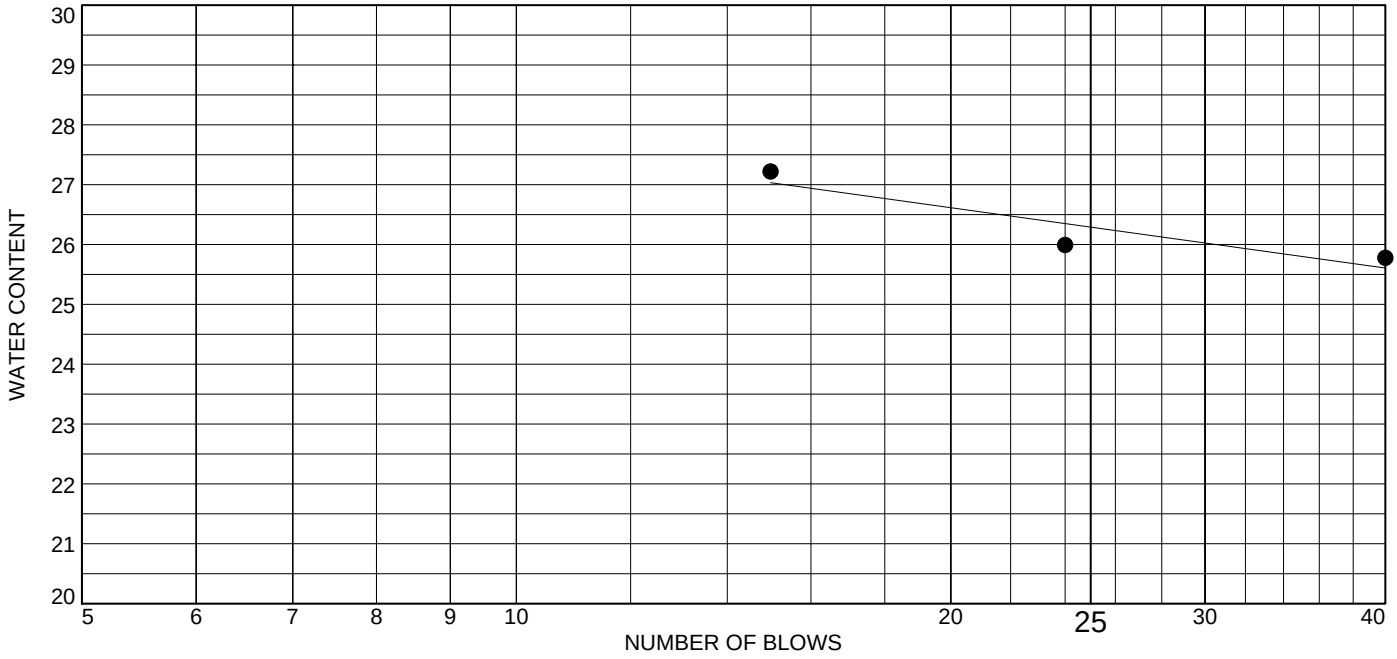
● A single point test was performed because of difficultly obtaining high blow counts due to type of material.

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	REDDISH BROWN SANDY LEAN CLAY	26	16	10			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B022 **Depth:** 20.0'-21.5'
Sample Number: S-7

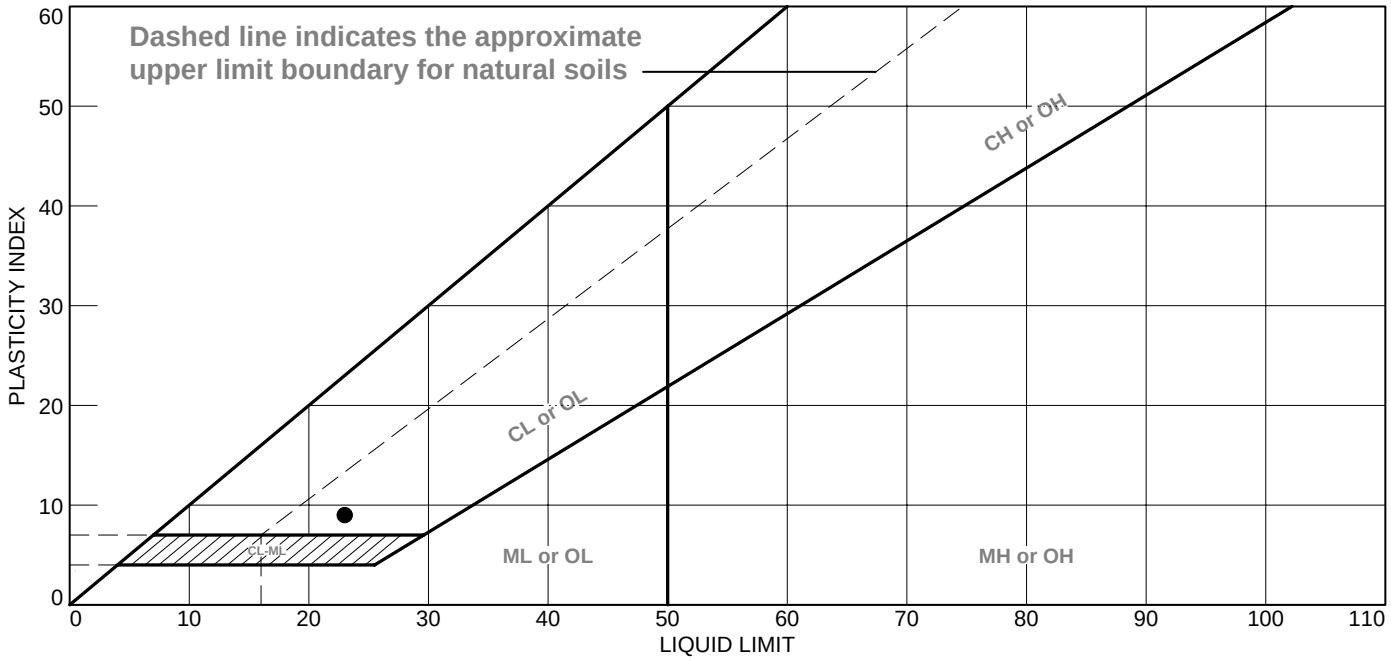
Remarks:

Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN LEAN CLAY WITH GRAVEL	23	14	9			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B024 **Depth:** 10.0'-11.5'
Sample Number: S-5

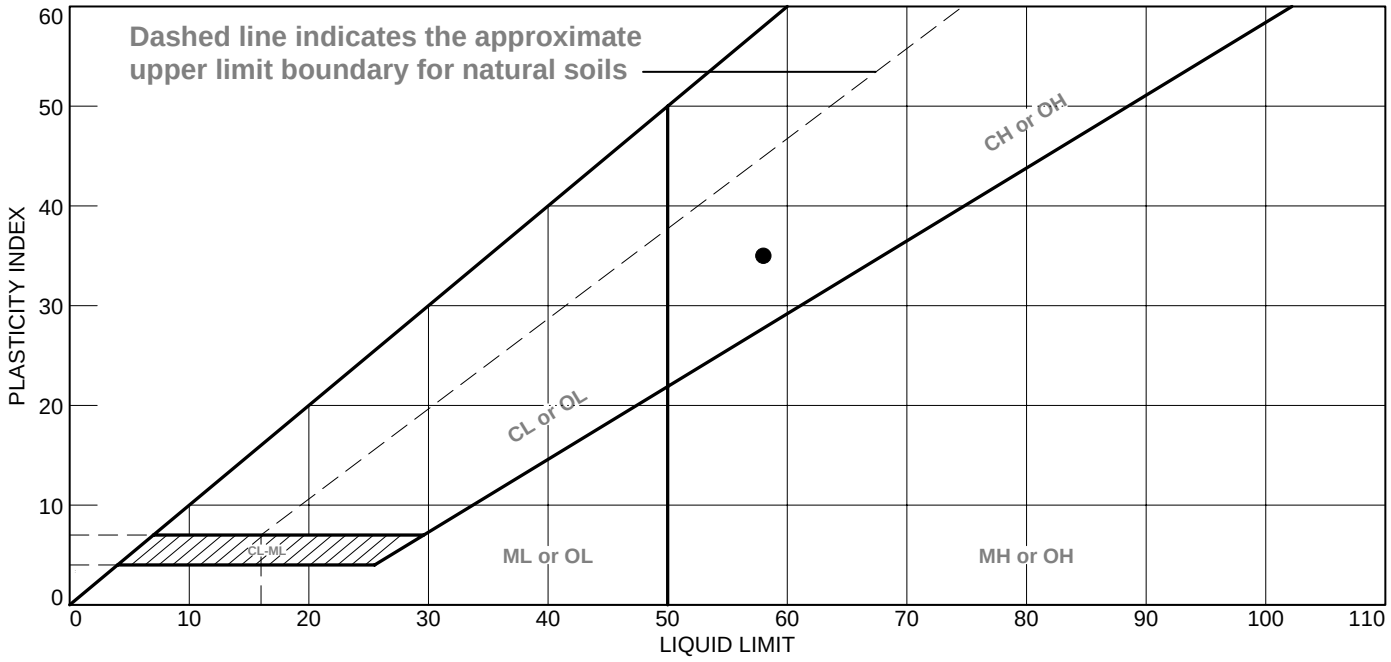
Terracon

Remarks:

Figure

Tested By: SJH **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK GRAY ORGANIC CLAY WITH SAND	58	23	35			0H

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B024 **Depth:** 26.5'-28.5'
Sample Number: S-9

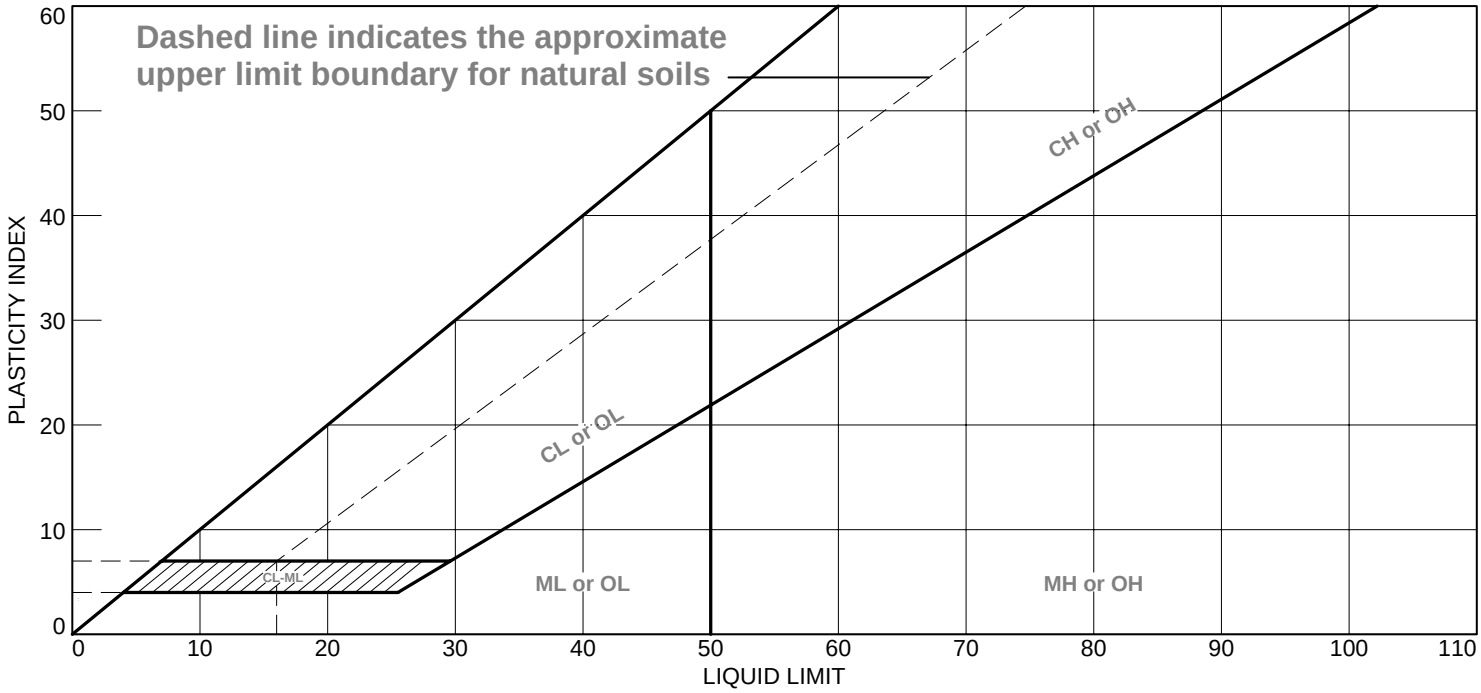
Remarks:

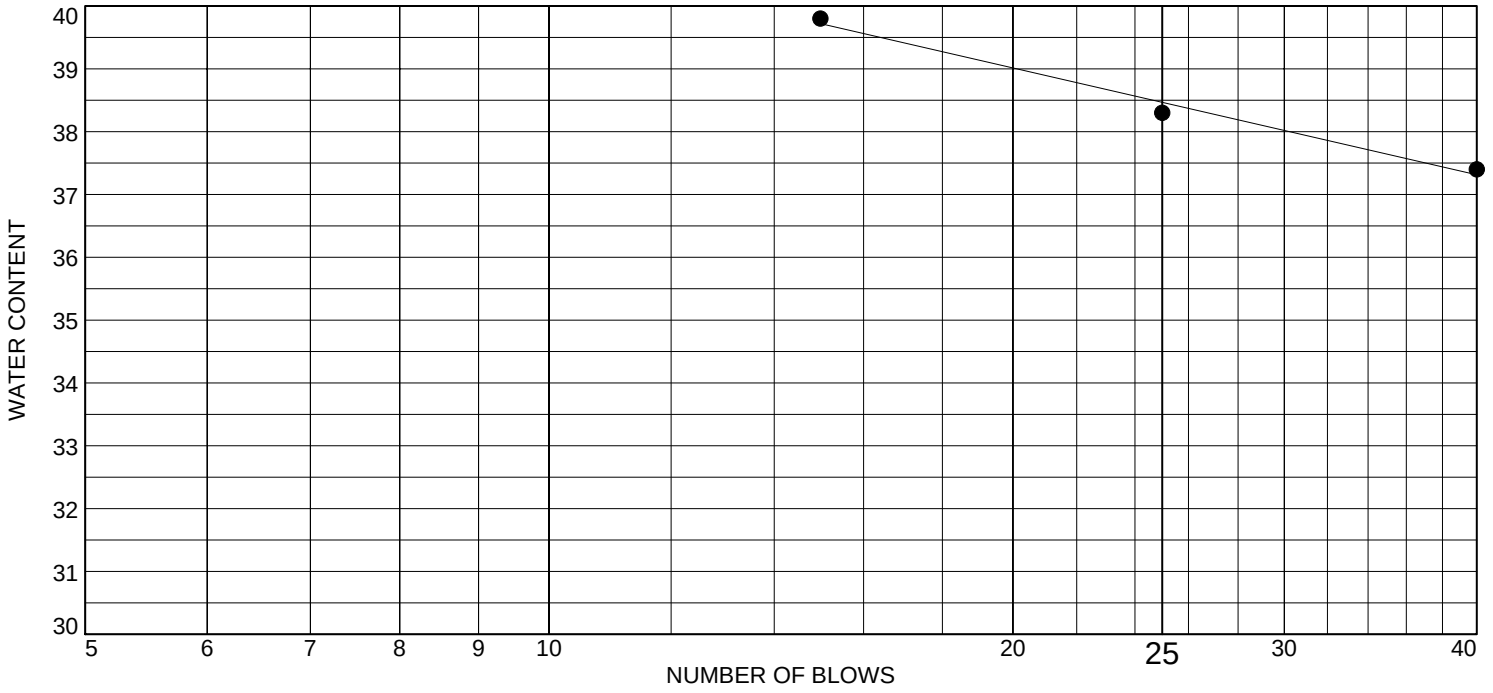
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK GRAY FLY ASH WITH SAND	38	38	NP	78.0	72.5	ML

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B025 **Depth:** 11.5'-14.0'

Sample Number: S-6

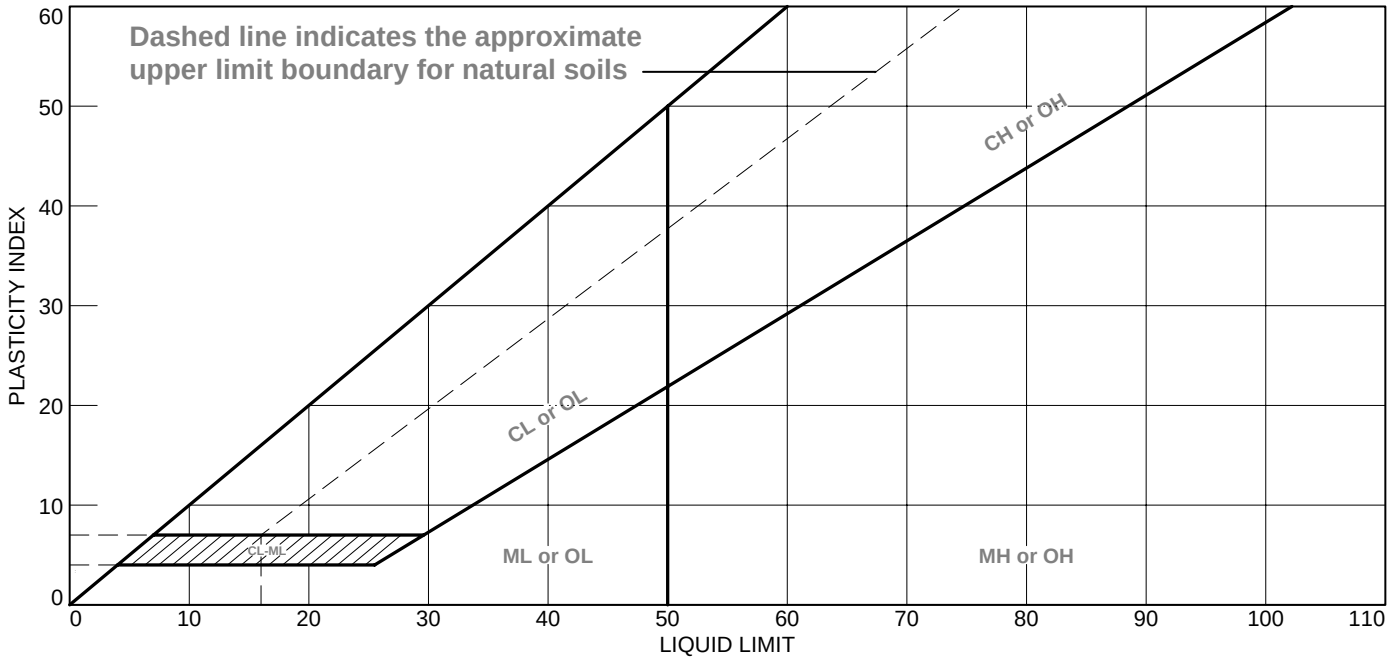
Remarks:

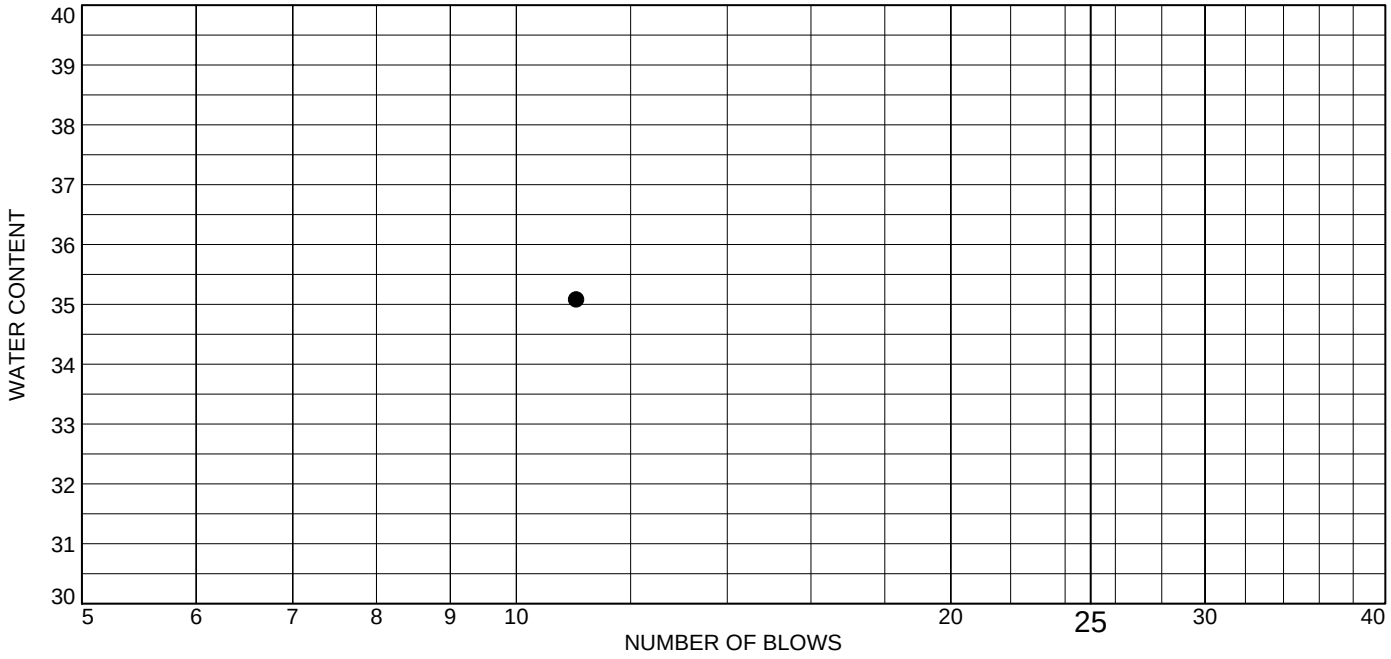
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK GRAY TO GRAY FLY ASH WITH SAND	32	34	NP			

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B025 **Depth:** 25.0'-27.0'
Sample Number: S-9

Remarks:

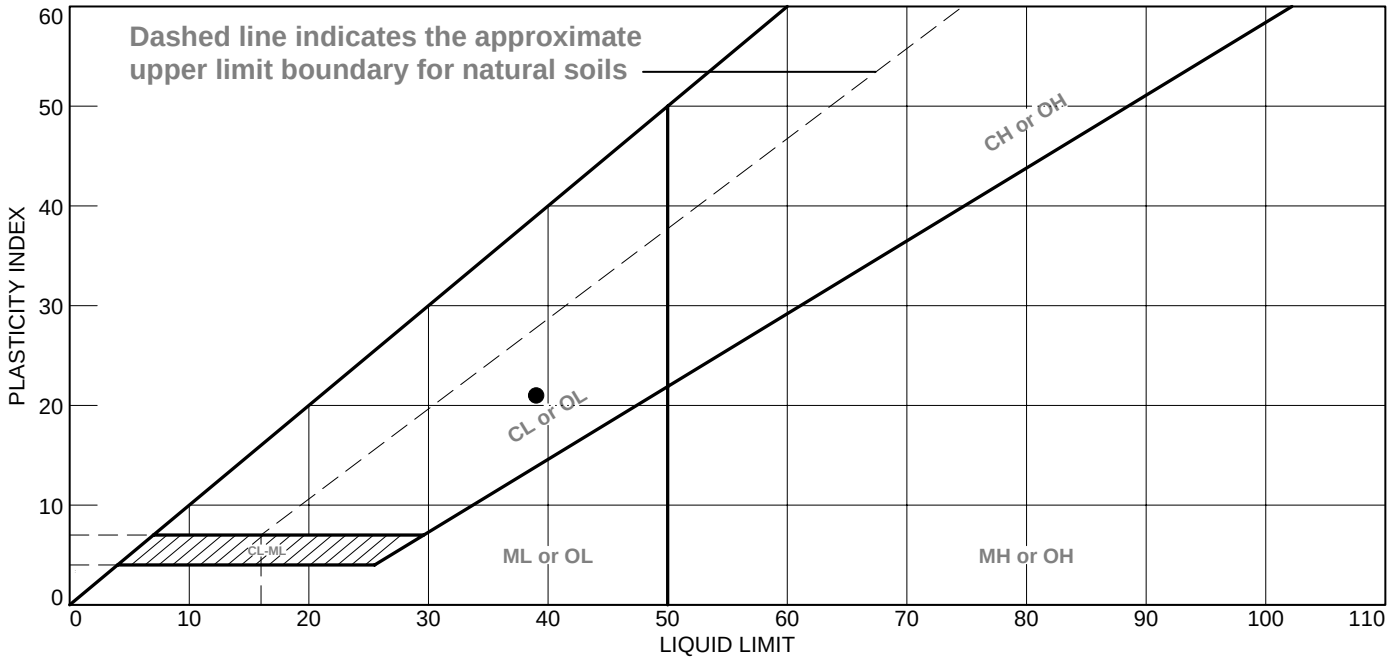
● A single point test was performed because of difficultly obtaining high blow counts due to type of material.

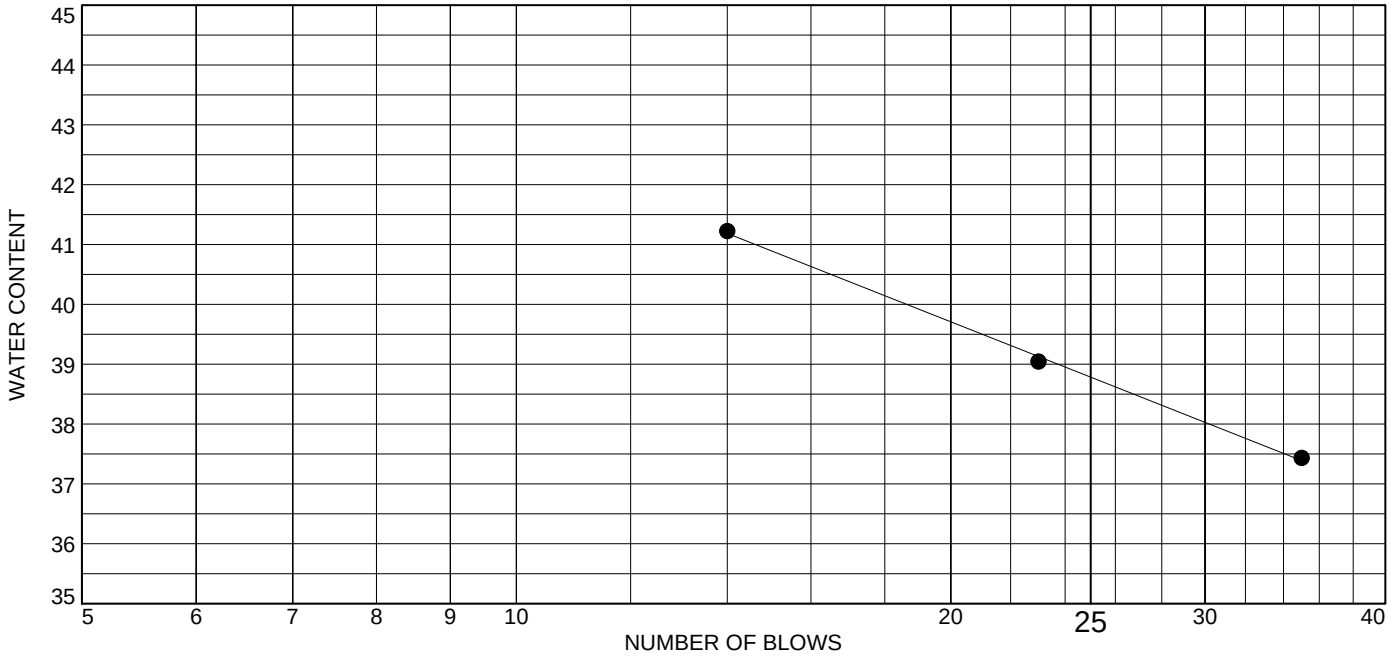
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN LEAN CLAY WITH GRAVEL	39	18	21			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B027 **Depth:** 15.0'-16.5'
Sample Number: S-4

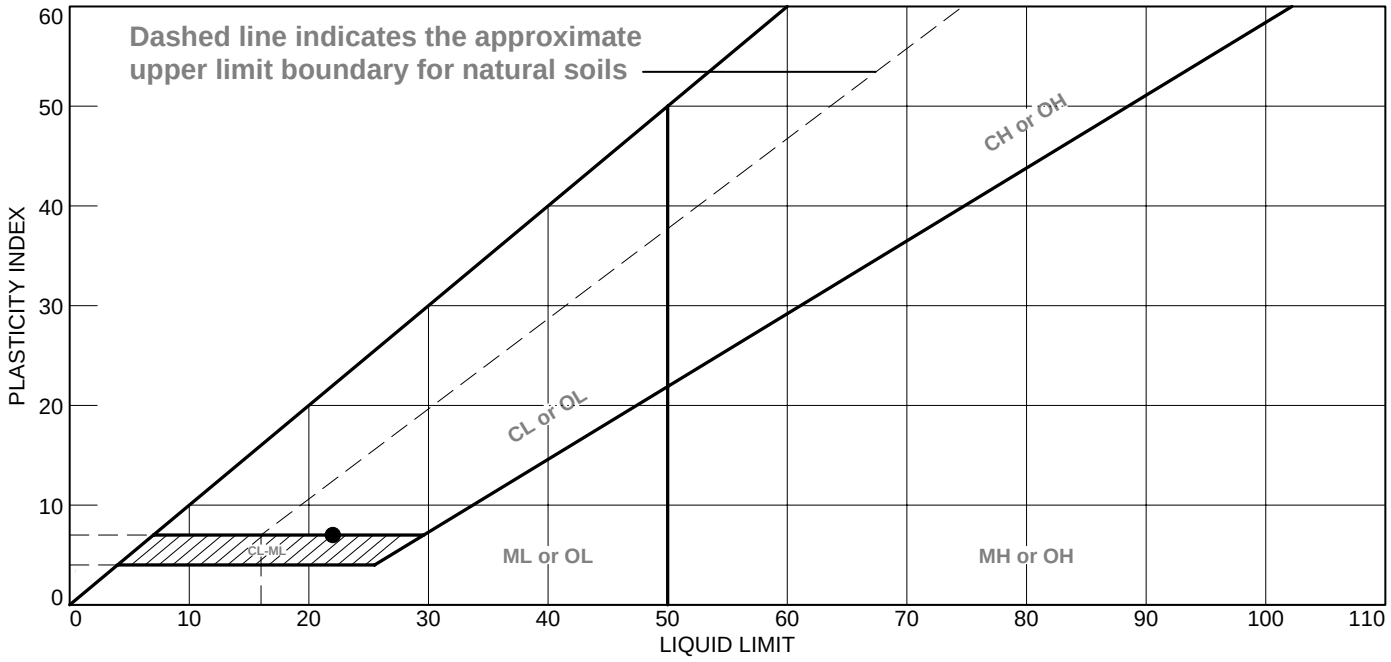
Remarks:

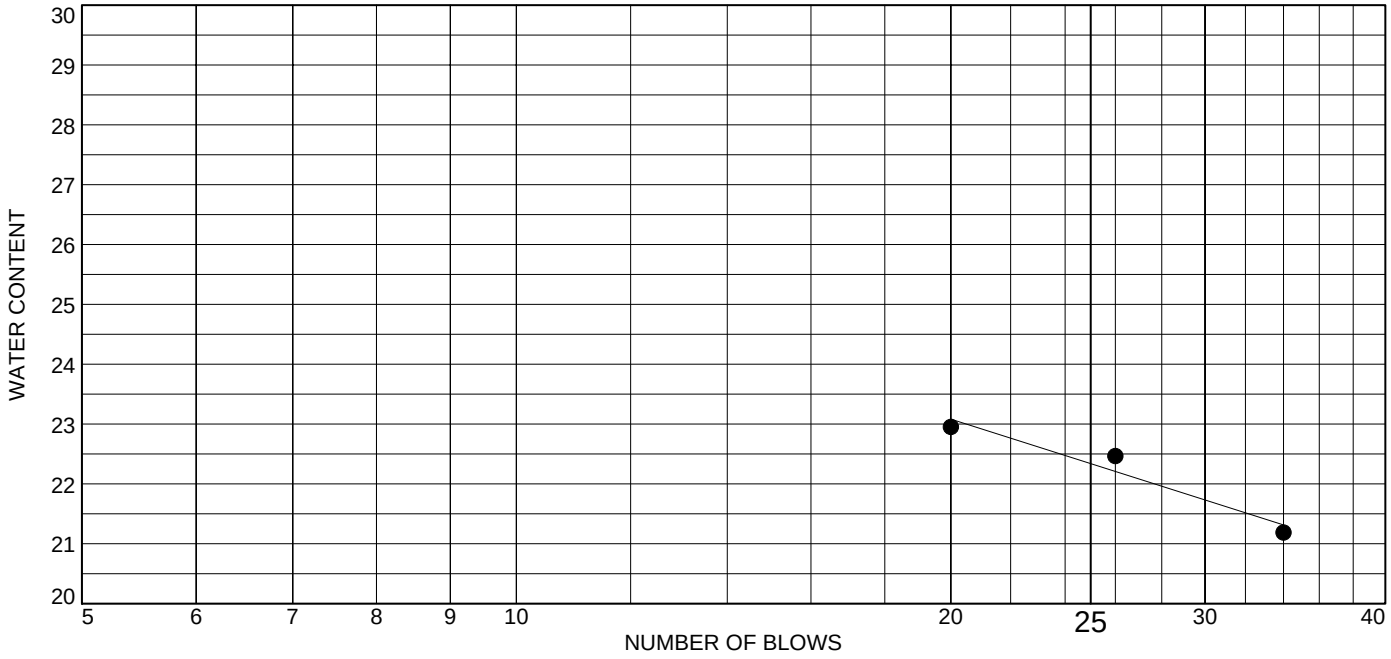
Terracon

Figure

Tested By: SJH **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN LEAN CLAY WITH SAND AND GRAVEL	22	15	7			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B029 **Depth:** 5.0'-7.0'
Sample Number: S-3

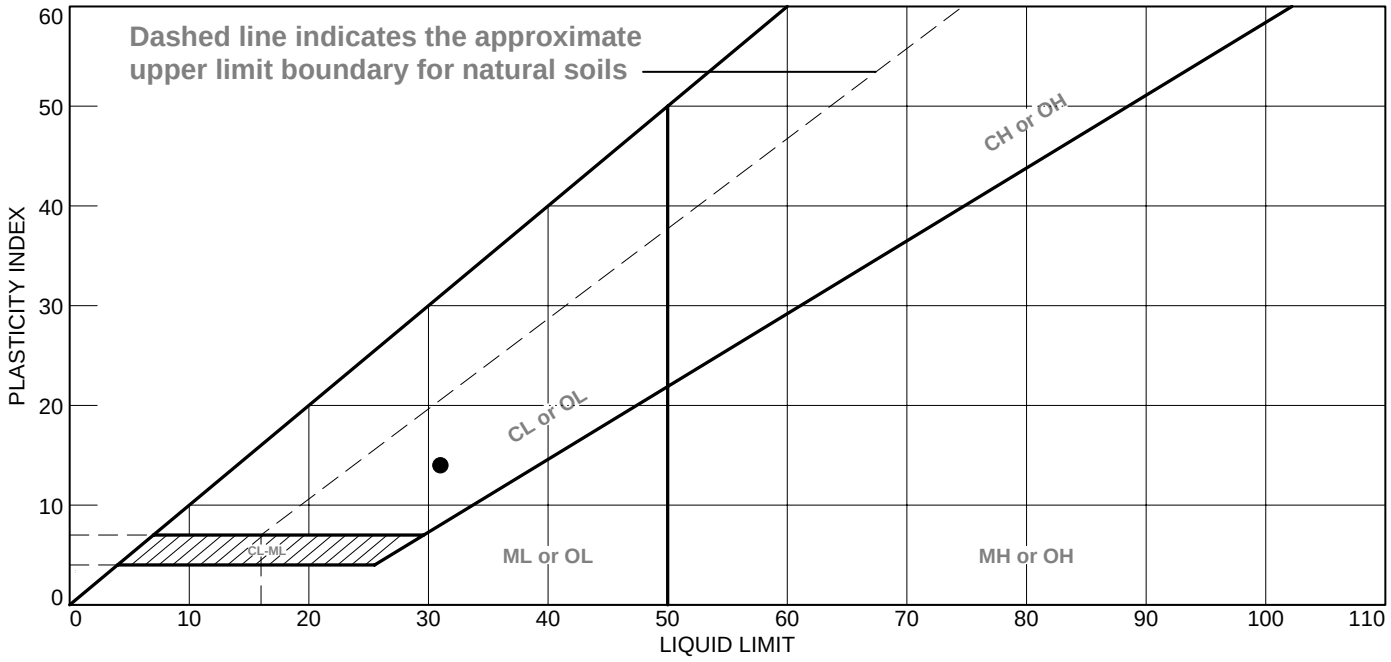
Terracon

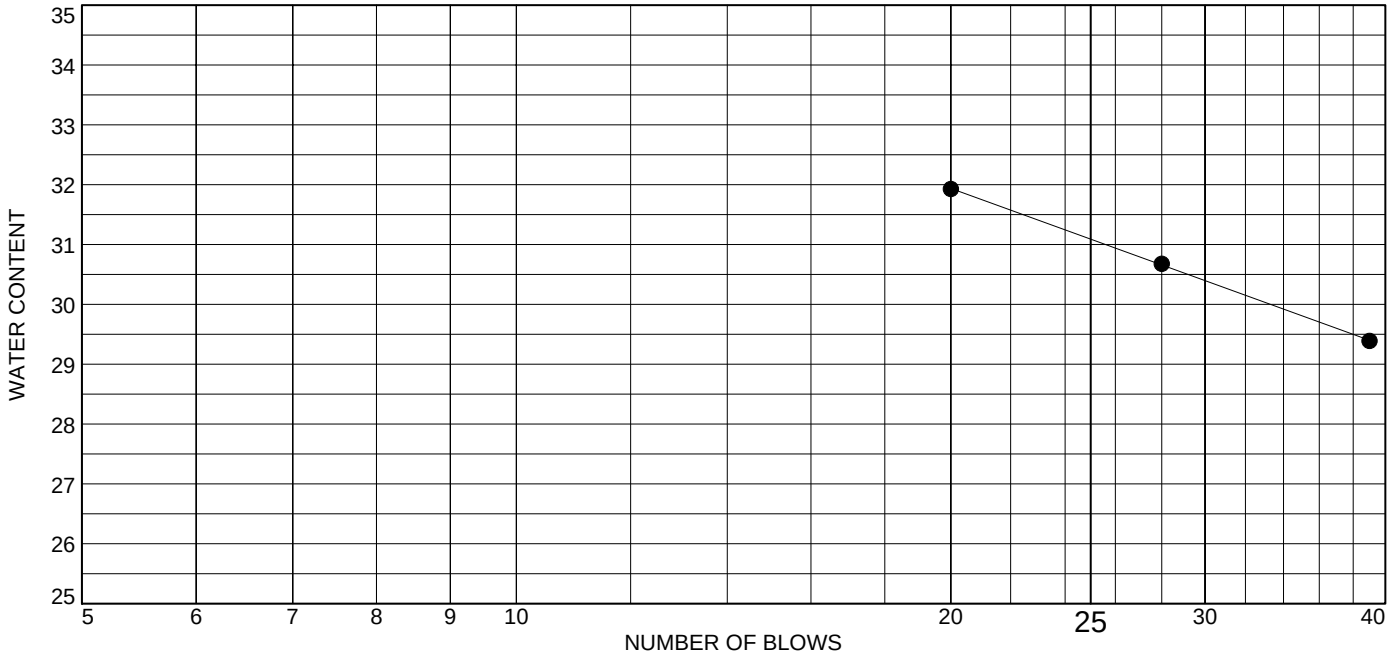
Remarks:

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK BROWN AND GRAY SLIGHTLY ORGANIC LEAN CLAY WITH SAND AND GRAVEL	31	17	14			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B029 **Depth:** 10.0'-12.0'
Sample Number: S-5

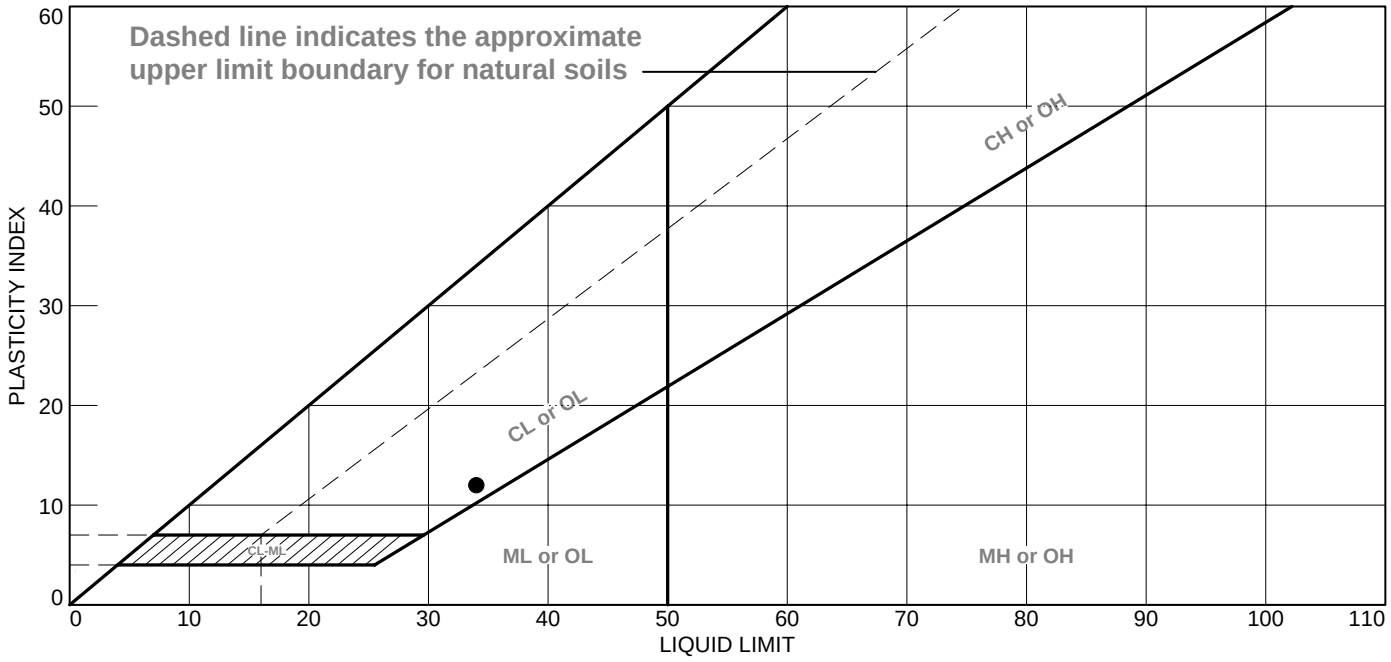
Remarks:

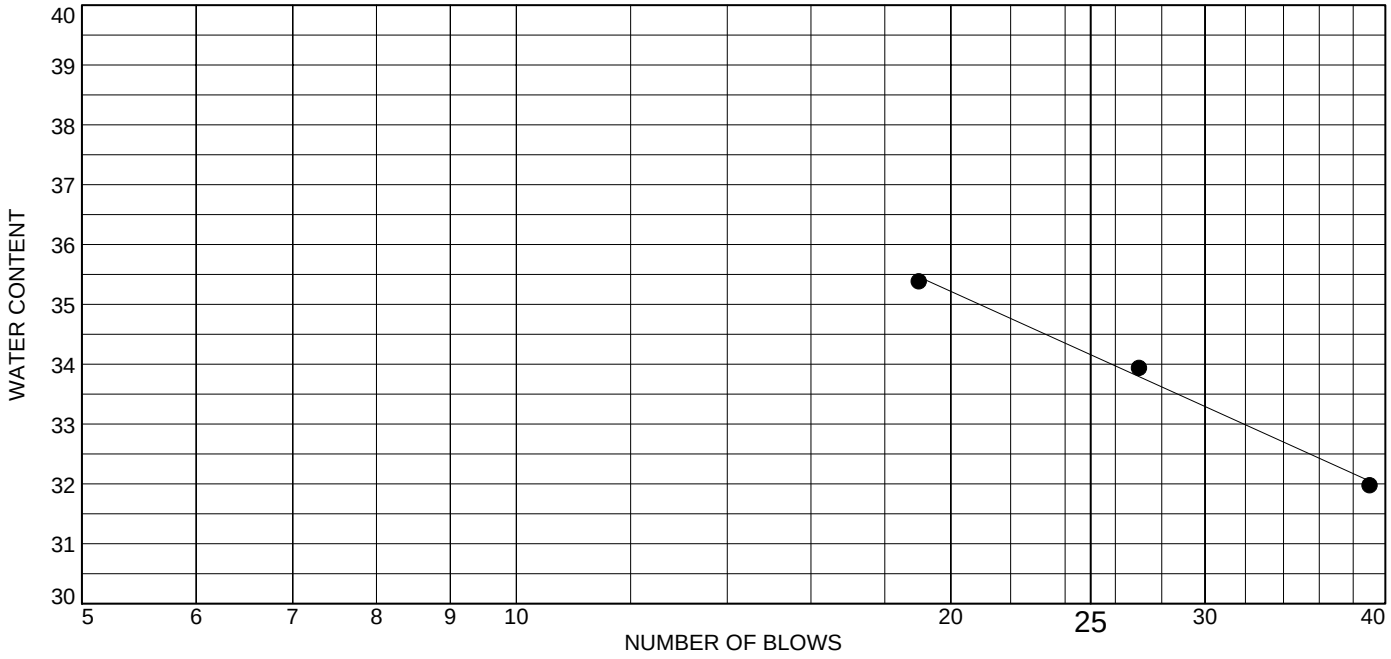
Terracon

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWN AND BLACK ORGANIC CLAY WITH GRAVEL - WOOD NOTED	34	22	12			OL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B030 **Depth:** 21.5'
Sample Number: S-7

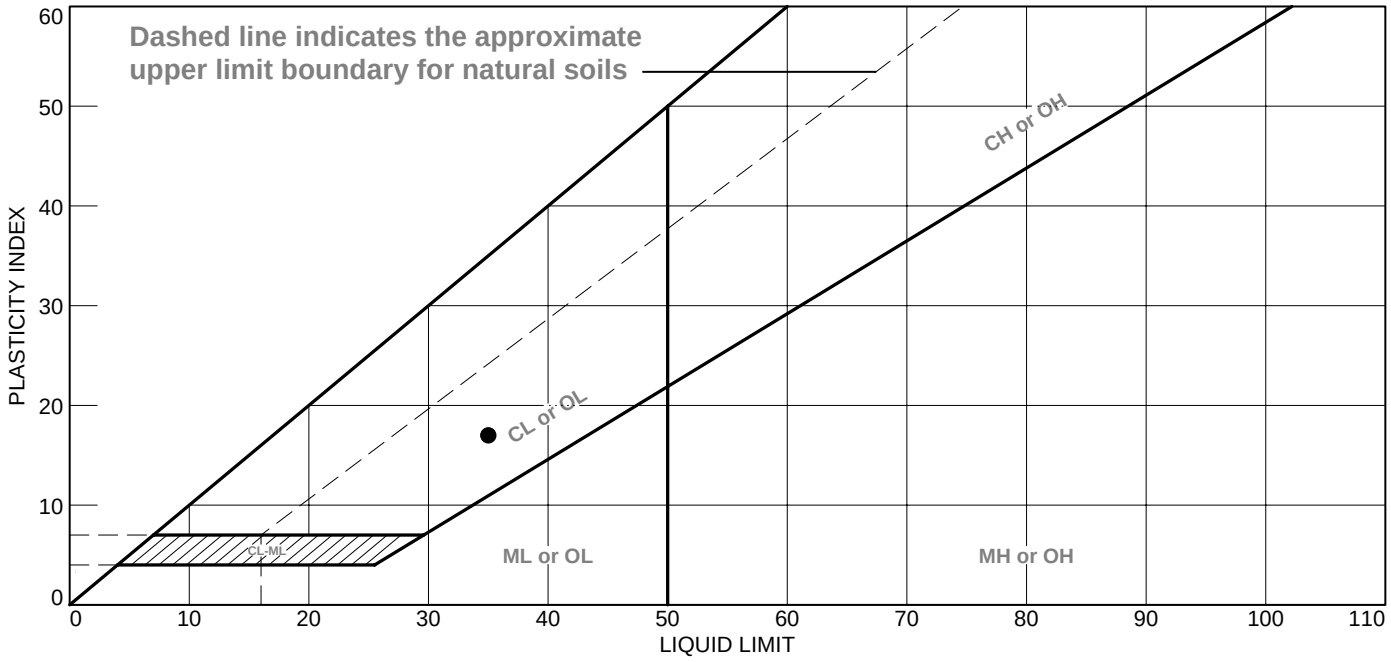
Remarks:

Terracon

Figure

Tested By: SJH **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWNISH GRAY LEAN CLAY WITH SAND AND GRAVEL	35	18	17			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B032 **Depth:** 5.0'-7.0'
Sample Number: S-3

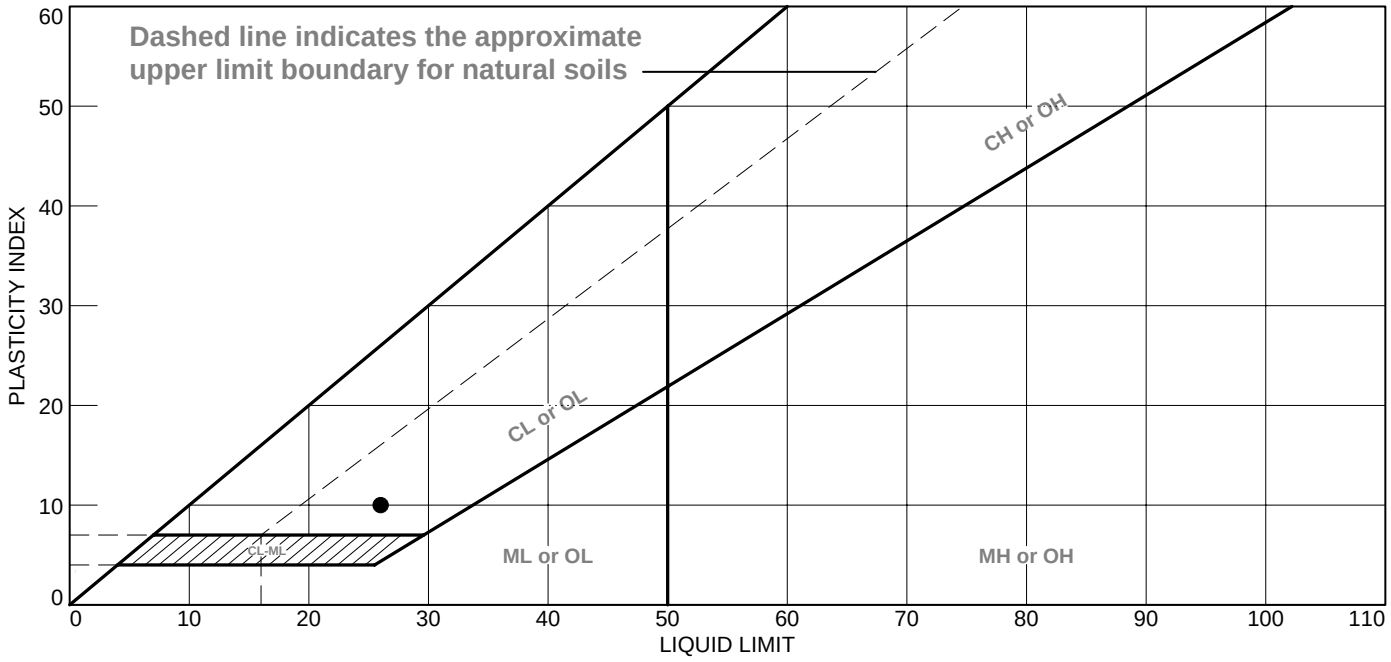
Remarks:

Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWN AND DARK GRAY LEAN CLAY WITH GRAVEL	26	16	10			CL

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B032 **Depth:** 10.0'-11.5'
Sample Number: S-5

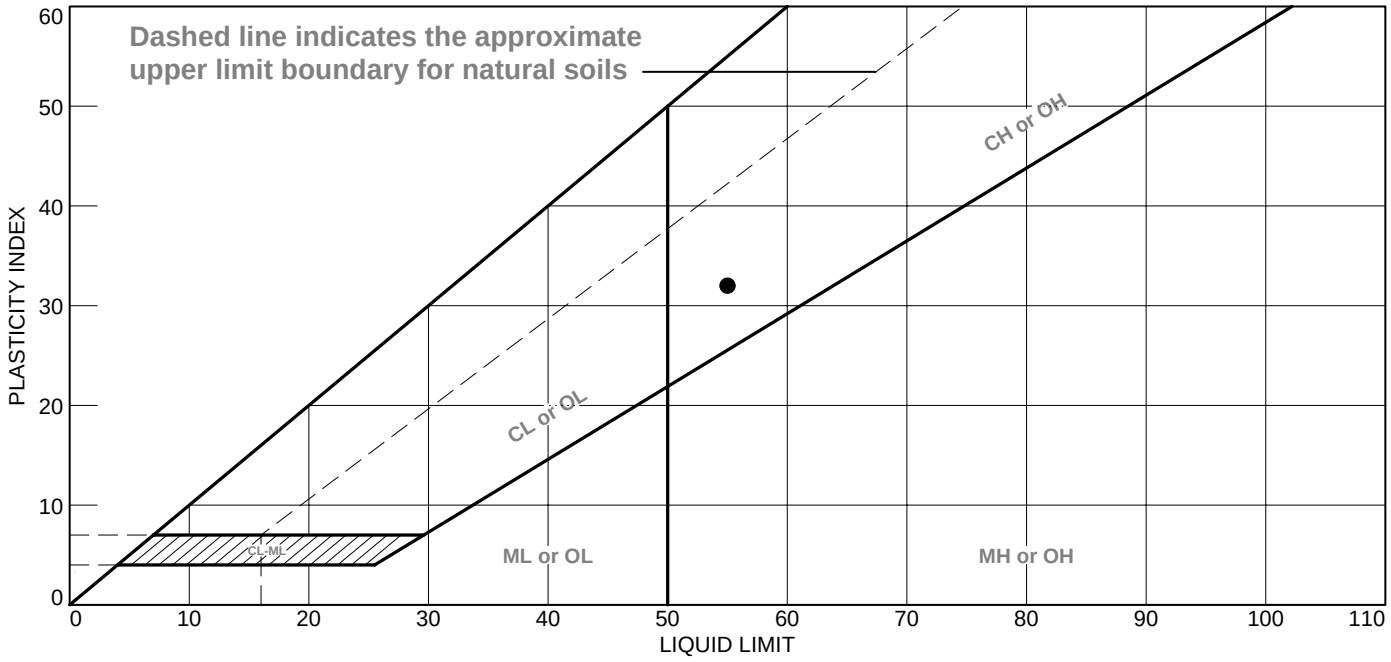
Remarks:

Terracon

Figure

Tested By: SJH **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GREENISH GRAY FAT CLAY	55	23	32			CH

Project No. MR155233 **Client:** AECOM

Project: DYNERGY - HENNEPIN

Source of Sample: HEN-B038 **Depth:** 10.5-11.5'
Sample Number: S-5B

Remarks:

Terracon

Figure

Tested By: HP **Checked By:** WPQ

Specific Gravity of Soils
ASTM D 854

Terracon
Consulting Engineers & Scientists

SPECIFIC GRAVITY OF SOIL SOLIDS
ASTM D-854

Project Number: MR155233
Project Name: Dynergy Hennepin
Test Date: 12/11/2015

Results Summary

Boring / Sample	Sample Description	USCS	Sample Number	Depth (ft)	Passing #4	Specific Gravity (Gs)
HEN-B002	BROWN SAND WITH CLAY	CL	S-2	2.50'-4.0'	100.00%	2.680
HEN-B004	BROWN, TAN AND GRAY GRAVEL WITH SAND	GP	S-2	2.5'-4.0'	100.00%	2.746
HEN-B006	BROWN AND LIGHT BROWN SAND WITH GRAVEL	SP	S-2	2.5'-4.0'	100.00%	2.665
HEN-B009	DARK BROWN SILT WITH SAND	ML	S-4	8.0'-9.0'	100.00%	2.672
HEN-B010	BROWN AND DARK BROWN SILTY SAND	SM	S-4	7.5'-9.0'	100.00%	2.723
HEN-B011	RUST BROWN SANDY LEAN CLAY	CL	S-2	2.5'-4.0'	100.00%	2.693
HEN-B018	BROWN, TAN AND GRAY SILT WITH CLAY AND GRAVEL	ML	S-3	5.0'-6.5'	100.00%	2.700
HEN-B020	BROWN SILT WITH CLAY, SAND AND GRAVEL	ML	S-3	5.0'-6.5'	100.00%	2.672
HEN-B023	FILL: BROWN AND DARK BROWN SILT WITH CLAY SAND AND GRAVEL	ML	S-3	5.0'-6.5'	100.00%	2.701
HEN-B024	BROWN AND GRAY SAND WITH SILT, CLAY AND GRAVEL	SM	S-2	2.5'-4.5'	100.00%	2.756
HEN-B025	BROWN LEAN CLAY WITH SILT AND SAND	CL	S-2	2.5'-4.5'	100.00%	2.708
HEN-B030	FILL: BROWN AND GRAY LEAN CLAY WITH SILT, SAND AND GRAVEL	CL	S-3	5.0'-6.5'	100.00%	2.746
HEN-B034	DARK BROWN LEAN CLAY WITH SILT AND SAND	CL	S-2	2.5'-4.0'	100.00%	2.704
HEN-B034	BROWN AND LIGHT BROWN GRAVEL WITH CLAY AND SAND	GP-GC	S-6	15.0'-16.5'	100.00%	2.808
HEN-B037	BROWN SAND WITH SILT AND GRAVEL	SP-SM	S-2	2.5'-4.0'	100.00%	2.685
HEN-B038	BROWN GRAVEL WITH CLAY AND SILT	GP-GC	S-6	15.0'-16.5'	100.00%	2.763

Corrosion Series of Tests
ASTM G 51
ASTM G 57
DIPRA Methods

Soil Resistivity	**ASTM G 57**
Soil pH	**ASTM G 51**
Soil REDOX	**DIPRA**
Soil Sulfides	**DIPRA**
Water Content	**ASTM D 2216**

Laboratory Services *750 Corporate Woods Parkway* *Vernon Hills, Illinois 60061* *Phone: (224) 352-7000 Fax: (224) 352-7024*

Soil Corrosivity Indication Series

Project No.: **MR155233**
Project Name: **Dynegy Hennepin**
Client Name: **AECOM**
Test Date: **12/15/2015**

Boring / Sample No.	Resistivity Natural Soil Box (ohm-cm)	Resistivity Saturated Soil Box (ohm-cm)	pH Soil Water Slurry	REDOX Soil Water Slurry (mV)	Sulfides Reaction (pos/neg)	As Received WC (%)	Saturated WC (%)	Total Points
HEN-B003 Sample 5 10.0'-12.0'	400,000	3680	9.22	70	NEG	2.1	45.7	
Points	-	0	3	3.5	0	-	-	**6.5**
HEN-B009 Sample 2 2.5'-4.0'	16,000	4,400	8.39	65	NEG	11.0	28.5	
Points	-	0	0	3.5	0	-	-	**3.5**
HEN-B023 Sample 4 7.5'-9.0'	13,600	3,940	8.19	80	NEG	8.0	24.7	
Points	-	0	0	3.5	0	-	-	**3.5**
HEN-B025 Sample 2 2.5'-4.0'	10,600	3,680	8.26	85	NEG	9.3	22.5	
Points	-	0	0	3.5	0	-	-	**3.5**

Resistivity:	Points:	pH:	Points:	Redox:	Points:	Sulfides:	Points:
<1500 ohms	10	0.0-2.0	5	Negative	5	Positive	3.5
1500-1800	8	2.0-4.0	3	0 - 50mV	4	Trace	2
1800-2100	5	4.0-6.5	0	50 - 100mV	3.5	Negative	0
2100-2500	2	6.5-7.5	0*	100mV+	0		
2500-3000	1	7.5-8.5	0				
3000+	0	8.5 +	3				

†

*- If Sulfides are present and a low or neg. ReDox, add 3 points

† - THIS SYSTEM IS BASED ON A 25.5 POINT CORROSIVITY RATING SYSTEM DEVELOPED BY THE AMERICAN NATIONAL STANDARDS FOR POLYETHYLENE ENCASEMENT AND DUCTILE-IRON PIPE SYSTEMS. IT SHOULD BE NOTED THAT THESE TEST RESULTS ARE AN INDICATION OF SOIL CHEMISTRY AND SHOULD BE USED AS A INDICATION OF POSSIBLE CORROSIVE CONDITIONS. TERRACON IS NOT LIABLE FOR ANY REMEDIAL MEASURES TAKEN ON THE BASIS OF THESE RESULTS.

Tested by: WPQ Checked By: BCM

Organic Content Test by Loss on Ignition ASTM D 2974 Method C

Terracon
Consulting Engineers & Scientists

ORGANIC CONTENT TEST

ASTM D-2974
Method C

Laboratory Services Group **750 Corporate Woods Parkway** **Vernon Hills, Illinois 60061** **Ph. (224)352-7000** **fax (224)352-7024**

Project No.: **MR155233**
Project Name: DYNEGY HENNEPIN
Date Tested: 12/14/15

Sample Information

Boring / Source:	HEN-B019
Sample No.:	S-2
Depth (ft.):	7.5'-8.5'

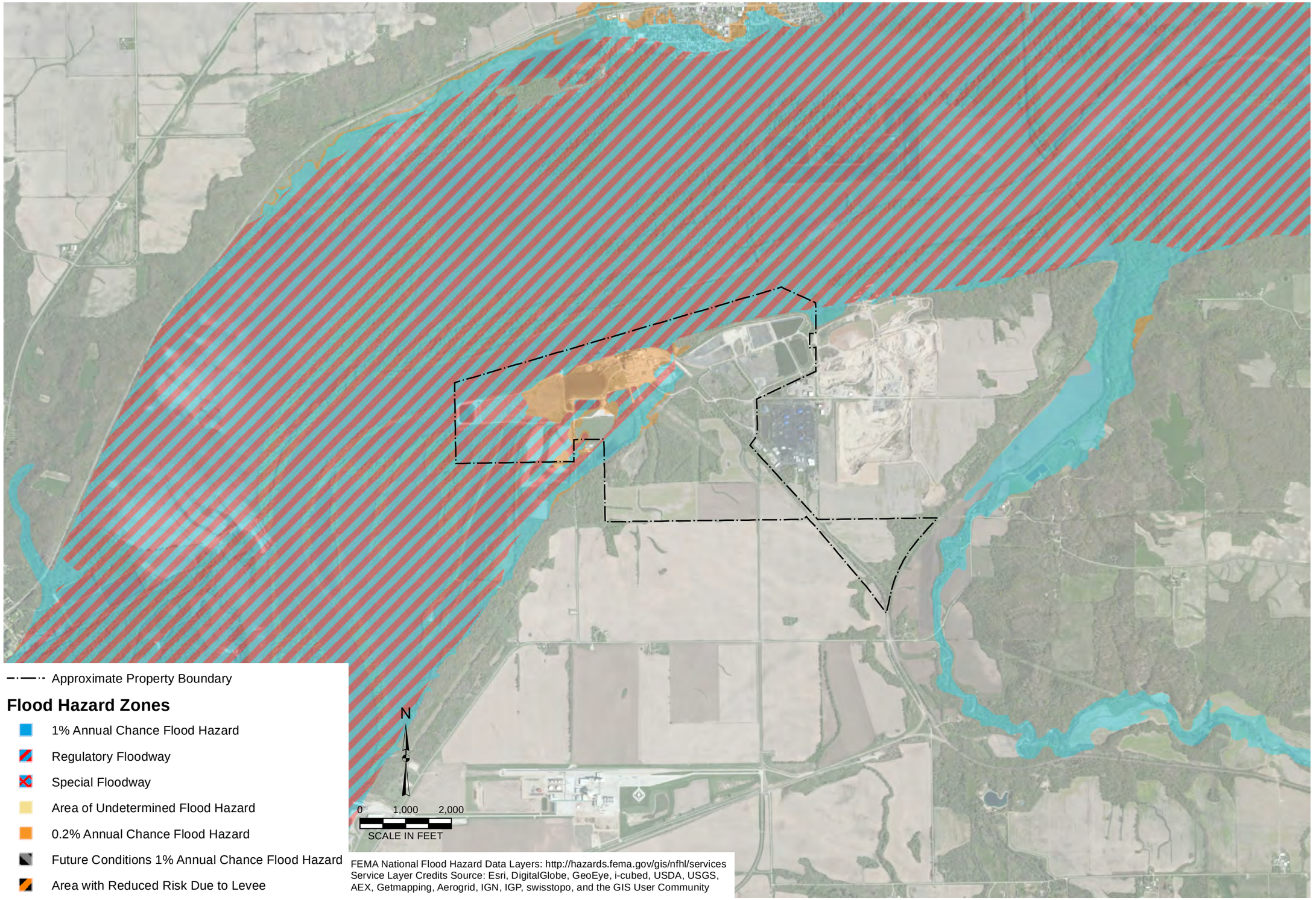
Organic Content Test Data

Tare No.:	F
Tare Wt. (gm): T	19.63
Wet Wt. + Tare (gm): A+T	59.14
Dry Wt. + Tare (gm): B+T	49.34
Moisture Content (%):	**32.99**
Wt. of Ash + Tare (gm): D+T	48.36
Percent Ash: (D-T/B-T)x100 = E	96.70
Organic Content (%):	**3.30**

** Note: Test performed by heating the sample to 440 degrees centigrade for a period of three hours.

Appendix E

FEMA National Flood Hazard Map



FEMA National Flood Hazard Data Layers: http://hazards.fema.gov/gis/nfhl/services
Service Layer Credits Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

FEMA NATIONAL FLOOD HAZARD MAP

HYDROGEOLOGICAL SUMMARY AND GROUNDWATER QUALITY ASSESSMENT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

DRAWN BY/DATE:
TDC 11/11/13
REVIEWED BY/DATE:
BRH 11/18/13
APPROVED BY/DATE:
SJC 5/14/14

PROJECT NO: 2140

APPENDIX: A

NATURAL RESOURCE TECHNOLOGY

Y:\Mapping\Projects\2121\2140\MXD\Appendix A_FEMA National Flood Hazard Map.mxd Author: mmejac Date/Time: 5/14/2014, 10:48:38 AM

Appendix F

Water Wells Survey
NRT/Kelron, June 3, 2009

Water Well Survey

Dynegy Midwest Generation
Hennepin Power Station
Hennepin, Illinois

June 3, 2009

Project No: 1957

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Figure 2 Aerial Photograph with Water Wells (1957-1-B02C)

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Table 1 Water Well Records within 2,500 Foot Radius of Property Boundary

APPENDICES

Appendix A: Illinois State Geological Survey Well Locations and Data
Appendix B: Illinois State Water Survey Private Well Database Well Data
Appendix C: Illinois Environmental Protection Agency Web-Based GIS Files
Appendix D: Record of Communications

REPORT CERTIFICATION

Certification of document preparation and supervision for the following:

Water Well Survey for Hennepin Power Station
Hennepin, Illinois

June 3, 2009

Professional Geologist Name:	Stuart J. Cravens
License Number:	196-000108
Expiration Date:	March 31, 2011

Illinois Licensed Professional Geologist

Signature: _____

Date: _____ (June 3, 2009)

Seal:

1 OVERVIEW

This report has been prepared for Dynegy Midwest Generation, Inc. (DMG) by Kelron Environmental and Natural Resource Technology, Inc. (NRT) and is intended to meet well survey procedures in relevant Illinois and federal regulations[1], including the "Right to Know" Potable Water Well Survey procedures of 35 Illinois Administrative Code 1600.210(b)(1) and 1600.210(b)(2). The purpose of this survey is to identify all existing water wells located within 2,500 feet of the property boundary of DMG's Hennepin Power Station (HPS or Facility), located within the Village of Hennepin's northern municipal limits in Putnam County, Illinois. The HPS property boundary (Figure 1) is located in:

- The north half of the southeast quarter and the south half of the northeast quarter of Section 27; and
- The north half of the northwest quarter of the southeast quarter; the north half of the northwest quarter of the southwest quarter; and, the north half of the northeast quarter of the southwest quarter of Section 26.

A non-community wellhead protection area (WHPA) has been designated by the Illinois Environmental Protection Agency (Illinois EPA) and Illinois Department of Public Health (IDPH) south of the East Ash Pond System and property boundary (Figures 1 and 2). A total of 11 water supply wells were identified within the search radius outside of the HPS property boundary using Illinois EPA, Illinois State Geological Survey (ISGS), Illinois State Water Survey (ISWS) information, and a visual survey. Additionally, four water wells owned by DMG are located within the HPS property boundary. Within the search radius, one well (Well #4) is located east of the Facility, one well (Well #3) is located west of the Facility, and nine wells are located south of the Facility (Well numbers 5 through 11, 14, and 15). One well (Well #7) is designated as a non-community water supply well (non-CWS). All these wells are either upgradient or side gradient from the active and out-of-service ash pond systems of the HPS.

[1] Leaking Underground Storage Tank regulations (35 Ill. Adm. Code 732); Leaking Underground Storage Tank regulations (35 Ill. Adm. Code 734); Site Remediation Program (35 Ill. Adm. Code 740.425(b)(2)(D)); RCRA Permit regulations (35 Ill. Adm. Code 703.183(s)(9); 35 Ill. Adm. Code 703.184(a)(3)); and the National Contingency Plan (40 CFR 300.430(d)).

2 WATER WELL DATABASE AND ALTERNATE SEARCH RESULTS

The following databases and sources of information were utilized in order to determine community water source and potable water well locations and construction in the vicinity of the HPS property boundary:

- Illinois State Geological Survey -Water Well Database Query;
- Illinois State Water Survey private well database;
- Illinois EPA web-based Geographic Information System (GIS) files;
- Illinois Department of Public Health;
- Putnam County Health Department; and
- Field observation of wells from visual survey.

2.1 Illinois State Geological Survey (ISGS)

The ISGS website provided an ArcIMS Viewer Map as well as a database query. According to the ISGS ArcIMS Viewer Map, 11 water wells are located within a 2,500-foot radius of the HPS property boundary (Figures 1 and 2). The wells are numbered 1, 2, 4 through 9, 12, and 13 on the map. Each map location number represents one well identification, with the exception of map Well #6, which appears to have two listings for the same well (Table 1). The ISGS database information, including any boring log and well construction information, is provided in Appendix A. Four mapped well numbers occur on the Facility property as follows:

- Well #1, located southwest of the main plant near the front entrance gate; and,
- Wells #2, #12, and #13 located south of the main plant and midway between the East and West Ash Pond Systems.

Well #1 was located incorrectly on the original driller's log and this error has been propagated through the ISGS (and ISWS and IEPA) databases. This well is used for irrigation of the coal pile and is not a potable source.

The depths of the wells in the ISGS database ranged from 64 to 128 feet deep. All wells, where lithology information is provided, obtain water from unconsolidated sand and gravel deposits. The ISGS water well database also contained test borings for DMG's Facility; none of these borings were for potable wells and were not included within the search results presented in this report.

2.2 Illinois State Water Survey (ISWS)

The ISWS database of well records included records for the wells identified in the ISGS database, with the exception of well numbers 4 and 12, for which there were no ISWS records. There were also two ISWS Private Well Database records that did not appear in any other databases: well numbers 3 and 14, both of which are very old wells with only approximate locations and unknown ownership. Wells #3 and #14 are dug wells with recorded construction dates of 1844 and 1922, respectively, and were most likely abandoned decades ago.

A number of well records from the ISWS contained minimal information for mapping; therefore, these wells are not included in this report as sufficient information was provided to determine the wells are not within the 2,500 feet search radius. A copy of the ISWS Private Well database records is included in Appendix B.

2.3 Illinois Environmental Protection Agency (Illinois EPA)

The Illinois EPA Database website provided ArcIMS Viewer Maps (Appendix C). The database provides information on community, non-community, and public water supply wells as defined on the Illinois EPA website:

- Community Water Supply: *a public water supply that serves or is intended to serve at least 15 service connections used by residents or regularly serves at least 25 residents.*
- Non-community Water Supply: *a public water supply that is not a community water supply.*
- Public Water Supply: *all mains, pipes and structures through which water is obtained and distributed to the public, including wells and well structures, intakes and cribs, pumping stations, treatment plants, reservoirs, storage tanks and appurtenances, collectively or severally, actually used or intended for use for the purpose of furnishing water for drinking or general domestic use and which serve at least 15 service connections or which regularly serve at least 25 persons at least 60 days per year. A public water supply is either a community water supply or a non-community water supply.*

Based on the Illinois EPA maps, community water systems (CWS) are not present within a 2,500 feet radius of the HPS property boundary. The nearest CWS wells and system details, included in Appendix C, are:

- Village of Depue (Facility Number 0110300) located approximately 1.5 miles north of the Facility;
- Village of Hennepin (Facility Number 1555100) located approximately 3 miles south of the Facility;
- Village of Bureau Junction (Facility Number 0110150) located approximately 3 miles southwest of the Facility; and
- Village of Granville (Facility Number 1550050) located approximately 3.5 miles southeast of the Facility.

According to Illinois EPA records, the HPS property boundary is located greater than 1-mile from the Minimum Setback Zones, Existing or Potential Maximum Setback Zones, and /or Recharge Areas for the CWS systems.

Based on the Illinois EPA maps, there is one non-community supply (non-CWS) well, 6 industrial / commercial wells, and 2 farm/domestic water wells located within the 2,500 feet radius of the HPS property boundary (Figures 1 and 2). All wells identified on Illinois EPA maps were also identified in ISGS and/or ISWS records. The non-CWS water supply system (Appendix C) is identified as the Exolon ESK System #0117408, which consists of one well (Map Well #7). The WHPA for this system lies within the 2,500-foot search radius (Figures 1 and 2) but south of the Hennepin Power Station's property boundary.

A wellhead protection area (WHPA) is the surface and subsurface area surrounding a water well or well field supplying a CWS or non-CWS water system through which contaminants from a source are theoretically likely to move and reach the water well or well field. All CWS and non-CWS systems utilizing groundwater in Illinois have a 1,000-foot wellhead / source water protection radius, also referred to as a Phase I WHPA.

2.4 Illinois Department of Public Health (IDPH)

The IDPH was contacted for confirmation information on the Exolon non-CWS system. J. Scott Bell with the IDPH confirmed the system is the only non-CWS within the search radius. Mr. Bell also stated the system is now identified as the Washington Mills non-CWS (Appendix D).

2.5 Putnam County Health Department

Personnel from the Bureau-Putnam County Health Department were not able to confirm or provide additional data on the non-CWS well system (Appendix D).

2.6 Visual Survey

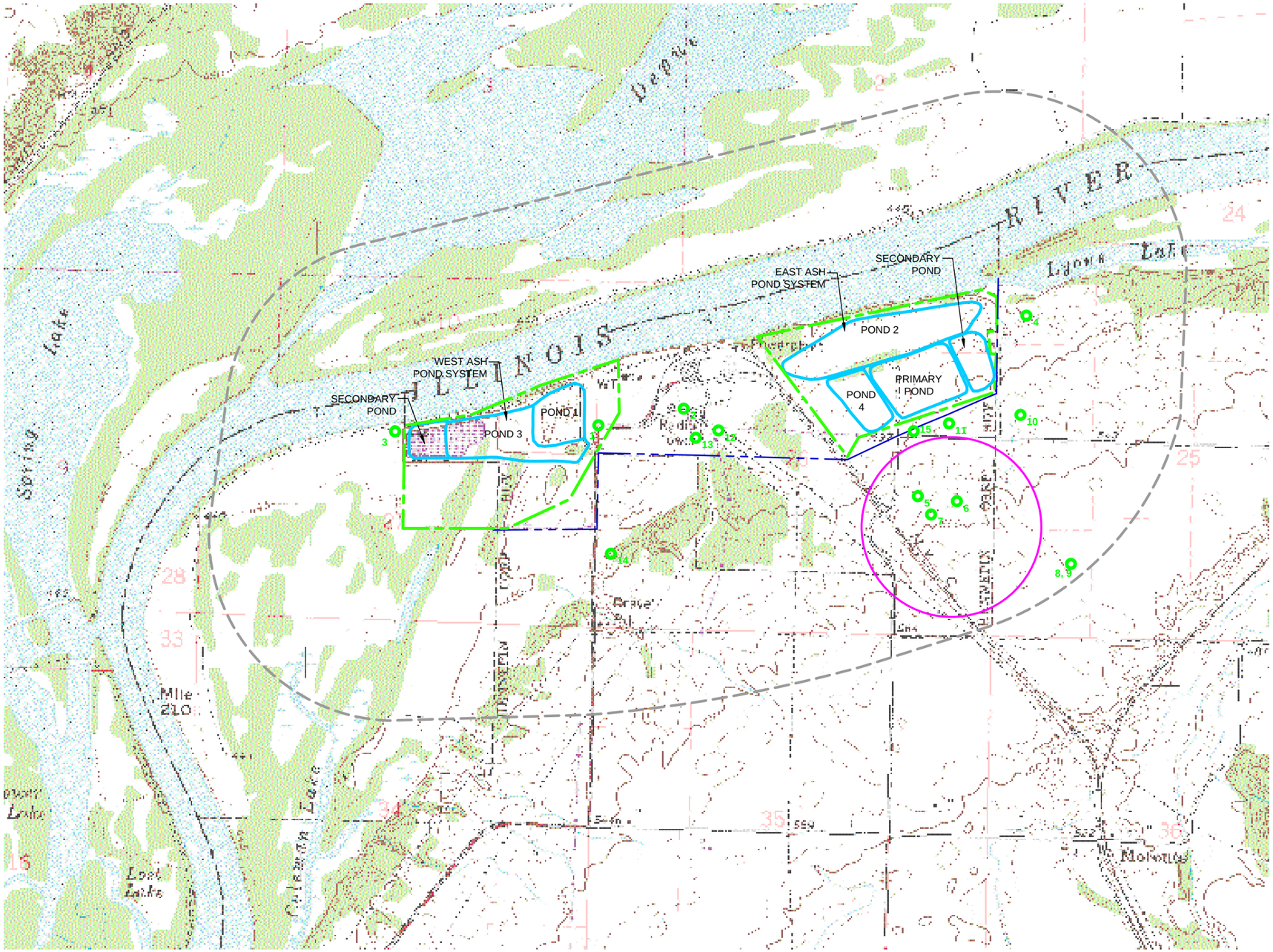
A visual survey, also referred to as a windshield survey, was conducted on April 14, 2009 to verify some well locations listed in the databases and also to locate wells not identified by ISGS, ISWS, Illinois EPA or DMG sources. Three wells were field identified (Table 1; Figures 1 and 2) that did not have corresponding well logs in any of the database sources: Well #10, located on property owned by Tri-Con Materials; and Wells #11 and #15, located on property that appears to be owned by Advanced Asphalt. All three of these wells are industrial-commercial wells with unknown operational status as to whether they are active or inactive.

3 CONCLUSIONS

According to database records of the ISGS, ISWS, and Illinois EPA, there are eight water wells (assumed to be potable) owned by private residences or companies within a 2,500 feet radius of the HPS property boundary and four water wells owned by DMG are located on the HPS property (Table 1). Three additional undocumented industrial-commercial wells were identified at locations south and southeast of the Facility during a visual (windshield) survey. A total of 15 water wells have been identified both on DMG's HPS property and within a 2,500-foot radius of the Facility property boundary.

In addition to the above sources of water well information provided by State agencies, Kelron obtained information from DMG personnel and the IDPH. Personnel with both these entities had no knowledge or information of any additional wells within a 2,500 feet radius of the HPS property boundary beyond those identified within the State databases.

The results of the water well survey are provided in Appendices A through D for each of the sources of information contacted. Based on all of the well information acquired from the listed sources, water supply wells within at least 2,500 feet of the HPS property boundary were placed on a topographic map (Figure 1) and aerial photograph (Figure 2) and shown in relation to the HPS property boundary. The current status of some of these wells (i.e., operational, abandoned, or sealed) is not known.



LEGEND

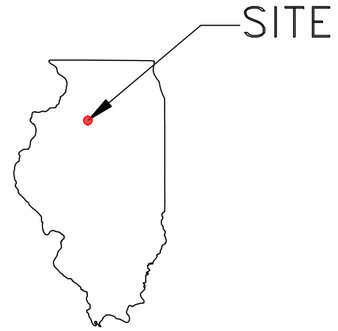
- 4 — WATER WELL LOCATION
- ASH POND
- APPROXIMATE PROPERTY BOUNDARY
- GROUNDWATER MANAGEMENT ZONE
- 2,500 FOOT RADIUS FROM PROPERTY BOUNDARY
- NON-CWS WELLHEAD PROTECTION AREA

SOURCE:
USGS DIGITAL RASTER GRAPHICS FILES FROM ILLINOIS NATURAL RESOURCES GEOSPATIAL DATA CLEARINGHOUSE (http://www.isgs.uiuc.edu)

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY SOURCE WATER ASSESSMENT PROGRAM (SWAP) ArcIMS MAPPING TOOL (http://maps.epa.state.il.us/website/swap/intro.html).

ILLINOIS STATE GEOLOGICAL SURVEY, DIGITAL WATER WELL RECORDS INTERACTIVE MAP (http://www.isgs.illinois.edu/maps-data-pub/wwdb/wwdb.shtml).

2009 KELRON/NRT FIELD OBSERVATIONS.
2009 DYNEGY MIDWEST GENERATION PERSONNEL CORRESPONDENCE.



N

0 750 1500
SCALE IN FEET

WATER WELL LOCATION MAP

WATER WELL SURVEY
HENNEPIN POWER STATION
HENNEPIN, ILLINOIS

DRAWN BY:	RLH	DATE: 06/01/09
CHECKED BY:	RJC	DATE: 06/01/09
APPROVED BY:	RJC	DATE: 06/01/09

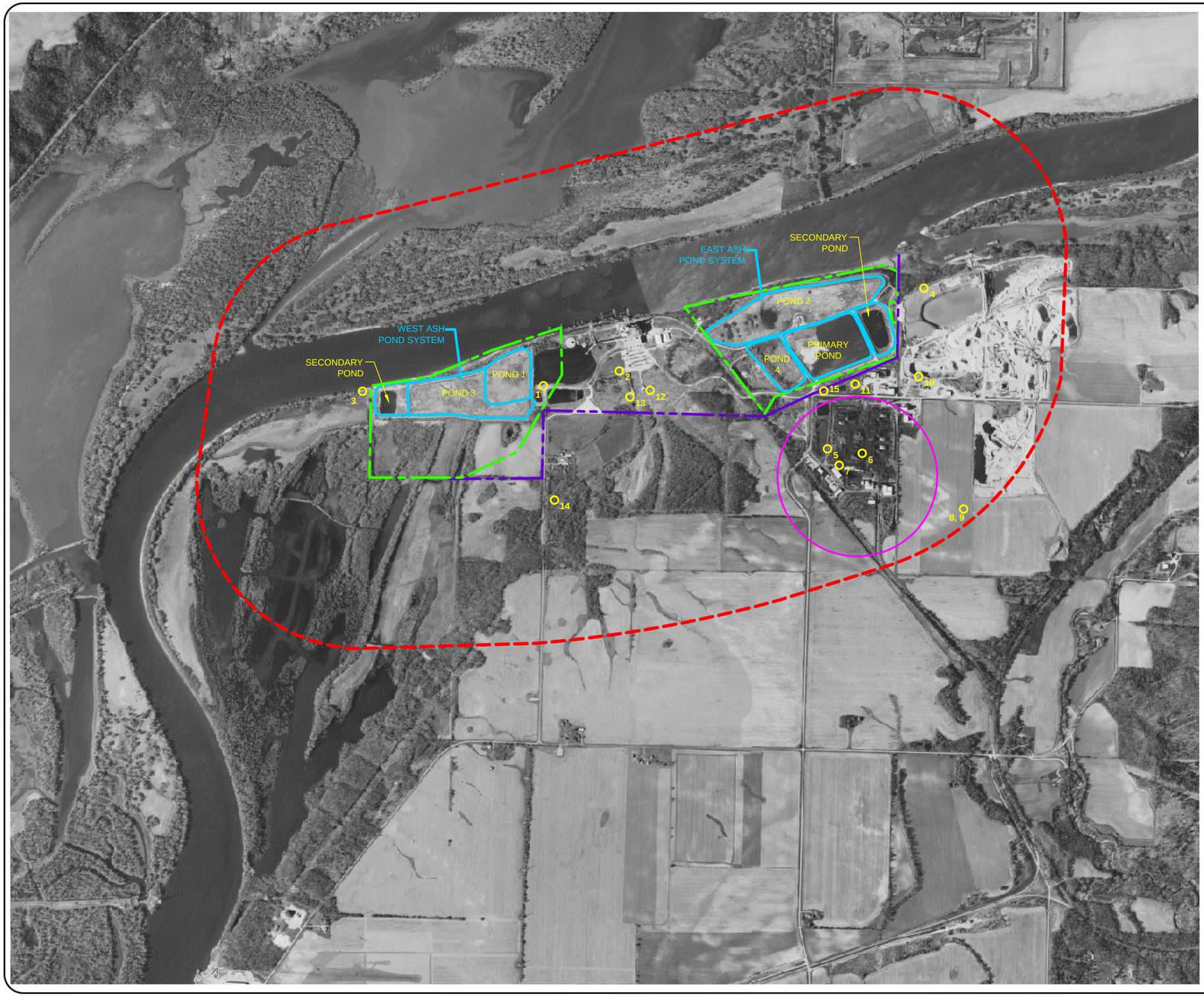
DRAWING NO: 1957-1-B01C
REFERENCE: o41089c3.tiff

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
1957/1.0

FIGURE NO.
1

KELRON environmental



LEGEND

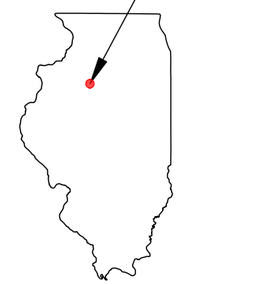
- 12 — WATER WELL LOCATION
- ASH POND
- APPROXIMATE PROPERTY BOUNDARY
- GROUNDWATER MANAGEMENT ZONE
- 2500 FT. RADIUS, FROM PROPERTY BOUNDARY
- NON-CWS WELLHEAD PROTECTION AREA

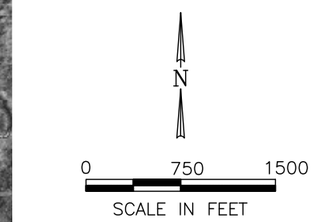
SOURCE NOTES:
2005 DIGITAL ORTHOPHOTO FROM ILLINOIS NATURAL RESOURCES GEOSPATIAL DATA CLEARINGHOUSE (http://www.isgs.uiuc.edu).

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY SOURCE WATER ASSESSMENT PROGRAM (SWAP) ArcIMS MAPPING TOOL (http://maps.epa.state.il.us/website/swap/intro.html).

ILLINOIS STATE GEOLOGICAL SURVEY, DIGITAL WATER WELL RECORDS INTERACTIVE MAP (http://www.isgs.illinois.edu/maps-data-pub/wwdb/wwdb.shtml).

2009 KELRON/NRT FIELD OBSERVATIONS.
2009 DYNEGY MIDWEST GENERATION PERSONNEL CORRESPONDENCE.





AERIAL PHOTOGRAPH WITH WATER WELLS

WATER WELL SURVEY
HENNEPIN POWER STATION
HENNEPIN, ILLINOIS

DRAWN BY:	RLH	DATE: 06/01/09
CHECKED BY:	RJC	DATE: 06/01/09
APPROVED BY:	RJC	DATE: 06/01/09

DRAWING NO: 1957-1-B02C
REFERENCE: 410891c31.sid, 410891c32.sid
410891c33.sid, 410891c34.sid

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
1957/1.0

FIGURE NO.
2

KELRON environmental

Table 1. Water Well Records Within 2,500-Foot Radius of Property Boundary
Hennepin Power Station; Hennepin, Illinois

Map Well #	Source of Well Information				Location Name at Time of Well Completion	Well Depth	County	Location				Year Drilled	Aquifer Type	Formation	Well Use
	ISGS	ISWS	IEPA	Other				Township	Range	Section	Subsection				
1*	121552070200	155-12-04	20702	DMG	Hennepin Power Station (DMG)	83	Putnam	33N	02W	27	SE/SE/NE	2004	Unconsolidated	Sand and Gravel	IC
2	121550012800	P403409	00128	DMG	Illinois Power Co., No. 5	113	Putnam	33N	02W	26	NE/NE/NW	1968	Unconsolidated	Sand and Gravel	IC
3	- -	125917	- -	- -	- -	30	Putnam	33N	02W	27	NE/NW/SW	1844	- -	- -	FD
4	121552045800	- -	20458	- -	Advanced Asphalt Co.	114	Putnam	33N	02W	25	SW/NW/NW	1995	Unconsolidated	Sand and Gravel	IC
5	121552029200	79101 P403400	20292	- -	Exolon, Well No. 1	109	Putnam	33N	02W	26	SW/NE/SE	1978	Unconsolidated	Sand and Gravel	IC
6	121552049700 121552047700	155-011-96 P405443	20497 20477	- -	Exolon, Well No. 3	124	Putnam	33N	02W	26	SE/NE/SE	1996	Unconsolidated	Sand and Gravel	IC
7	121552025800	76743	20258	SWA	Exolon, Well No. 2 (ID 15500143)	128	Putnam	33N	02W	26	SW/NE/SE	1978	Unconsolidated	Sand and Gravel	NCWS
8	121552051800	314693	20518	- -	Kenneth Brown	72	Putnam	33N	02W	25	NE/SW/SW	1999	Unconsolidated	Sand and Gravel	FD
9	121552068500	359951	20685	- -	Kenneth Brown	64	Putnam	33N	02W	25	NE/SW/SW	2002	Unconsolidated	Sand and Gravel	FD
10	- -	- -	- -	Visual	Tri-Con Materials	--	Putnam	33N	02W	25	SW/SW/NW	- -	- -	- -	IC
11	- -	- -	- -	Visual	Potentially Advanced Asphalt	--	Putnam	33N	02W	26	SE/SW/NE	- -	- -	- -	IC
12	121552043500	- -	20435	DMG	Illinos Power Co., No. 1A/6	125	Putnam	33N	02W	26	NE/NE/NW	1993	Unconsolidated	Sand and Gravel	IC
13	121552059800	176545 P403406	20598	DMG	Illinois Power Co., No. 4	114	Putnam	33N	02W	26	NE/NE/NW	1969	Unconsolidated	Sand and Gravel	IC
14	- -	125916	- -	- -	- -	17	Putnam	33N	02W	26	NW/SW/SW	1922	Unconsolidated	Sand and Gravel	FD
15	- -	- -	- -	Visual	Potentially Advanced Asphalt	--	Putnam	33N	02W	26	SW/SE/NE	- -	- -	- -	IC

Sources of Information

DMG	Dyngey Midwest Generation
IEPA	Illinois Environmental Protection Agency
ISGS	Illinois State Geological Survey
ISWS	Illinois State Water Survey
SWA	IEPA Source Water Assessment

Well Use

FD	Farm and/or Domestic Water Well
IC	Industrial/Commercial Water Well
CWS	Community Water Supply
NCWS	Non-Community Water Supply

Notes

- -	Not applicable or no information available.
*	Used for irrigation of coal pile only.

APPENDIX A

ILLINOIS STATE GEOLOGICAL SURVEY WELL LOCATIONS AND DATA

ILLINOIS STATE GEOLOGICAL SURVEY

MAP # 1

ISWS # 155-12-04
P 411819

Irrigation Well	Top	Bottom
gravel	0	4
gravel & boulders	4	18
12-25 slot sand	18	26
gravel & boulders	26	33
1/8" - 1" gravel, no fines	33	80
20-60 slot sand	80	83
shale at	83	83
Total Depth		83

Casing: 12" STEEL from 0' to 62'
12" STAINLESS STL SCREEN from 62' to 82'

Screen: 20' of 12" diameter 80 slot

Grout: BENTONITE from 0 to 20.

Grout: #2 MUSCATINE from 20 to 82.

Water from sand at 33' to 82'.

Static level 13' below casing top which is 2' above GL

Pumping level 20' when pumping at 50 gpm for 1 hour

Permanent pump installed at 60'

Address of well: same as above

Location source: Location from permit

Permit Date: August 9, 2004 **Permit #:**

COMPANY Harold Dean Albrecht

FARM Dynegy Midwest-Hennepin Power

DATE DRILLED August 11, 2004 **NO.**

ELEVATION 0 **COUNTY NO.** 20702

LOCATION NE NW SW

LATITUDE 41.296294 **LONGITUDE** -89.335163

COUNTY Putnam **API** 12155207020**0** **27 - 33N - 2W**

ILLINOIS STATE GEOLOGICAL SURVEY

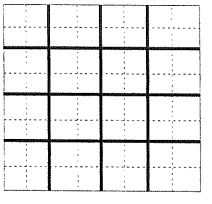
Water Well	Top	Bottom
Total Depth		113
Driller's Log filed		

MAP #2

ISWS # P403409

Permit Date: **Permit #:**

COMPANY Layne Western Co., Inc.
FARM Illinois Power
DATE DRILLED September 1, 1968 **NO.** 5
ELEVATION 0 **COUNTY NO.** 00128
LOCATION NE NE NW
LATITUDE 41.304882 **LONGITUDE** -89.31122
COUNTY Putnam **API** 12155**0**012800 **26 - 33N - 2W**



ILLINOIS STATE GEOLOGICAL SURVEY

MAP #4

Semi-Private Water Well	Top	Bottom
yellow rocky sand & gravel	0	75
very fine Sankoty sand	75	114
blue shale at	114	114
Total Depth		114

Casing: 6" BLACK STEEL from 3' to 109'
Screen: 4' of 6" diameter 10 slot
Grout: BENTONITE from 0 to 90.
Size hole below casing: 6"

Water from Sankoty at 109' to 113'.
Static level 75' below casing top which is 1' above GL
Pumping level 105' when pumping at 10 gpm for 2 hours

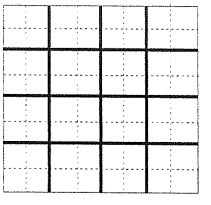
Permanent pump installed at 112' on June 29, 1995, with a capacity of 10 gpm

Address of well: R.R. #1
Hennepin, IL

Location source: Location from permit

Permit Date: May 31, 1995 **Permit #:**

COMPANY Lutes, George W.
FARM Advanced Asphalt Co.
DATE DRILLED June 12, 1995 **NO.**
ELEVATION 0 **COUNTY NO.** 20458
LOCATION SW NW NW
LATITUDE 41.30505 **LONGITUDE** -89.299075
COUNTY Putnam **API** 121552045800 **25 - 33N - 2W**



ILLINOIS STATE GEOLOGICAL SURVEY

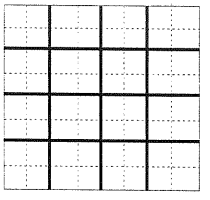
Water Well	Top	Bottom
Total Depth		109
Driller's Log filed		
Sample set # 61998 (0' - 105') Received: June 15, 1979		

MAP # 5

ISWS # 79101
P403400

Permit Date: **Permit #:**

COMPANY Layne Western Co., Inc.
FARM Esk Corporation
DATE DRILLED September 1, 1978 **NO.** 1
ELEVATION 0 **COUNTY NO.** 20292
LOCATION 1830'S line, 1070'E line of SE
LATITUDE 41.298332 **LONGITUDE** -89.304115
COUNTY Putnam **API** 121552029200 **26 - 33N - 2W**



ILLINOIS STATE GEOLOGICAL SURVEY

MAP #6

ISWS # 155-011-96

P 403400

Noncommunity - Public Water Well	Top	Bottom
SS #68792 (0-120')	0	0
fine brown sand	0	4
gray clay	4	5
coarse sand & gravel with boulders	5	79
brown clay with gravel	79	81
fine sand with gravel	81	117
gray shale	117	124
Total Depth		124

Casing: 12" STEEL .375" from 0' to 102'
Screen: 15' of 12" diameter .13 slot
Grout: CEMENT from 0 to 20.
Size hole below casing: 38"

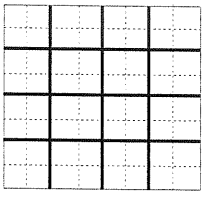
Water from sand & gravel at 102' to 117'.

Sample set # 68792 (0' - 120') Received: March 6, 2000

Location source: Location from permit

Permit Date: September 5, 1996 **Permit #:** 155-011

COMPANY Buffington, G.
FARM Exolon - ESK Company
DATE DRILLED October 1, 1997 **NO.** 3
ELEVATION 0 **COUNTY NO.** 20497
LOCATION 1775'N 550'W SE/c
LATITUDE 41.298186 **LONGITUDE** -89.302211
COUNTY Putnam **API** 121552049700 **26 - 33N - 2W**



ILLINOIS STATE GEOLOGICAL SURVEY

MAP #6

Private Water Well	Top	Bottom
fine brown sand	0	4
gray clay	4	5
coarse sand & gravel	5	79
brown clay with gravel	79	81
fine sand with gravel	81	117
gray shale	117	124
Total Depth		124

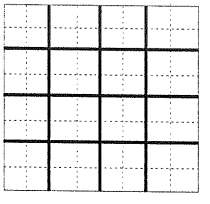
Casing: 12" STEEL .375" from 0' to 102'
Screen: 15' of 12" diameter .13 slot
Grout: CEMENT from 0 to 20.
Size hole below casing: 38"

Water from sand & gravel at 102' to 117'.
Permanent pump installed at 80' on , with a capacity of 300 gpm

Location source: Location from permit

Permit Date: September 5, 1996 **Permit #:**

COMPANY Buffington, G.
FARM Exolon - ESK Company #3
DATE DRILLED October 1, 1996 **NO.**
ELEVATION 0 **COUNTY NO.** 20477
LOCATION 1775'N 550'W SE/c SE
LATITUDE 41.298186 **LONGITUDE** -89.302211
COUNTY Putnam **API** 121552047700 **26 - 33N - 2W**



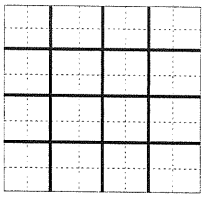
ILLINOIS STATE GEOLOGICAL SURVEY

Water Well	Top	Bottom
Total Depth		128
Driller's Log filed		
Sample set # 61999 (0' - 130') Received: June 15, 1979		

MAP # 7

Permit Date: **Permit #:**

COMPANY Layne Western Co., Inc.
FARM Esk Corporation
DATE DRILLED July 1, 1978 **NO.** 2
ELEVATION 0 **COUNTY NO.** 20258
LOCATION 1590'S line, 890'E line of SE
LATITUDE 41.297672 **LONGITUDE** -89.303448
COUNTY Putnam **API** 121552025800 **26 - 33N - 2W**



ILLINOIS STATE GEOLOGICAL SURVEY

MAP # 8

Private Water Well	Top	Bottom
dirty sand	0	8
gravel	8	18
clay	18	36
yellow gravel (a lot of water loss)	36	50
gray gravel (a lot of water loss)	50	72
shale at	72	72
Total Depth		72

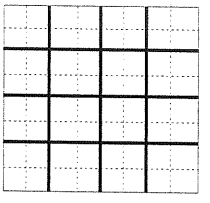
Casing: 4" PVC SCH 40 from -1' to 51'
Screen: 4' of 4" diameter 15 slot
Grout: BENT GROUT MIX from 0 to 46.
Water from sand & gravel at 0' to 0'.
Static level 18' below casing top which is 1' above GL
Pumping level 0' when pumping at 50 gpm for 3 hours

Address of well: R.R. #1
Hennepin, IL

Location source: Location from permit

Permit Date: August 3, 1999 **Permit #:**

COMPANY Jet Hall
FARM Brown, Kenneth
DATE DRILLED August 25, 1999 **NO.**
ELEVATION 0 **COUNTY NO.** 20518
LOCATION NE SW SW
LATITUDE 41.296001 **LONGITUDE** -89.296594
COUNTY Putnam **API** 121552051800 25 - 33N - 2W



ILLINOIS STATE GEOLOGICAL SURVEY

MAP # 9

Private Water Well	Top	Bottom
sandy brown clay	0	12
gravel	12	20
pinkish gray clay	20	28
yellow gravel (lots of water loss)	28	50
fine sand	50	64
Total Depth		64

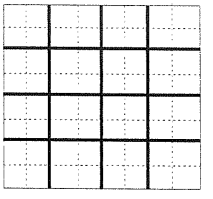
Casing: 6" PVC from 0' to 42'
6" SS SCREEN 18/20 SLOT from 42' to 50'
Screen: 8' of 6" diameter slot
Grout: BENT CLAY SLRY from 0 to 40.
Grout: MUSCATINE #1 from 40 to 50.
Water from sand & gravel at 28' to 64'.
Static level 5' below casing top which is 1' above GL
Pumping level 7' when pumping at 12 gpm for 2 hours

Address of well: same as above

Location source: Location from permit

Permit Date: October 4, 2002 **Permit #:**

COMPANY Jet Hall/Lutes H2o Well Drlg.
FARM Brown, Kenneth
DATE DRILLED November 15, 2002 **NO.**
ELEVATION 0 **COUNTY NO.** 20685
LOCATION NE SW SW
LATITUDE 41.296001 **LONGITUDE** -89.296594
COUNTY Putnam **API** 121552068500 **25 - 33N - 2W**



ILLINOIS STATE GEOLOGICAL SURVEY

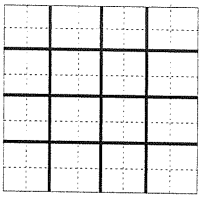
MAP #12

Noncommunity - Public Water Well	Top	Bottom
SS #68242 (0'-120')	0	0
black topsoil	0	2
brown clay, a little clayey	2	7
yellow-brown coarse gravel & boulders	7	27
brown coarse sand to coarse gravel	27	41
gray & brown soft silty clay	41	43
brn med sand to coarse gravel & boulders	43	50
reddish brown coarse gravel & boulders	50	67
multi-colored boulders	67	73
conglomerate clay & boulders /trace lime	73	82
light gray silty clay	82	84
hard tight coarse gravel	84	86
brn med sand to coarse gravel & boulders	86	96
boulder	96	98
fn brn snd; coarse gravel w/finer layers	98	112
brown fine sand to medium gravel	112	118
firm gray shale	118	125
Total Depth		120

Casing: 36" STEEL from 12' to 62'
18" STEEL 70.59#/FT. from -2' to 90'
Screen: 25' of 18" diameter .1 slot
Grout: CONCRETE from 0 to 20.
Water from sand & gravel at 90' to 115'.
Static level 17' below casing top which is 3' above GL
Pumping level 31' when pumping at 1086 gpm for 8 hours
Permanent pump installed at 50' on October 31, 1993, with a

Permit Date: August 31, 1993 **Permit #:**

COMPANY Buffington, G.
FARM Illinois Power Co.
DATE DRILLED September 30, 1993 **NO.** 1A/5 6?
ELEVATION 0 **COUNTY NO.** 20435
LOCATION NE NE NW
LATITUDE 41.304882 **LONGITUDE** -89.31122
COUNTY Putnam **API** 121552043500 **26 - 33N - 2W**



MAP # 12
PAGE 2

capacity of 500 gpm

Sample set # 68242 (10' - 120') Received: July 14, 1994

Location source: Location from permit

Buffington, G. Illinois Power Co. 1A/5

COUNTY Putnam **API 121552043500** **26 - 33N - 2W**

ILLINOIS STATE GEOLOGICAL SURVEY

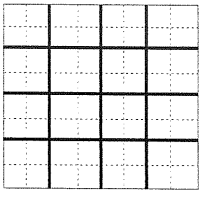
Water Well	Top	Bottom
Total Depth		114
Sample set # 56227 (65' - 114') Received: May 16, 1969		

MAP #13

ISWS#
176545
P403406

Permit Date: **Permit #:**

COMPANY Layne-Western Drlg
FARM Il. Power Co.
DATE DRILLED **NO.** 4
ELEVATION 0GL **COUNTY NO.** 20598
LOCATION NE NE NW
LATITUDE 41.304882 **LONGITUDE** -89.31122
COUNTY Putnam **API** 121552059800 **26 - 33N - 2W**



APPENDIX B

ILLINOIS STATE WATER SURVEY PRIVATE WELL DATABASE WELL DATA

Illinois Department of Public Health
WATER WELL CONSTRUCTION REPORT

Date 8-31-04

(Dynegy Midwest Gen - Hennepin Power)

RECEIVED 11/1/04

GEOLOGICAL AND WATER SURVEY WELL RECORD

TYPE OR PRESS FIRMLY WITH BLACK INK PEN. COMPLETE WITHIN 30 DAYS OF WELL COMPLETION AND SEND TO THE APPROPRIATE HEALTH DEPARTMENT.

1. Type of Well a. **Driven** Well Casing diam. _____ in. Depth _____ ft.
   b. **Bored** Well Buried Slab [ ] Yes [ ] No
   Hole Diameter ____ in. to _____ ft.; ____ in. to _____ ft.; ____ in. to _____ ft.
   c. **Drilled** Well **PVC** casing Formation packer set at depth of _____ ft.
   Hole Diameter ____ in. to _____ ft. ____ in. to _____ ft. ____ in. to _____ ft.

Type of Grout	# of Bags	Grout Weight	From (ft.)	To (ft.)	Tremie Depth (ft.)

d. **Drilled** Well **Steel** Casing- - - Mechanically Driven [ ] Yes [ ] No
Hole Diameter 19 in. to 82 ft. ____ in. to _____ ft. ____ in. to _____ ft.

Type of Grout	# of Bags	Grout Weight	From (ft.)	To (ft.)	Tremie Depth (ft.)
bentonite			0	20	20

e. Well finished within [X] Unconsolidated Materials [ ] Bedrock

f. Kind of Gravel Sand Pack Grain Size/Supplier # From (ft.) To (ft.)

#2 Muscatine		20	82

2 Well Use [ ] Domestic [X] Irrigation [ ] Commercial [ ] Livestock
[ ] Monitoring [ ] Other
3 Date Well Completed 8-11-04 Well Disinfected [X] Yes [ ] No
Driller's estimated well yield 50 gpm w/air
4 Date Permanent Pump Installed 8-16-04
5 Pump Capacity _____ gpm Set at (depth) 60 ft.
6 Pitless Adapter Model and Manufacturer _____
7 Well Cap Type and Manufacturer Weld-on Top Plate
8 Pressure Tank Working Cycle _____ gals. Captive Air [ ] Yes [ ] No
9 Pump System Disinfected [X] Yes [ ] No
10 Name of Pump Company ~~Albrecht Well Drilling, Inc,~~
11 Pump Installer ~~Harold D. Albrecht~~ License # 102-002466
12 Harold D Albrecht License # 102-002466
Licensed Pump Contractor Signature
PICS 15534260, #7 P# 411819

Illinois Department of Public Health
Division of Environmental Health
525 W. Jefferson St.
Springfield, IL 62761

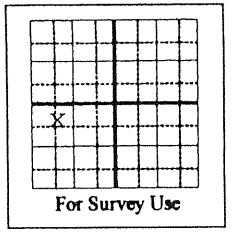
DO NOT write on these lines

X11819

IMPORTANT NOTICE: This state agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. **DISCLOSURE OF THIS INFORMATION IS MANDATORY.** This form has been approved by the Forms Management Center.

ISGS # 12155209020 0

14. Property Owner Dynegy Midwest Well # 4521
14. Driller Harold D. Albrecht License # 102-002466
15. Name of Drilling Co. Albrecht Well Drilling, Inc.
16. Permit No. 155-12-04 Date Issued 8-9-04
17. Date Drilling Started August 10, 2004
18. Well **SITE** address R.R.#1 Hennepin, IL
19. Township Name Hennepin Land ID # 01-27-100-000
20. Subdivision Name n/a Lot # n/a
21. Location a. County Putnam
    b. Township 33N Range 2W Section 27 7d
    c. NE Quarter NW Quarter SW Quarter
    d. Coordinates _____ Site Elevation _____ ft. (msl)



22. Casings, Liners* and Screen Information

Diam. (in.)	Material	Joint	Slot Size	From (ft.)	To (ft.)
12	steel			0	62
12"	SS		80	62	82

(*) _____
(List reason for liner, type of upper and lower seals installed)

23. Water from Sand at a depth of 33 ft. to 82 ft.
a. Static water level 13 ft. below casing which is 18 in. above ground
b. Pumping level is 20 ft. pumping 50 gpm after pumping for ½ hours w/air

24. Earth Materials Passed Through

	From (ft.)	To (ft.)
gravel	0	4
gravel & boulders	4	18
12-25 slot sand	18	26
gravel & boulders	26	33
1/8" - 1" gravel [no fines]	33	80
~~20-60 slot sand~~	80	83
shale	83	

(If **dry hole**, fill out log and indicate how hole was sealed.)

Harold D Albrecht 102-002466
25. Licensed Water Well Contractor Signature License Number

MAP #1

SEE REVERSE SIDE FOR ADDITIONAL INFORMATION)

ILLINOIS DEPARTMENT OF PUBLIC HEALTH
WELL CONSTRUCTION REPORT

1. Type of Well
   a. Dug____. Bored____. Hole Diam.____in. Depth____ft.
   Curb material _____. Buried Slab: Yes_____No_____
   b. Driven _____. Drive Pipe Diam. _____in. Depth _____ft.
   c. Drilled ✓. Finished in Drift ✓. In Rock _____.
   Tubular _____. Gravel Packed ✓.
   d. Grout:

(KIND)	FROM (Ft.)	TO (Ft.)
None		

2. Distance to Nearest:
   Building _____ Ft. Seepage Tile Field _____
   Cess Pool _____ Sewer (non Cast iron) _____
   Privy _____ Sewer (Cast iron) _____
   Septic Tank _____ Barnyard _____
   Leaching Pit _____ Manure Pile _____
3. Is water from this well to be used for human consumption?
   Yes _____ No ✓
4. Date well completed Aug 22, 68
5. Permanent Pump Installed? Yes ✓ No _____
   Manufacturer Layne Type Line shaft
   Capacity 1000 gpm. Depth of setting 60 ft.
6. Well Top Sealed? Yes ✓ No _____
7. Pitless Adaptor Installed? Yes _____ No ✓
8. Well Disinfected? Yes ✓ No _____
9. Water Sample Submitted? Yes _____ No ✓

REMARKS:

P.W.S. H09H09

GEOLOGICAL WATER SURVEYS WATER WELL RECORD

10. Dept. Mines and Minerals permit No. M-4405 Year 1968
11. Property owner Ill. Power Co. Well No. 5
    Address Hennepin Ill
    Driller Layne-Western Co. License No. 92-14
12. Water from Drift Formation 13. County Putnam
    at depth 0 to 112 ft. Sec. 26, 5th
    14. Screen: Diam. 18 in. Twp. 33N
    Length: 30 ft. Slot 0.080" Rng. 2W
    Elev. ____ Ground

15. Casing and Liner Pipe

Diam. (in.)	Kind and Weight	From (Ft.)	To (Ft.)
30"	3/8" steel	0	63'-6"
18"	3/8" steel	0	63'-6"
18"	3/8" steel	73'-6"	73'-6"

SHOW LOCATION IN SECTION PLA
NE NE NE

16. Size Hole below casing: 30 in.
17. Static level 13'4" ft. below casing top which is 0 ft above ground level. Pumping level 33 ft. when pumping at 1000 gpm for 6 hours.

18. FORMATIONS PASSED THROUGH	THICKNESS	DEPTH O BOTTOM
Drift	112	112
Shale	?	?
(CONTINUE ON SEPARATE SHEET IF NECESSARY)		

SIGNED R. L. Layne DATE Nov 2, 68

MAP # 2
ISGS # 1215500128 00

Whi py –
Ill. Dept. of Public Health
Yellow Copy – Well Contractor
Blue Copy – Well Owner

INSTRUCTIONS TO DRILLERS

FILL IN ALL PERTINENT INFORMATION REQUESTED AND MAIL ORIGINAL TO STATE DEPARTMENT OF PUBLIC HEALTH, ROOM 616, STATE OFFICE BUILDING, SPRINGFIELD, ILLINOIS, 62706. DO NOT DETACH GEOLOGICAL / WATER SURVEYS SECTION. BE SURE TO PROVIDE PROPER WELL LOCATION.

ILLINOIS DEPARTMENT OF PUBLIC HEALTH
WELL CONSTRUCTION REPORT

1. Type of Well
   a. Dug____. Bored____. Hole Diam.____in. Depth 104 ft.
   Curb material____. Buried Slab: Yes____No____
   b. Driven____. Drive Pipe Diam.____in. Depth____ft.
   c. Drilled x. Finished in Drift x. In Rock____.
   Tubular____. Gravel Packed x.
   d. Grout:

(KIND)	FROM (Ft.)	TO (Ft.)
ready mix	7	20

2. Distance to Nearest:
   Building____Ft. Seepage Tile Field____
   Cess Pool____ Sewer (non Cast iron)____
   Privy____ Sewer (Cast iron)____
   Septic Tank____ Barnyard____
   Leaching Pit____ Manure Pile____
3. Is water from this well to be used for human consumption?
   Yes____ No x
4. Date well completed 10/2/78
5. Permanent Pump Installed? Yes____ No x
   Manufacturer____ Type____
   Capacity____gpm. Depth of setting____ft.
6. Well Top Sealed? Yes x No____
7. Pitless Adaptor Installed? Yes____ No x
8. Well Disinfected? Yes x No____
9. Water Sample Submitted? Yes x No____

REMARKS:

County # 20292

1565
12155202920 0

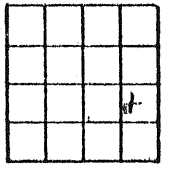
IDPH 4.065
10/68

P403400

PLC's 15534255, #1

GEOLOGICAL AND WATER SURVEYS WELL RECORD
(Industrial)

10. Property owner ESK Corporation Well No. 1
    Address Hennepin IL
    Driller Layne-Western Co. License No. 102-13
11. Permit No. 79101 Date 9/6/78
12. Water from drift (Formation)
    at depth 89 to 104 ft.
13. County Putnam
    Sec. 26 NW
    Twp. 33N
    Rge. 2W
    Elev.____
14. Screen: Diam. 12 in(Tele)
    Length: 15 ft. Slot 40



SHOW LOCATION IN SECTION PLAT
1830'N, 1070'W SEC, (Industrial)

15. Casing and Liner Pipe

Diam. (in.)	Kind and Weight	From (Ft.)	To (Ft.)
12	steel 0.330"	89	+2

16. Size Hole below casing: 38 in.
17. Static level 72 ft. below casing top which is 2 ft. above ground level. Pumping level 85 ft. when pumping at 530 gpm for 8 hours.

18. FORMATIONS PASSED THROUGH	THICKNESS	DEPTH OF BOTTOM
Fine sand to coarse gravel /boulders	0	6
Fine brown sand	6	8
Fine sand to coarse gravel /boulders	8	64
Fine to coarse sand	64	105
Fine sand to coarse gravel, boulders & traces of clay	105	109

(CONTINUE ON SEPARATE SHEET IF NECESSARY)

SIGNED D. G. Lohmeier DATE 10/3/78
D. G. Lohmeier, P.E.

MAP #5

White & Pink Copies:
Ill. Dept. of Public Health
Yellow Copy: Well Contractor
Golden Copy: Well Owner

Well Construction Report

MAP #6
1565 #12155 2049700

THIS FORM MUST BE COMPLETED WITHIN 30 DAYS
OF WELL COMPLETION AND SENT TO
THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
525 WEST JEFFERSON STREET
SPRINGFIELD, ILLINOIS 62761

1. Type of Well
   a. Bored____ Hole Diam.____in. Depth____ft
   Buried Slab: Yes___ No___
   b. Driven____ Drive Pipe Diam.____in. Depth____ft
   c. Drilled X Finished in Drift X In Rock____
   d. Grout:

(KIND)	FROM (Ft.)	TO (Ft.)
cement	0	20

2. Well furnishes water for human consumption? Yes X No___
3. Date well drilled October 1
4. Permanent pump installed? Yes___ Date in future No X
   Manufacturer Layne & Bowler Type VTP
   Location
   Capacity 300 gpm. Depth of setting 80 ft.
5. Well top sealed? Yes X No___ Type steel plate
6. Pitless adapter installed? Yes___ No X
   Manufacturer Model No.
   How attached to casing?
7. Well disinfected? Yes X No___
8. Pump and equipment disinfected Yes___ No___

IMPORTANT NOTICE

This State Agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosiure of this information is mandatory. This form has been approved by the Forms Management Center.

PRESS FIRMLY WITH BLACK PEN OR TYPE

P# 405443 Do Not Use Felt Pen

CO#20497

IL482-0126

PICS 15534255, #3

GEOLOGICAL AND WATER SURVEYS WELL RECORD
Project Driller, MIKE RIFE & MARY MICHELS

9. Driller Layne-Western License No. 102-003241
10. Well Site Address MENNEPIN IL
11. Property Owner Exolon-ESK Well No. 3
12. Permit No. 155-011-96 Date Issued 9/5/96
13. Location: 550'W & 1775'N of S.E. corner
    County Putnam
    Sec. 26
    Twp. 33N
    Rge. 2W

Show location in section plat

SW NW SE

14. Water from sand & gravel at depth 102 ft to 117 ft

15. Casing and Liner Pipe

Diam.(in)	Kind and Weight	From (ft)	To (ft)
12	steel-.375"	0	102

16. Screen: Diam. 12 in, Length 15' XX Slot Size .130"
17. Size hole below casing 38 in. 18. Ground Elev.____ ft msl.
19. Static level____ft below casing top which is ____ft. above ground level. Pumping level ____ft, pumping gpm for ____ hours.

20. Earth Materials Passed Through	Depth of Top	Depth of Bottom
Fine brown sand	0	4
Gray clay	4	5
Coarse sand & gravel with boulders	5	79
Brown clay with gravel	79	81
Fine sand with gravel	81	117
Gray shale	117	124

Continue on separate sheet if necessary.

Signed GREGORY D. BUFFINGTON, P.E. Date 11/5/96

MAP # 7
ISGS # 20258

White copy – Ill. Dept. of Public Health
Yellow Copy – Well Contractor
Blue Copy – Well Owner

INSTRUCTIONS TO DRILLERS

FILL IN ALL PERTINENT INFORMATION REQUESTED AND MAIL ORIGINAL TO STATE DEPARTMENT OF PUBLIC HEALTH, ROOM 616, STATE OFFICE BUILDING, SPRINGFIELD, ILLINOIS, 62706. DO NOT DETACH GEOLOGICAL / WATER SURVEYS SECTION. BE SURE TO PROVIDE PROPER WELL LOCATION.

ILLINOIS DEPARTMENT OF PUBLIC HEALTH
WELL CONSTRUCTION REPORT

1. Type of Well
   a. Dug____. Bored____. Hole Diam.____in. Depth 128 ft.
   Curb material _____. Buried Slab: Yes____No____
   b. Driven _____. Drive Pipe Diam.____in. Depth____ft.
   c. Drilled X. Finished in Drift X. In Rock____.
   Tubular____. Gravel Packed X.
   d. Grout:

(KIND)	FROM (Ft.)	TO (Ft.)
Grout	7	20

2. Distance to Nearest:
   Building _____ Ft. Seepage Tile Field _____
   Cess Pool _____ Sewer (non Cast iron) _____
   Privy _____ Sewer (Cast iron) _____
   Septic Tank _____ Barnyard _____
   Leaching Pit _____ Manure Pile _____
3. Is water from this well to be used for human consumption?
   Yes X No____
4. Date well completed 8/15/78
5. Permanent Pump Installed? Yes____ No X
   Manufacturer _____ Type _____
   Capacity _____gpm. Depth of setting _____ ft.
6. Well Top Sealed? Yes X No____
7. Pitless Adaptor Installed? Yes____ No X
8. Well Disinfected? Yes X No____
9. Water Sample Submitted? Yes X No____

REMARKS:

County # 20258

IDPH 4.065
10/68

116
12
128

PICS 15534255 # 2 P403401

GEOLOGICAL AND WATER SURVEYS WELL RECORD
(Potable)

10. Property owner ESK Corporation Well No. 2
    Address Hennepin, Illinois
    Driller Layne-Western Co. Inc License No. 102-13
11. Permit No. 76743 Date 7/12/78
12. Water from drift Formation 13. County Putnam
    at depth 116 to 128 ft.
14. Screen: Diam. 12 in (Tele)
    Length: 12 ft. Slot 40
    Sec. 26.2c
    Twp. 33N
    Rge. 2W
    Elev. ____

SHOW LOCATION IN SECTION PLAT
1590'N 890'W, SE¼, (Industrial)

15. Casing and Liner Pipe

Diam. (in.)	Kind and Weight	From (Ft.)	To (Ft.)
12	steel 0.330"	0	116

16. Size Hole below casing: 20 in.
17. Static level 90 ft. below casing top which is 2 ft. above ground level. Pumping level 112 ft. when pumping at 261 gpm for 8 hours.

18. FORMATIONS PASSED THROUGH	THICKNESS	DEPTH OF BOTTOM
Gravel, boulders	0	82
Brown clay	82	88
Med. sand, gravel, fine sand	88	128

(CONTINUE ON SEPARATE SHEET IF NECESSARY)

SIGNED D. G. Lohmeier DATE 10/3/78
D. G. Lohmeier, P.E.

MAP # 12

ISGS #1215520435 00

PAGE 1

WELL INFORMATION – DRIFT WELLS

Layne-Western Company, Inc.

PROFESSIONAL SERVICES FOR WATER SYSTEMS

721 West Illinois Avenue • Aurora, Illinois 60506-2892 • Phone: 708/897-6941

Name of Job Illinois Power Company Date 10/05/93

City or Village Hennepin State IL

Well No.: ~~5~~ 6 (Local 1A) Drillers: Glidewell, Will, Rife

Well Location: _____ ft. (_____) and _____ ft. (_____) of the _____ corner of

Section 26 NE, Twp. 33 (N), Range 2 (W) Putnam County.

Otherwise located as fractional section

Work Began: 8-24-93 Work Completed: 10-07-93 Well Depth: 115'

All measurements made from existing ground level at time well was drilled.

Casing Record:

Amount	Dia.	Wt. or Thickness	Material				
92'	18"	0.375"	Steel	with Welded	joints from	90'	to +2'
50'	36"	0.375'	Steel	with Welded	joints from	12'	to 62'

Screen Record: Type Houston

Amount	Dia.	Opening	Material				
25'	18"	0.100	S.Steel	with Welded	joints from	115'	to 90'
				with	joints from		to

Type of Seal at Bottom Stainless Steel Plate

Hole Record:

38" min.	inch from	0	to 118'
	inch from		to

Gravel Pack Record:

Amount	Size	Source	From	To
47 Tons	#3	Northern	118"	70'

Cementing Record: Ready Mix Concrete - 20' to 9'

Backfill Record: Bentonite Seat at 62 ft.

Backfill Sand 62 to 20

P 404906

MAP #12
PAGE 2

WELL LOG

Feet		Feet	Description
0	to	2	Black topsoil
2	to	7	Brown sand, a little clayey
7	to	27	Yellow brown coarse gravel&boulders
27	to	41	Brown coarse sand to coarse gravel
41	to	43	Gray & brown soft silty clay
43	to	50	Brown medium sand to coarse gravel & boulders
50	to	67	Reddish brown coarse gravel & boulders
67	to	73	Multi-colored boulders
73	to	82	Conglomerate clay & boulders traces of weathered lime
82	to	84	Light gray silty clay
84	to	86	Hard tight coarse gravel
86	to	96	Brown jagged medium sand to coarse gravel & boulders
96	to	98	Boulder
98	to	112	Brown fine sand to coarse gravel with finer layers
112	to	118	Brown fine sand to medium gravel
118	to	125	Firm gray shale
	to		
	to		
	to		
	to		
	to		
	to		
	to		

Well Test Data: Static Level 17 ; pumping level 31' after 8 hours pumping at 1086 g.p.m.

Length of test 8 hrs. See Well Test Data Sheet Dated October 4, 1993

REMARKS:

MAP #12
PAGE 3

WELL TEST DATA SHEET

Layne-Western Company

A Layne Company

PROFESSIONAL SERVICES FOR WATER SYSTEMS

721 West Illinois Avenue • Aurora, Illinois 60506-2892 • Phone: 708/897-6941

Job Illinois Power Company Well No. ~~5~~ 6 Date Tested 10/4/93

Location Hennepin, IL Tested By C. Glidewell

Dia. of Well 18" Driver 671 Engine

Depth of Well 115' from G.L. Pump Used: Column and Shaft 8 x 1-11/16"

Length of Airline 85' Bowls

Non-Pumping Level 17' Manufacturer Layne

Orifice Size 10" x 8" Serial No. Test Pump

Time	Piezometer Reading (in.)	G.P.M.	Air Gauge Reading (feet)	Pumping Level	Drawdown	Disch. Pressure		Total Pumping Head	Remarks
						Lbs.	Feet		
9:30		0	68	17'	SWL				
10:00	13.5	1086	56	29	12				Cloudy
10:30	13.5	1086	56	29					Clear
11:00	13.5	1086	56	29					No Sand
1:30	13.5	1086	56	29					
12:00	13.5	1086	54	31	14				
12:30	13.5	1086	54	31					
1:00	13.5	1086	54	31					
1:30	13.5	1086	54	31					
2:00	13.5	1086	54	31					
2:30	13.5	1086	54	31					
3:00	13.5	1086	54	31					
3:30	13.5	1086	54	31					
4:00	13.5	1086	54	31					
4:30	13.5	1086	54	31					
5:00	13.5	1086	54	31					
5:30	13.5	1086	54	31	14				

Final Specific Capacity = 77.6 GAL/FT.

MAP #12
PAGE 4

WELL TEST DATA SHEET

Layne-Western Company

A Layne Company

PROFESSIONAL SERVICES FOR WATER SYSTEMS

721 West Illinois Avenue • Aurora, Illinois 60506-2892 • Phone: 708/897-6941

Job Illinois Power
Well No. #6 (1A)
Date Tested 10/27/93
Location Hennepin, IL.
Tested By Marvin Michelson
Dia. of Well 18"
Driver 60 HP Westinghouse
Depth of Well 115' (from G.L.)
Pump Used:
Column and Shaft 8"x1 11/16"x2 1/2"
Length of Airline 50'
Bowls 11 stage - 12 RKMC
Non-Pumping Level 29' (Direct)
Manufacturer Layne-Western
Orifice Size IP Tripod - 6 x 5
Serial No. 22200

Time	Piezometer Reading (in.)	G.P.M.	Air Gauge Reading (feet)	Pumping Level	Drawdown	Disch. Pressure		Total Pumping Head	Remarks
						Lbs.	Feet		
7:00		0	29						
1:15	14.3	466	35	35	6	120			cloudy 78/78/80
1:20	17.3	513	35	35	6	115			78/78/79
1:25	19	543	35	35	6	100			clear
	21	570	36	36	7	105			clear
	22.8	597	36	36	7	100			clear
	24.5	616	36	36	7	95			clear
	26.8	641	37	37	8	90			clear
	28.3	659	37	37	8	85			77/77/78
	30.3	682	37	37	8	80			77/77/78
	32.3	704	38	38	9	75			77/77/78
	34	726	38	38	9	70			77/77/78
	36	747	38	38	9	65			77/77/78
	37.3	757	38	38	9	60			77/77/78
	39.3	777	39	39	10	55			77/77/78
	41	797	39	39	10	50			77/77/78
1:40	43	816	40	40	11	45			77/77/78
	44.8	826	40	40	11	40			77/77/78
	46.5	849	40	40	11	35			77/77/78
	48	862	41	41	12	30			77/77/78
	49.8	876	42	42	13	25			Sp Q =67.4

ISGS # 1215520598000 #4 MIAT PROJECT 4/17/65

City Hennepin (Hackberry Landing) County Putnam SW NW NW Sec 26

Section 26 Twp. No. 33N Range 2W

Location (in feet from section corner) NE¼, NE¼, NW¼

Owner Illinois Power Co. Authority

Contractor Layne-Western Co. Address 721 West Illinois Ave., Aurora, Ill. 60507

Date drilled Aug 26, 69 Elev. above sea level top of well

Depth 116' 113.5

Log Sand and gravel

Were drill cuttings saved Yes Where filed State of Illinois

Size hole 30" If reduced, where and how much

Casing record 18" to 93'-6"; 18" stainless screen to 116'

Distance to water when not pumping 13'-4" Distance to water is 24

feet after pumping at 1080 G. P. M. for 7 hours.

Reference point for above measurements Top of casing

Type of pump Test pump Distance to cylinder

Length of cylinder Length of suction pipe below cylinder

Length stroke Speed

Hours used per day Type of power

Rating of motor Rating of pump in G. P. M.

Can following be measured: (1) Static water level

(2) Pumping level (3) Discharge

(4) Influence on other wells

Temperature of water Was water sample collected Yes

Date Effect of water on meters, hot water coils, etc.

Date of Analysis Analysis No.

Recorder

Date

2807-22617 12

April 1, 1969

WELL PRODUCTION TEST
ILLINOIS POWER COMPANY, WELL NO. 4
PUTNAM COUNTY
by

Layne-Western

42 26, 5S2 fractional

MAP #13 PAGE 2

625

ISGS # 12155205980D

Owner:	Illinois Power Company
Location:	NE 1/4, NE 1/4, NW 1/4, Sec. 26, T. 33N., R. 2W.
Date of Test:	8/27/68
Date Completed:	August 1968
Length of Test:	6 hours
Aquifer:	Sand & gravel

WELL DATA

PUMPED WELL

Well No:	4
Driller:	Layne-Western
Depth:	113.5
Hole Record:	48" 0-15'; 42" 15-30'; 34" 30-60'; 30" 60-113.5'
Casing Record:	30" 0-62'; 18" 0-63.5 and 73.5-93.5' (gravel packed, 2-113.5')
Screen Record:	10' of 18" #6 slot S.S. 63.5-73.5'; 20' of 18" #6 slot S. S. 93.5-113.5'
Pump and Power:	Test pump; 100 hp motor
Measuring Point:	18" above GL, top of casing
Measuring Equipment:	10x8" orifice, steel tape
Static Level:	13'4"

R 403404

MEASUREMENTS

MAP #13 PAGE 3

PUMPED WELL

Date 1968	Hour	Time (min)	Alt. gage (ft)	Depth to water (ft)	Draw-down (ft)	Piez. tube (in)	Pump. rate (gpm)	Remarks
8/27	7:50A		13.33					FPNR*
	8:45		17.58					Fire pump running (on at 8:37)
	8:59		13.58					FPNR*
	9:00	0				24.5	1543	Pump on
	9:15	15	31.17	31.17	17.82	25	1557	FPNR*
	9:30	30	33.42	33.42	20.08	25.5	1571	Fire pump running
	10:00	60	33.58	33.58	20.25	25.5	1571	Fire pump running
	10:30	90	33.58	33.58	20.25	25.5	1571	Fire pump running
	11:00	120	31.42	31.42	18.08	25.5	1571	Fire pump running
	11:30	150	33	33	19.67	25.5	1571	Fire pump running
	12:00N	180	33.33	33.33	20	25.5	1571	Fire pump running
	12:30P	210	33.08	33.08	19.75	25.5	1571	Fire pump running
	1:00	240	33.25	33.25	19.75	25.5	1571	Fire pump running
	1:30	270	33.82	33.82	20.50	25.5	1571	Fire pump running
	2:00	300	32.92	32.92	19.58	25.5	1571	Fire pump running
	2:30	330	33	33	19.67	25.5	1571	Fire pump running
	3:00	360	33	33	19.67	25.5	1571	Fire pump running
	3:05	365						Reduced capacity to 1080 gpm
	3:30	390	26.17	26.17	12.67	11	1080	Fire pump running
	4:00	420	24.08	24.08	10.75	11	1080	FPNR* (off at 3:33)
	4:30	450	24.08	24.08	10.75	11	1080	FPNR*
	5:00	480	24.08	24.08	10.75	11	1080	FPNR*
								End of Test

*FPNR=Fire pump not running

MAP #13
PAGE 4

DRILLER'S LOG
WELL NO. 4

Formation	From	To
Brown sandy soil	0'	8"
Brown med. sand to coarse gravel with boulders	8"	22 1/2'
Black silty soil	22 1/2'	23 1/2
Brown med. sand to coarse gravel with trace of clay and silt	23 1/2	26 1/2
Light gray silty clay, soft	26 1/2	28
Brown med. sand	28	29 1/2
Multi-colored clay silt, soft, soft sandstone boulder at 30'	29 1/2	32
Brown med. sand to coarse gravel, trace of rusty colored sandy silt, some boulders	32	49 1/2
Gray sandy clay	49 1/2	50 1/2
Brown and gray med. sand to coarse gravel	50 1/2	58
Light gray silty clay	58	59
Med. sand to coarse gravel, multi-colored	59	67
Light gray silty clay	67	67 1/2
Med. sand to coarse gravel, multi-colored	67 1/2	79
Fine to med. sand, gray	79	87
Limestone boulder	87	88
Brown med. sand to coarse gravel	88	97
Brown fine to med. sand, trace of gravel	97	106 1/2
Brown med. sand to coarse gravel	106 1/2	112 1/2
Gray shale	112 1/2	

Location:

NE¼, NE¼, NW¼, S.26
T.33N., R.2W.

P Number: 431044 | NEW | SAVE | CANCEL | DELETE | Entered By: tbryant 10/31/2007

Data Set Location: 1 OF 9 | > | >| | Last User: tbryant 10/31/2007

SUMMARY | POINT INFO | IWIP INFO | LOCATION VERIFICATION | OBSERVATION | PAPER FILES | QA / QC

Well Type: | Total Depth: 44.00 (ft.) | AQ Code:

Aquifer Type: | Well Use: RE | Date Completed: <1991

Owner: DYNEGY MIDWEST GEN - HENNEPIN POWER

Facility Point Number: 8 | IWIP Facility ID: 15534260

Driller:

Drilling Company:

Permit #: VALID # VALID LOCATION

Address:

City: | State: | Zip:

Land ID: | Lot #:

Subdivision:

FIPS: 155 TWN: 33N RNG: 02W SEC: 26 QQQ: SE NE NW Plot: 5G VALID LOC.

PLSS Source: CR | Principal Meridian: 3

	Decimal Degrees	CALC	Deg.	Min.	Sec.	Decimal Minutes	Lat-Lon Source: GPS
Latitude: N	41.3032333		41	18	11.64		
Longitude: W	39.3162167		39	18	58.38		

LS Elevation: (ft.) | Elevation Method: | Elevation Source:

Casing Dia.: (in.) | Variable: | Casing Depth: (ft.) | Slotted:

Screen Length: (ft.)

Water From: | depth of: (ft.) | to: (ft.)

Static Level Below Casing Top: (ft.)

Inches Casing Above Ground Level: (in.)

Pumping Level Below Casing Top: CALC

Static Water Level: | Pumping Level:

Pumping: gpm for hours

General Remarks: USED 1991-1993 AS PART OF A LEAKING UNDERGROUND TANK REMEDIATION PER JOHN AUGSPOLS 10-31-07 TB.

Record Type: | SIC: 4911 | SIC Source: 1

Record Type Remarks:

Previous Owners:

Date Sealed: 08/16/2007 | SGS Number:

Lambert X: 3051710 | Lambert Y: 3011702 | CALC

Lambert Method:

Lambert Method Remarks:

Lambert Accuracy:

Lambert Source:

Database Data
Date Completed:
Date Sealed: 20070816

RECOR FILTE | FIND NUMBE | VIEW PUMPAG | VIEW SC | VIEW FACILIT | VIEW PERMI | PRINT SCREE

NO MAP # TEST WELLS

P431044
Facility 15534260, #8

SCANNED

Private Well Database

Illinois State Water Survey
Address / Phone Information

Records for **Putnam** county, **33N** township, **01W** range, **30** section.

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125859	1G	119	RG	DO	~~	~~	00173

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
S DEAN ALBRECHT	07/06/1973				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125860	2H	100	RG	DO	~~	~~	00127

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
S DEAN ALBRECHT	10/15/1968				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125861	2H	100	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
S DEAN ALBRECHT	07/31/1969				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
314745	8A	170	RGCP	DO	DL	UN	20515

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
COUNTRY WELL & PUMP	10/02/1997				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
329423	5B	26	RGP	DO	BD	UN	20541

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
ROY THORNE	03/28/2000	13			

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
348053	3H	65	RGP	DO	BD	UN	20670

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
THORNE WELL DRILLING/MIKE DRYDEN	03/07/2003				

View the results in "Table Format" Search for a different Section

If this page does not print correctly, change your browser's layout mode to landscape.

Please view our **Data Disclaimer**, Water Well Records Policies and Procedures, and **Plot Location System**

Column headings link to data explanations.

Private Well Database

Illinois State Water Survey
Address / Phone Information

Records for **Putnam** county, **33N** township, **01W** range, **31** section.

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125862	1A	201	RG	DO	~~	~~	00180

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
S DEAN ALBRECHT	06/12/1973				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125863	1F	200	RG	DO	~~	~~	20256

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
K & K WELL DRILLING	07/11/1977				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125864	2F	4	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
	03/12/1934				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125865	5F	200	RG	DO	~~	~~	00164

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
S DEAN ALBRECHT	11/17/1972				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
296155	8H	213	RG	DO	DL	UN	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
KEITH THIERY	04/30/1997	134	136	20	2

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
358239	8H	241	RG	DO	DL	UN	20698

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
COMPLETE WELL DRILLING/DARREL DOBER	06/19/2003	179	189	12	2

View the results in "Table Format" Search for a different Section

If this page does not print correctly, change your browser's layout mode to landscape.

Please view our **Data Disclaimer**, Water Well Records Policies and Procedures, and **Plot Location System**

Column headings link to data explanations.

Private Well Database

Illinois State Water Survey
Address / Phone Information

Records for **Putnam** county, **33N** township, **02W** range, **24** section.

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
343982	5D	303	RGP	DO	DL	UN	20622

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
LUTES H2O DRILLING/G.DELHOTEL	07/30/2001	229		30	2

View the results in "Table Format" Search for a different Section

If this page does not print correctly, change your browser's layout mode to landscape.

Please view our **Data Disclaimer**, Water Well Records Policies and Procedures, and **Plot Location System**

Column headings link to data explanations.

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Illinois State Water Survey, Contact Information
University of Illinois at Urbana-Champaign

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Email the Web Administrator with questions or comments.
Last Modified: March 11, 2008

Private Well Database

Illinois State Water Survey
Address / Phone Information

Records for **Putnam** county, **33N** township, **02W** range, **25** section.

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125915	3F	196	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
EGART	1922				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
314693	7B	72	RGCP	DO	DL	UN	20518

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
LUTES DRILLING	09/14/1999	17		50	3

MAP # 8

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
359951	7B	64	RG	DO	DL	UN	20685

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
LUTES H2O DRILLING/JET HALL	11/15/2002	4	6	12	2

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
382144	1A	158	RG	DO	DL	UN	20747

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
LUTES H2O DRILLING/KEITH THIERRY	04/10/2006	100		15	1

View the results in "Table Format" Search for a different Section

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Private Well Database

Illinois State Water Survey
Address / Phone Information

Records for **Putnam** county, **33N** township, **02W** range, **26** section.

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125916	8B	17	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
	1922				

MAP #14

View the results in "Table Format" Search for a different Section

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Address / Phone Information

Records for **Putnam** county, **33N** township, **02W** range, **27** section.

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125917	5D	30	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
	1884				

out of order

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Illinois State Water Survey
Address / Phone Information

Records for **Putnam** county, **33N** township, **02W** range, **34** section.

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125918	1D	300	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
	1848				

OUT OF DATE

View the results in "Table Format" Search for a different Section

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Column headings link to data explanations.

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Private Well Database

Illinois State Water Survey
Address / Phone Information

Records for **Putnam** county, **33N** township, **02W** range, **35** section.

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125919	1E	127	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
BICKERMAN	1909				

OUT OF RADIUS

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125920	3A	75	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
BICKERMAN	1895				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125921	7D	110	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
	1904				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125922	8E	160	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
BICKERMAN	1920				

View the results in "Table Format" Search for a different Section

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Private Well Database

Illinois State Water Survey
Address / Phone Information

Records for **Putnam** county, **33N** township, **02W** range, **36** section.

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125160	7A	155	RG	DO	~~	~~	00118

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
S DEAN ALBRECHT	01/12/1968				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125923	1G	186	RG	DO	~~	~~	20286

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
S D ALBRECHT	08/18/1977				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125924	1H	155	RG	DO	~~	~~	00107

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
S DEAN ALBRECHT	1966				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125925	5E	35	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
	1874				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125926	6D	105	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
BICKERMAN	1898				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
125927	8E	85	RG	DO	~~	~~	

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
	1874				

Well ID	Plot	Depth	Record Type	Well Use	Well Type	Aquifer Type	ISGS No.
359954	4E	67	RGP	DO	DL	UN	20688

Driller	Date Drilled	Static Level	Pumping Level	Pumping GPM	Pumping Hours
LUTES H2O DRILLING/JET HALL	05/08/2003	19		50	2

View the results in "Table Format" Search for a different Section

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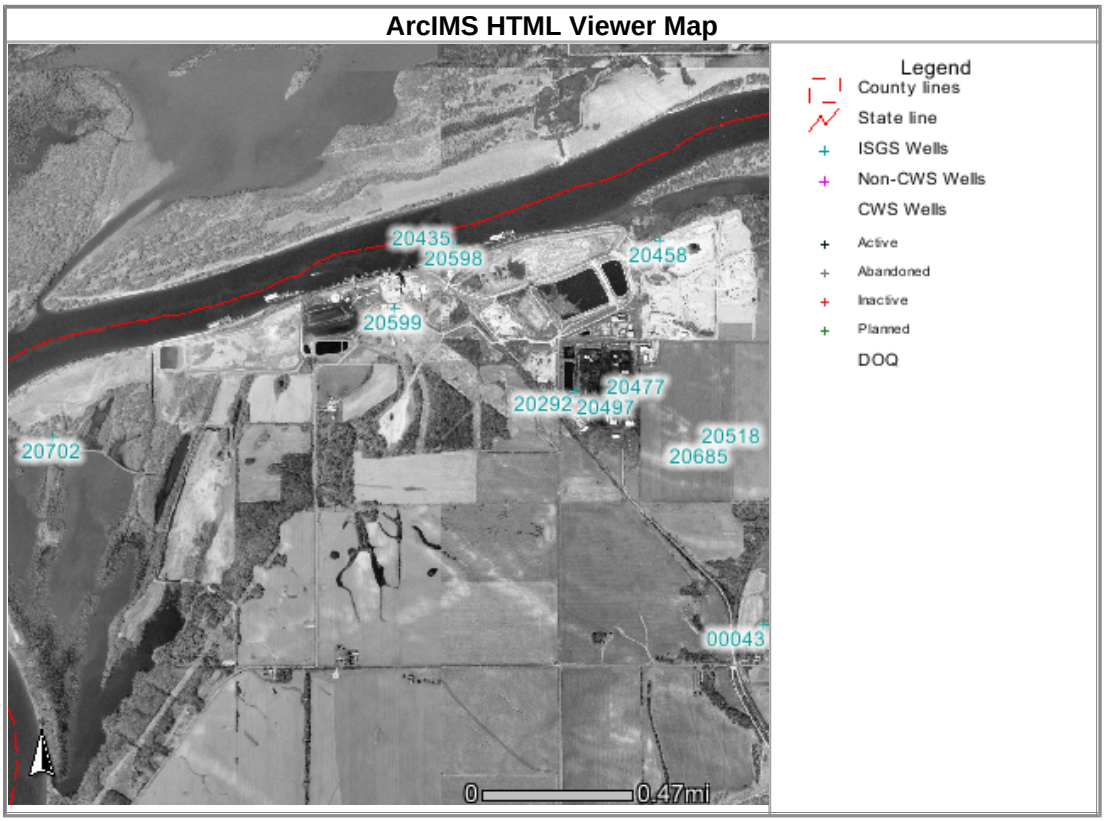
Please view our **Data Disclaimer**, Water Well Records Policies and Procedures, and **Plot Location System**

Column headings link to data explanations.

APPENDIX C

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
WEB-BASED GIS FILES

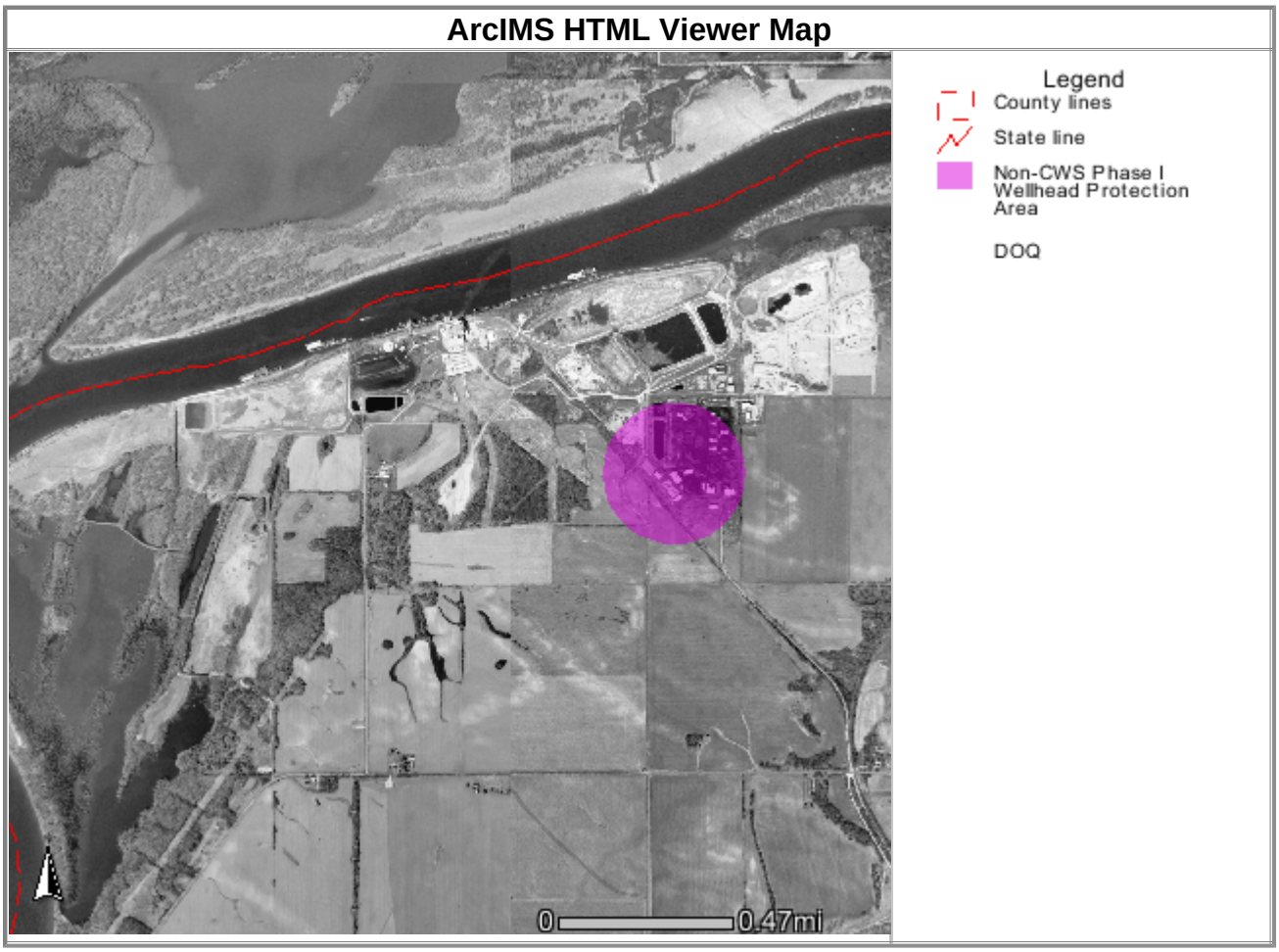
Information and data presented were obtained from various Federal, State, and local agencies and are subject to revision.



ISGS Wells

Rec	API_NUMBER	TOTAL_DEPT	FARM_NAME	ELEVATION	STATUS	LAM_X	LAM_Y	LATITUDE	LONGITUDE	COUNTY_NO
1	121552070200	83	Dynegy Midwest-Hennepin Power	0	WATER	3045102	3008480	41.296270	89.335096	20702

Information and data presented were obtained from various Federal, State, and local agencies and are subject to revision.



Non-CWS Phase I Wellhead Protection Area

Rec	area	perimeter	buff1000_	buff1000_i	inside
1	3125482.25000	6275.02881	1420	1419	100

Source Water Assessment Summary

0117408 - EXOLON ESK

Last Updated on 2/3/2006

Source of Groundwater
The Exolon Company water supply system consists of one well. The well draws its water supply from an unconfined aquifer, which consists of sand.

Source Water Quality
The well at the Exolon Company is sampled for bacteria, nitrate/nitrites and lead and copper. In addition the Exolon Company is also required to sample for inorganic compounds (IOC), volatile compounds (VOC), and synthetic compounds (SOC).

On review of the geological composition, land-use practices, and well construction it was found that the well is susceptible to VOC, SOC, IOC, nitrate/nitrites, and bacteria.

Construction/Treatment
The Exolon Company has a 12-inch drilled well with steel casing. The well has an estimated depth of 130 feet. The well has a turbine pump and a 1,000 pressurized storage tank. The well receives no treatment.

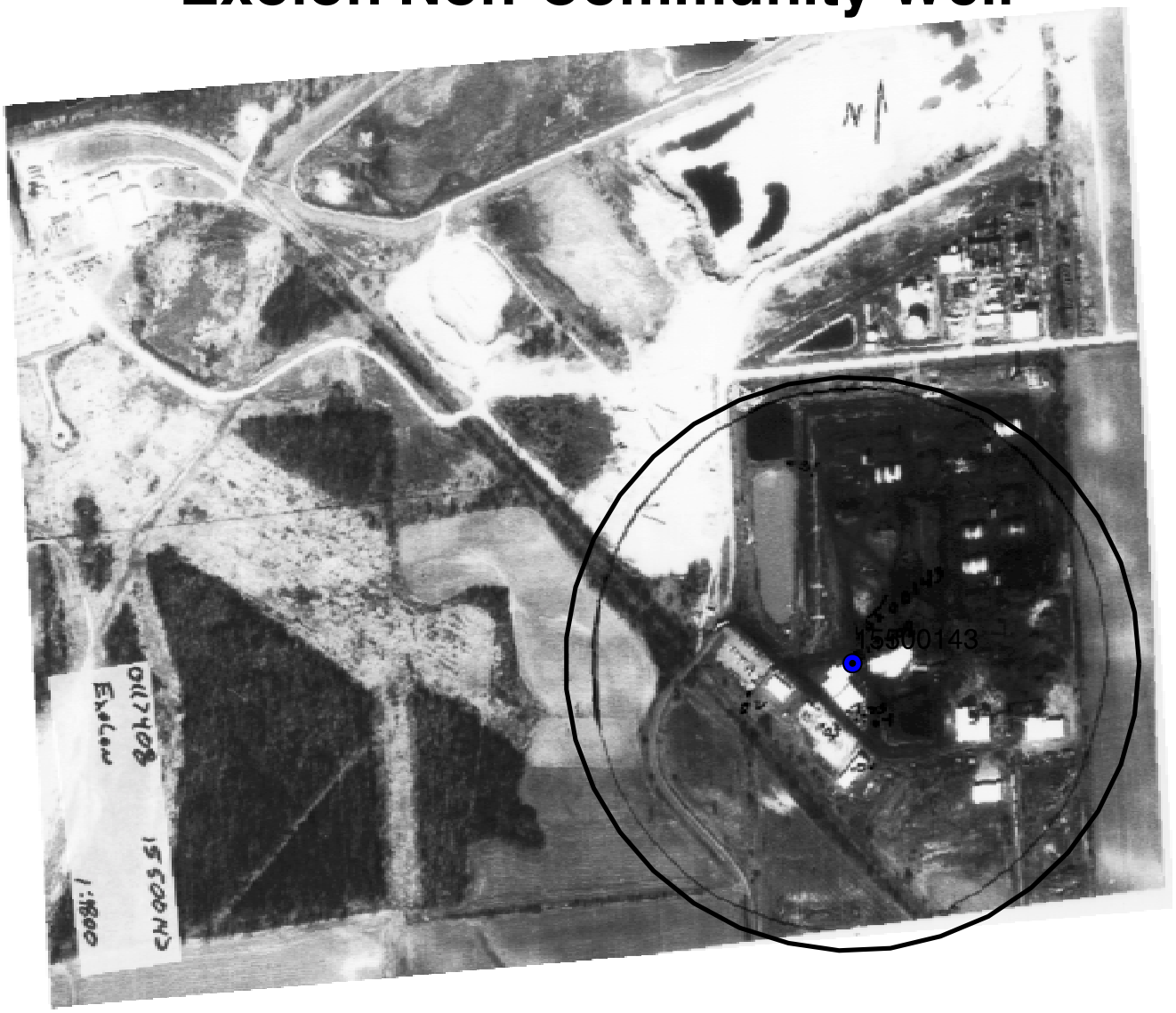
Finished Water Quality
A review of the Exolon Company water supply at this time shows that the system is in compliance with the groundwater quality standards established under 35 Illinois Administrative Code Part 620.

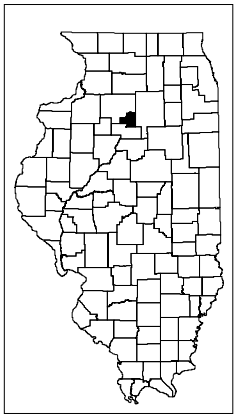
Potential Sources of Contamination
The following sites are listed as potential sources of contamination due to the nature of their activity and their geographic proximity (within a 1,000 foot buffer) to the source water protection area.

See Table on Topographic Map Coverage(Second Map)

Susceptibility to Contamination
The Illinois Department of Public Health has determined that the Exolon Company water supply has a high susceptibility to contamination. This determination is based on a number of criteria including: available geological data, land-use practices, and well depth.

Aerial Photograph Coverage
Exolon Non-Community Well





N

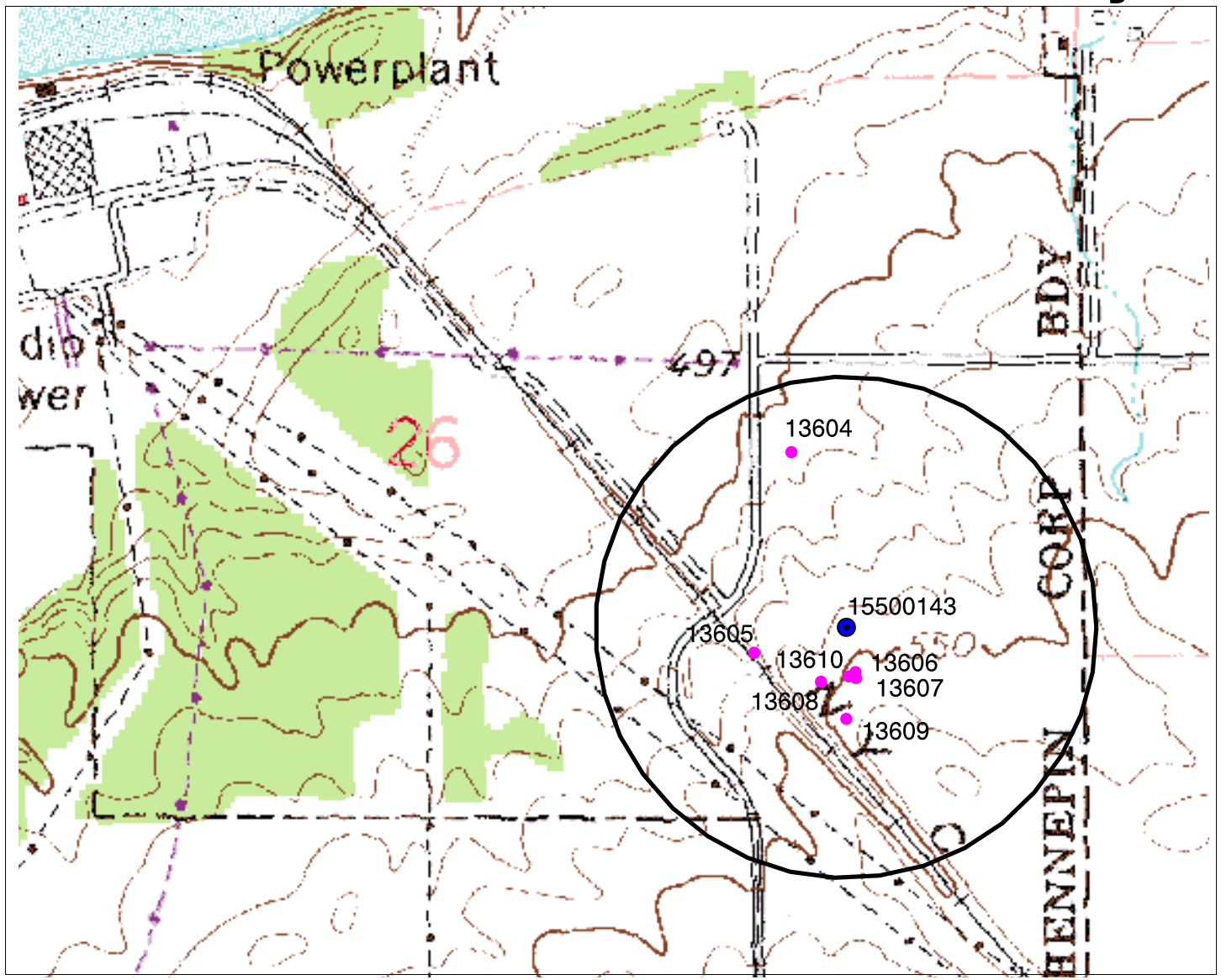
1000 0 1000 Feet

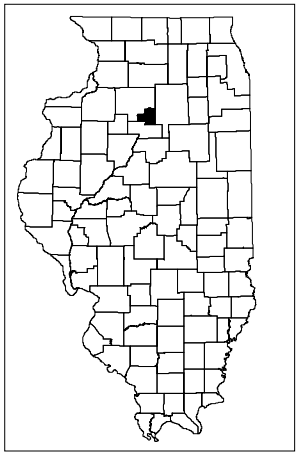
Non-Community Water Supply Wells

Illinois Environmental Protection Agency
Division of Public Water Supplies
Groundwater Section

Illinois Department of Public Health

Topographic Map Coverage
Exolon Non-Community Well





N

Potential_	Potential_	Source_id
Exolon	Lagoon on-site	13604
Exolon	Single Unit Septic	13605
Exolon	A.G. L.P. < 25000 gal.	13606
Exolon	A.G. Pet Stor < 25000 gal.	13607
Exolon	Electrical Generator/Subs	13608
Exolon	A.G. Pet Stor	13609
Exolon	B.G. Pet Stor > 500 gal	13610

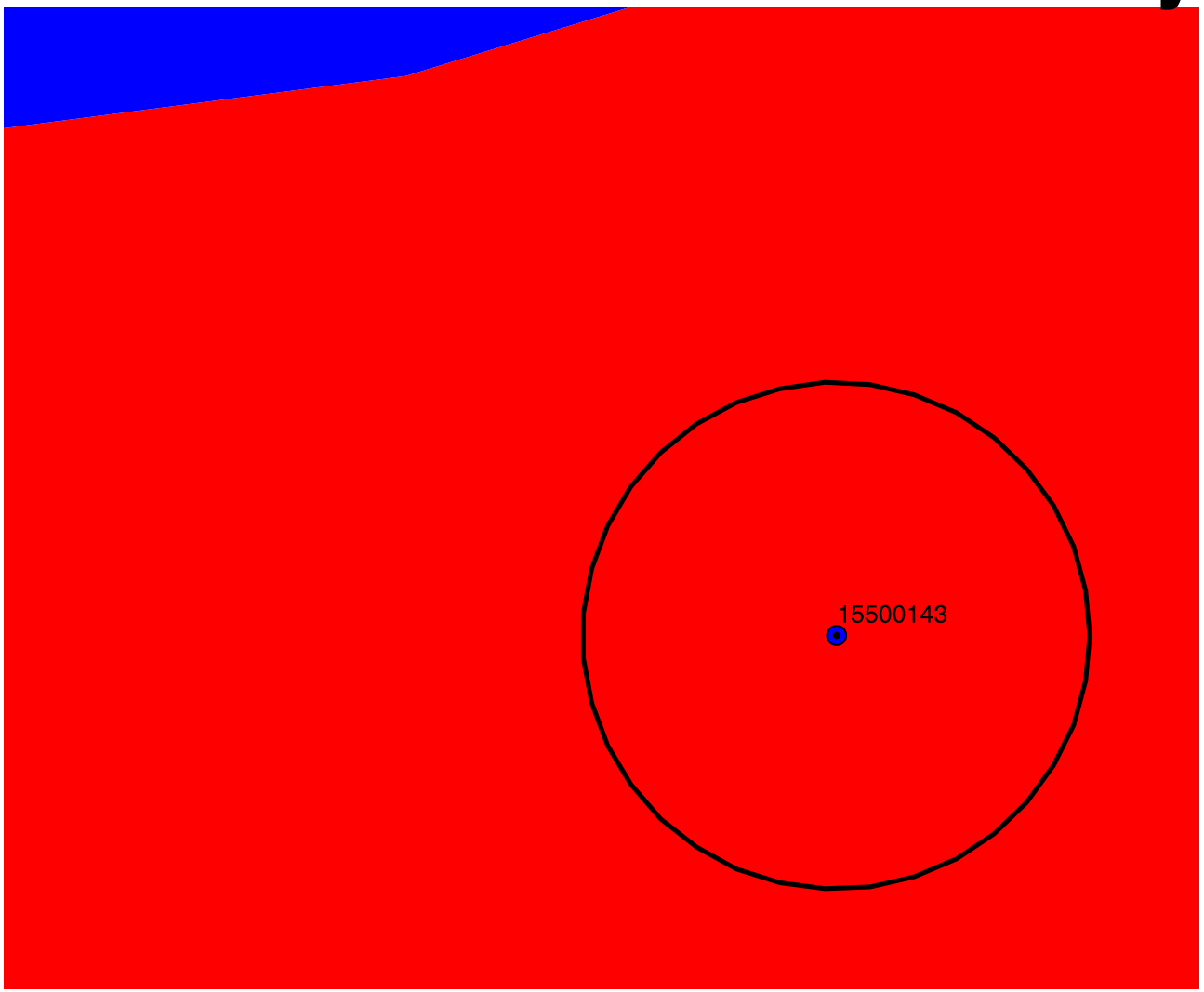
Non-Community Water Supply Wells
Potential Sources of Contamination

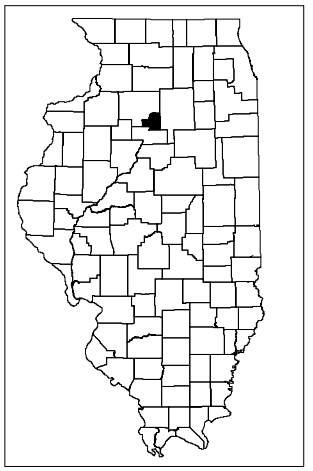
Illinois Environmental Protection Agency
Division of Public Water Supplies
Groundwater Section

Illinois Department of Public Health

1000 0 1000 2000 3000 4000 Feet

Nitrate Sensitivity
Exolon Non-Community Well





N

Disclaimer: This nitrate sensitivity data is being used at a scale smaller than at which it was digitized. This may make features look angular or rasterized, or may make them appear to be out of place. This map should be used as a general reference only, and a smaller scale assessment should be performed for further evaluation of this site.

Non-Community Water Supply Wells

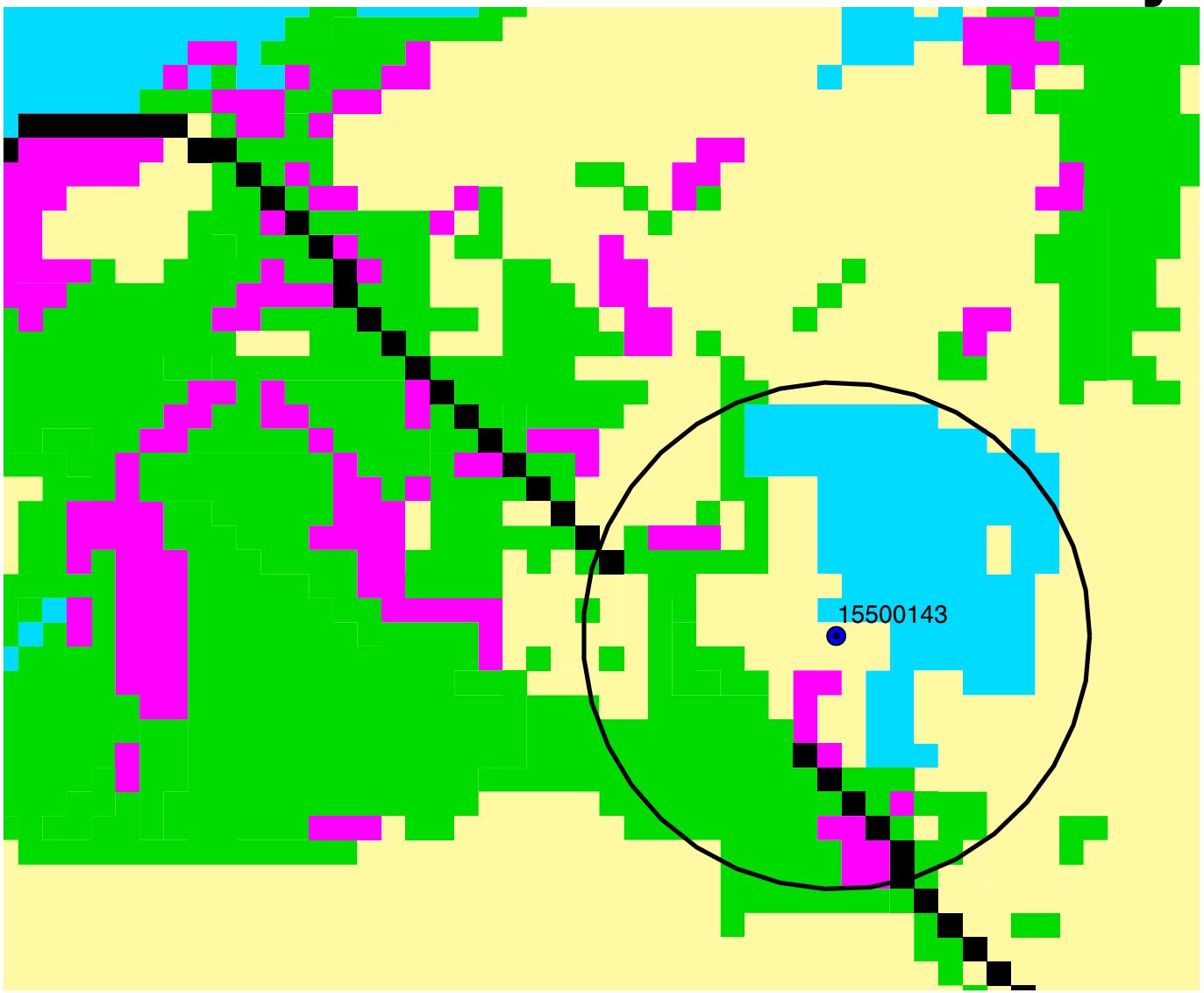
Nitrate Sensitivity
- Excessive
- High
- Moderate
- Somewhat Limited
- Limited
- Very Limited
- Disturbed Land
- Surface Water

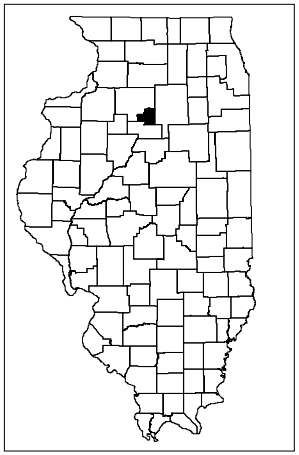
1000 0 1000 2000 3000 Feet

Illinois Environmental Protection Agency
Division of Public Water Supplies
Groundwater Section

Illinois Department of Public Health

Land Use/Land Cover
Exolon Non-Community Well





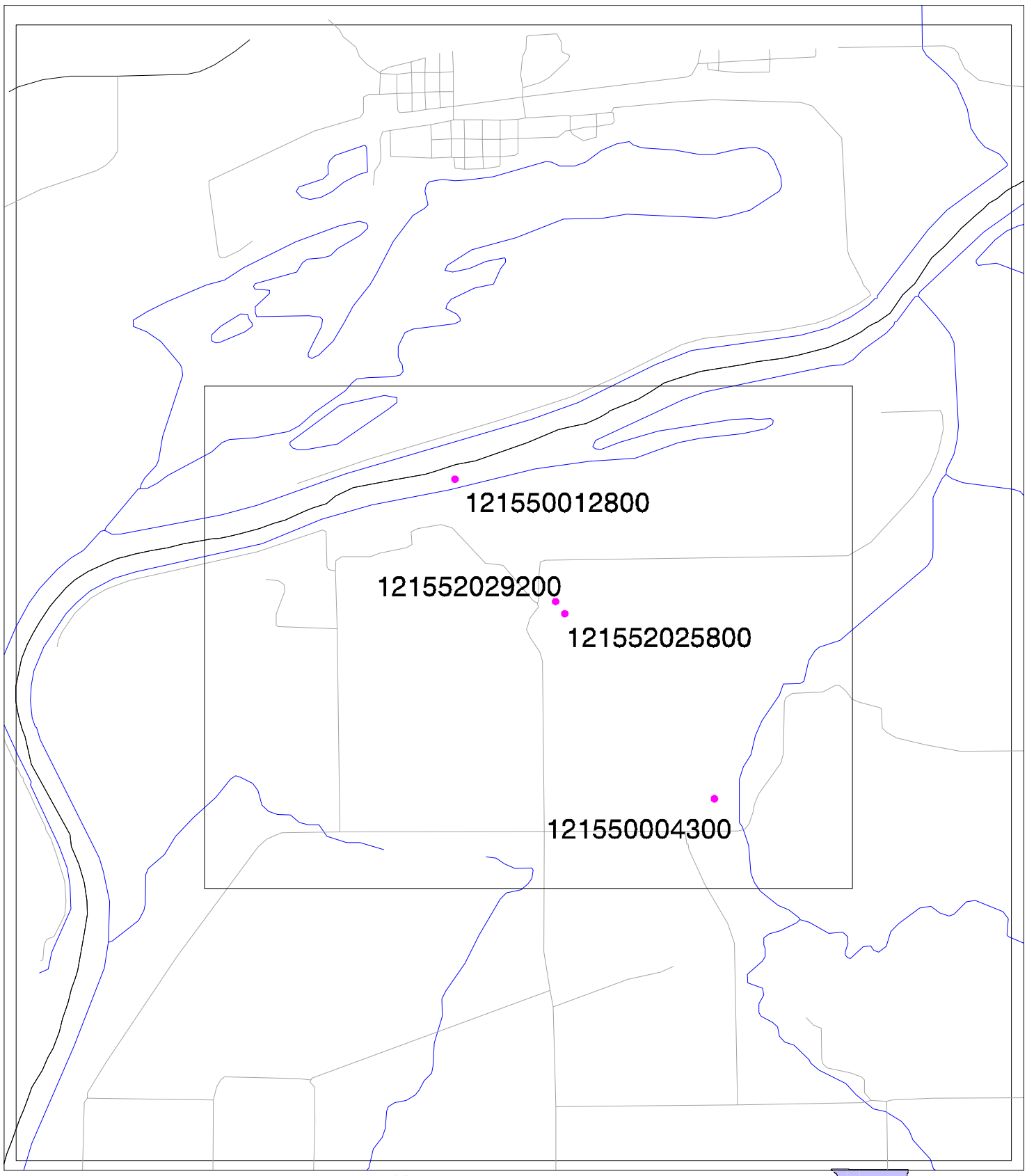
N

Non-Community Water Supply Wells
Land Use/Land Cover
Urban
Transportation
Agriculture
Forest/Grassland
Water/Wetland

1000 0 1000 2000 3000 Feet

Illinois Environmental Protection Agency
Division of Public Water Supplies
Groundwater Section

Illinois Department of Public Health



N

Scale
1:30011

Illinois Geographic-Lithologic Analysis Support System

I-GLASS

Illinois EPA
Division of Public Water Supplies
Groundwater Section

Illinois Department of Public Health

Use of this map is restricted to Illinois EPA Staff.
The IEPA is not liable for any misinterpretation of these data by non-IEPA staff.
This map contains information derived from tabular and spatial datasets obtained from the Illinois State Geological Survey, the Illinois State Water Survey, the Illinois Department of Natural Resources, and the United States Geological Survey.

Illinois Environmental Protection Agency

Source Water Assessment Program

FACT SHEET

DE PUE

BUREAU COUNTY

Prepared in cooperation with the U.S. Geological Survey.

Information and data used in the preparation of this Fact Sheet are provided by the Illinois EPA and are subject to revision.

IMPORTANCE OF SOURCE WATER:

The Village of DePue (Facility Number 0110300) has two public water supply wells. Wells #2 and #3 (IEPA #11336 and #11337) produce 176,300 gallons per day on average to an estimated population of 1729 through 710 service connections.

WATER SUPPLIES THAT OBTAIN SOURCE WATER FROM THIS FACILITY:

As of January 2001, no other facilities purchase water from this community water supply.

SOURCE OF WATER SUPPLY:

Wells #2 and #3 are located behind the waterworks on 2nd Street. Wells #2 and #3 pump 220 and 250 gallons per minute, respectively, and have a production capacity of 288,000 gallons per day. Wells #2 and #3 are 1487 and 1490 feet deep, respectively, and utilize a deep bedrock aquifer. The bedrock is overlain by permeable river deposits and impermeable bedrock. The aquifer utilized is considered confined by the Illinois EPA, therefore is not considered geologically sensitive.

WELL DATA FOR THIS FACILITY:

Well ID	Well Description	Status	Depth (Feet)	Min Setback (Feet)	Aquifer Description
11336	WELL 2	A	1487	200	DEEP BEDROCK
11337	WELL 3	A	1490	200	DEEP BEDROCK

SOURCE WATER QUALITY:

The public water supply wells at DePue were sampled as part of a Statewide Groundwater Monitoring Network on March 12, 1987. The well samples were analyzed for volatile organic compounds (VOC) and inorganic chemicals (IOC). The analyses detected no quantifiable levels of VOC in either well. The inorganic analyses performed found the water from both wells to meet all groundwater quality standards established in 35 Illinois Administrative Code Part 620.410.

FINISHED WATER QUALITY:

Finished water quality data tables of monitored parameters, contaminants detected, health advisory information, drinking water standards or maximum contaminant levels are available at http//www.epa.gov/ogwdw. Similar information is also available in the Consumer Confidence Report supplied by the water supply to its customers. A review of this information does not indicate levels of organic or inorganic compounds which exceed the drinking water quality standards. Radium and Alpha emitters were detected in radionuclide analyses done in 1999. Alpha emitters were detect at a level of 15 pCi/l and combined radium was detected at a level of 6.9 pCi/l, the maximum

contaminant levels (MCL) are 15 and 5 pCi/l respectively.

POTENTIAL SOURCES OF CONTAMINATION:

The site labeled on the Wellhead Protection Planning Map and described in the following table is considered a "potential" source of contamination. (Maps and tables are not available in the Visually Impaired version. However, the information presented in these maps and tables is summarized within the following text sections of this fact sheet.) The Illinois EPA performed a detailed well Site Survey in 1989 to identify potential sources of contamination to the village's wells. These sources are identified based on the nature of its activity, the availability of data in the electronic data bases, and its geographical proximity to the source water protection area. In addition, the Illinois EPA made use of its information from the its leaking underground storage tank database (http://epadata.epa.state.il.us/land/ust/search.asp) and site remediation program database (http://epadata.epa.state.il.us/land/srp/search.asp) to further assess potential sources of contamination to the community's source water. These databases include information from the Illinois EPA Division of Land Pollution Control (LPC) and the Illinois Emergency Management Agency (IEMA). The following list of facilities contained within these databases. As a result of multiple possible contamination sources, individual sites may be listed on the table more than once in relation to the wells.

IEMA #900361 - LPC #0110300003 - Mobil Chemical Company, Depot & Marquette Streets., Depue 61322

SITE DATA FOR THIS FACILITY:

Well ID	Map Code	Site Name	Site Description	Distance (Feet)
11336	02556	CASEY'S GENERAL STORE	BELOW GROUND STORAGE (PET	975
11337	02556	CASEY'S GENERAL STORE	BELOW GROUND STORAGE (PET	975

OTHER IDENTIFIED POTENTIAL SOURCES:

For this community water supply, no additional potential sources of contamination have been identified beyond those in Illinois EPA databases.

SUSCEPTIBILITY TO CONTAMINATION:

Based on information obtained in a Well Site Survey published in 1989 by the Illinois EPA, one "potential" source is located within 1,000 feet of the wells.

The Illinois EPA has determined that the Depue Community Water Supply's source water is not suspectibile to contamination. This determination is based on a number of including: monitoring conducted at the wells; monitoring conducted at the entry point to the distribution system; available hydrogeologic data on the wells; and land use proximite to the wells.

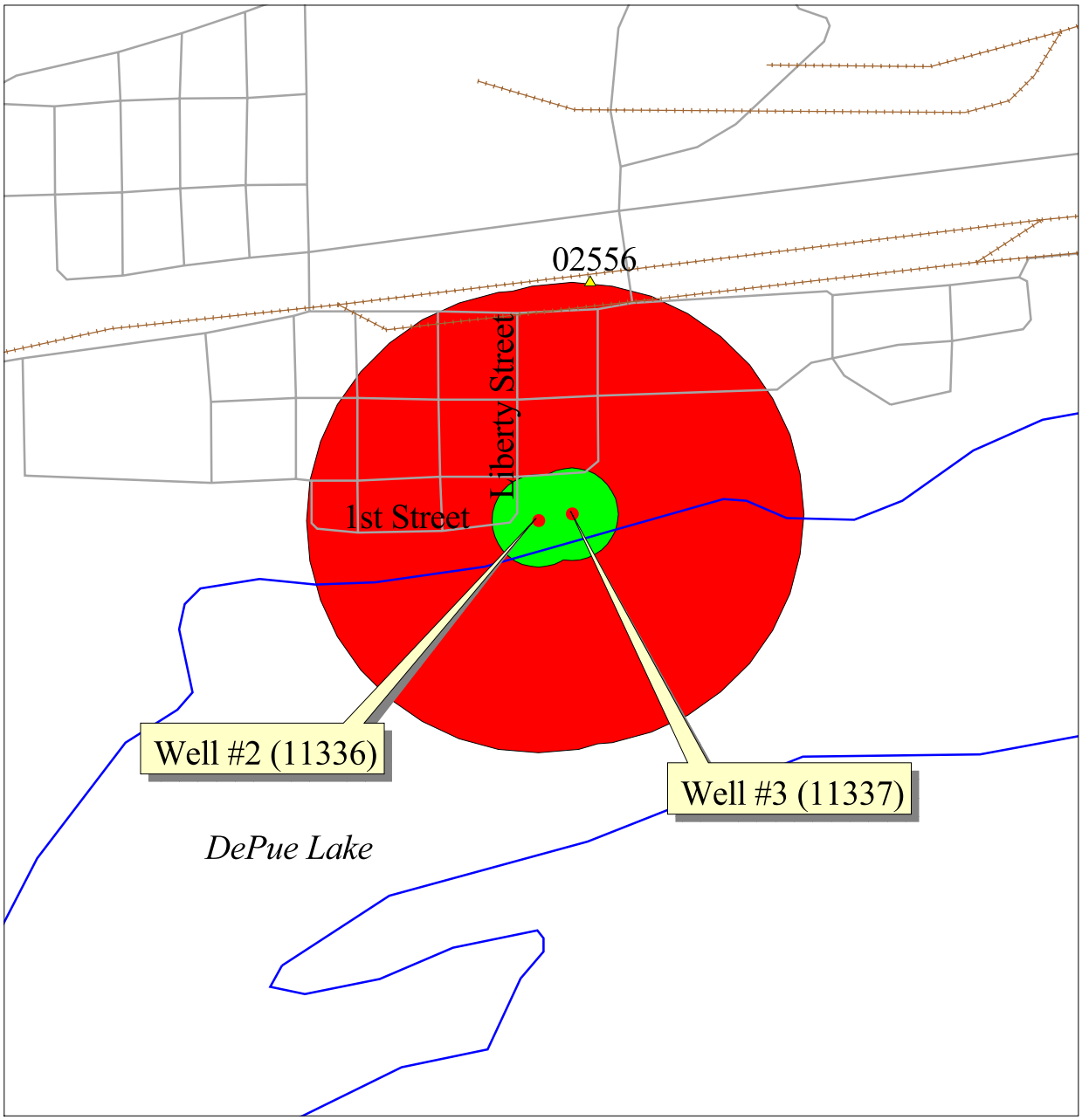
Furthermore, in anticipation of the U.S. EPA's proposed Ground Water Rule, the Illinois EPA has determined that the Depue Community Water Supply is not vulneraible to viral contamination. This determination is based upon the evaluation of the following criteria during the Vulnerability Waiver Process: the community's wells are properly constructed with sound integrity and proper siting conditions; a hydrogeologic barrier exists which should prevent pathogen movement; all potential routes and sanitary defects have been mitigated such that the source water is adequately protected; monitoring data did not indicate a history of disease outbreak; and the sanitary survey of the water supply did not indicate a viral contamination threat. Because the community's wells are constructed in a confined aquifer, which should prevent the movement of pathogens into the wells, well hydraulics was not considered to be a significant factor in the susceptibility determination.

SOURCE WATER PROTECTION EFFORTS:

The Ilinois Environmental Protection Act provides minimum protection zones of 200 feet for your wells. These minimum protection zones are regulated by the Illinois EPA. To further reduce the risk to source water, the water supply has implemented a wellhead protection program which includes the proper abandonment of potential routes of groundwater contamination and correction of sanitary defects at the water treatment facility. This effort resulted in the community water supply receiving a special exception permit from the Illinois EPA which allows a reduction in monitoring. The outcome of this monitoring reduction has saved the community considerable laboratory analysis costs.

To further minimize the risk to the community's groundwater supply, the Illinois EPA recommends that three additional activities be assessed. First, the facility may wish to enact a "maximum setback zone" ordinance. These ordinances are authorized by the Illinois Environmental Protection Act and allow county and municipal officials the opportunity to provide additional protection up to a fixed distance, normally 1,000 feet from their wells. Second, the water supply staff may wish to revisit their contingency planning documents. Contingency planning documents are a primary means to ensure that, through emergency preparedness, a community will minimize their risk of being without safe and adequate water. Finally, the water supply staff is encouraged to review their cross connection control program to ensure that it remains current and viable. Cross connections to either the water treatment plant (for example, at bulk water loading stations) or in the distribution system may negate all source water protection initatives provided by the community.

WELLHEAD PROTECTION PLANNING MAP
FOR DEPUE (FACILITY #0110300)



400 0 400 800 1200 Feet

Legend

- CWS Wells
- Potential Sources Of Contamination
- Rails
- Roads
- Streams
- Minimum Setback Zone
- Existing or Potential Maximum Setback Zone

FOR MORE INFORMATION CONTACT:

Groundwater Section, Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, IL 62794-9276
Ph# (217)785-4787

Source Information
Roads, Rails, and Streams from Illinois DNR.
CWS Wells and Potential Sources from Illinois EPA.
Map compiled by Groundwater Section, Illinois EPA.

Illinois Environmental Protection Agency

Source Water Assessment Program

FACT SHEET

HENNEPIN PWD

PUTNAM COUNTY

Prepared in cooperation with the U.S. Geological Survey.

Information and data used in the preparation of this Fact Sheet are provided by the Illinois EPA and are subject to revision.

IMPORTANCE OF SOURCE WATER:

The Village of Hennepin (Facility Number 1555100) obtains its water from three active community water supply wells. Wells #3, #4, and #5 (Illinois EPA #11602, 11603, and 11604, respectively) supply an average of 149,600 gallons per day (gpd) to 312 services or a population of 750.

WATER SUPPLIES THAT OBTAIN SOURCE WATER FROM THIS FACILITY:

No connected water supplies existed at the time this Source Water Assessment fact sheet was completed.

SOURCE OF WATER SUPPLY:

Wells #3 and #4 are located at the central and southern end of Hennepin, respectively, and well #5 is located north of Hennepin. They produce 250, 400, and 650 gallons per minute (gpm), respectively and are operated for a combined maximum output of roughly 341,900 gpd. Wells #3, #4, and #5 are 100, 107, and 135 feet in depth, respectively. All three wells obtain their source water from a shallow, permeable sand and gravel aquifer overlain by materials of variable permeability. Permeability is a measure of the capability of a soil or sediment to transmit fluids. The Illinois EPA considers these wells to be geologically sensitive.

WELL DATA FOR THIS FACILITY:

Well ID	Well Description	Status	Depth (Feet)	Min Setback (Feet)	Aquifer Description
11602	WELL 3	A	100	400	Sand & Gravel
11603	WELL 4	A	107	400	Sand & Gravel
11604	WELL 5	A	135	400	Sand & Gravel

SOURCE WATER QUALITY:

Hennepin's wells have been sampled since January 20, 1981 for inorganic chemicals (IOC), volatile organic compounds (VOC), and synthetic organic compounds (SOC) as part of a Statewide Groundwater Monitoring Program. The VOC and SOC analyses did not detect quantifiable levels of any organic compounds. IOC analyses indicate that concentrations of these chemicals are consistent with other sand and gravel aquifers of similar character in Illinois. It is important to note that the IOC results were below the groundwater quality standards established under 35 Illinois Administrative Code Part 620.410, with the exception of manganese concentrations. Manganese concentrations range from 15 to 339 parts per billion (ppb). The groundwater quality standard for manganese, as established under Part 620.410, is 150 ppb. However, the Illinois EPA considers the elevated level of manganese to be the result of natural mineralization of the aquifer. Hence, the level of manganese is not considered a violation due to the stipulation in Part 620.410 that no violation occurs as a result of a natural occurrence of an IOC.

FINISHED WATER QUALITY:

As referenced in the Source Water Quality Section of this report, Hennepin has mineralized groundwater. Sampling performed after treatment indicates that levels of manganese in the source water have been reduced to below the drinking water standards. Further information on finished water quality data tables of monitored parameters, contaminants detected, health advisory information, drinking water standards and maximum contaminant levels are available at http://www.epa.gov/ogwdw/. Similar information is also available in the Consumer Confidence Report supplied by the Village of Hennepin to their customers.

POTENTIAL SOURCES OF CONTAMINATION:

The sites labeled on the Wellhead Protection Planning Map and described in the following tables are considered "potential" sources of contamination. (Maps and tables are not available in the Visually Impaired Accessible version. However, the information presented in the maps and tables is summarized within the following text sections of this fact sheet.) These sites are predominantly identified through the Illinois EPA's Well Site Survey program based on the nature of their activity, the availability of data in electronic databases, and their geographic proximity to the source water protection area. In addition, the Illinois EPA made use of the information from its leaking underground storage tank database (http://epadata.epa.state.il.us/land/ust/search.asp) and site remediation program database (http://epadata.epa.state.il.us/land/srp/search.asp) to further assess potential sources of contamination to the village's source water. These databases include information from the Illinois EPA Division of Land Pollution Control (LPC) and the Illinois Emergency Management Agency (IEMA). The following is a list of facilities contained within these databases. As a result of multiple possible contamination sources, individual sites may be listed in the table more than once in relation to a well.

IEMA # Site Name Street City ZIP Code
902789 Illinois Power Co. Power Station, 2 miles north of Hennepin 61327
921595 Putnam County C.U.S.D. #535 South 5th St., Elemetary School Hennepin 61327
923676 Illinois Power Co. Power Plant Rd. Hennepin 61327

SITE DATA FOR THIS FACILITY:

Well ID	Map Code	Site Name	Site Description	Distance (Feet)
11602	23251	PUTNAM COUNTY SHERIFF'S OF	ABOVE GROUND STORAGE (PET	350
11602	23250	JUDD CONSTRUCTION COMPAN	ABOVE GROUND STORAGE (PET	1800
11602	23252	HENNEPIN MARINE	BOAT YARD	800
11602	23253	HENNEPIN HARDWARE	STORE/SALES	900
11602	23254	HENNEPIN BOAT MARKET	ABOVE GROUND STORAGE (PET	750
11603	23250	JUDD CONSTRUCTION COMPAN	ABOVE GROUND STORAGE (PET	1300
11603	23254	HENNEPIN BOAT MARKET	ABOVE GROUND STORAGE (PET	1650
11603	23251	PUTNAM COUNTY SHERIFF'S OF	ABOVE GROUND STORAGE (PET	800
11603	23252	HENNEPIN MARINE	BOAT YARD	1450
11603	23253	HENNEPIN HARDWARE	STORE/SALES	1750
11604	23255	MODERN HARD CHROME	MANUFACTURING PROCESS (e.g.	500
11604	23256	AIR PRODUCTS	CHEMICAL HANDLING (i.e. MANU	1400
11604	23249	INTERNATIONAL STEEL GROUP	WATER TREATMENT PLANT	1600
11604	23248	INTERNATIONAL STEEL GROUP	INJECTION WELL (ROUTE)	1200
11604	23247	INTERNATIONAL STREEL GROU	SLUDGE DISPOSAL ON-SITE	650
11604	01434	LTV STEEL CO	SLUDGE DISPOSAL ON-SITE	650
11604	01435	LTV STEEL CO	INJECTION WELL (ROUTE)	1200
11604	22477	LTV STEEL WWTP	WATER TREATMENT PLANT	1600

OTHER IDENTIFIED POTENTIAL SOURCES:

For this community water supply, no additional potential sources of contamination have been identified beyond those in Illinois EPA databases.

SUSCEPTIBILITY TO CONTAMINATION:

To determine Hennepin's susceptibility to groundwater contamination, the Illinois Rural Water Association conducted a well site survey in October, 2002. Based on the information obtained in this document, there are 13

potential sources of groundwater contamination that could pose a hazard to groundwater utilized by Hennepin's community water supply. These include 1 chemical handling facility, 1 manufacturing process, 1 boat yard, 1 sales store, 2 onsite sludge disposals, 2 injection wells, 2 water treatment plants, and 3 above ground fuel storage tanks. In addition, information provided by the Leaking Underground Storage Tank and Remedial Project Management Sections of the Illinois EPA indicated sites with on-going remediation that might be of concern.

According to the Hennepin PWD facility, LTV Steel Co. and the associated injection well and water treatment plant have been sold to the International Steel Group. However, the sludge disposal associated with this site is no longer active.

Based upon this information, the Illinois EPA has determined that the Hennepin Community Water Supply's source water is susceptible to contamination. As such, the Illinois EPA has provided 5-year recharge area calculations for the wells. The land use within the recharge areas of the wells was analyzed as part of this susceptibility determination. This land use includes residential, commercial and agricultural properties.

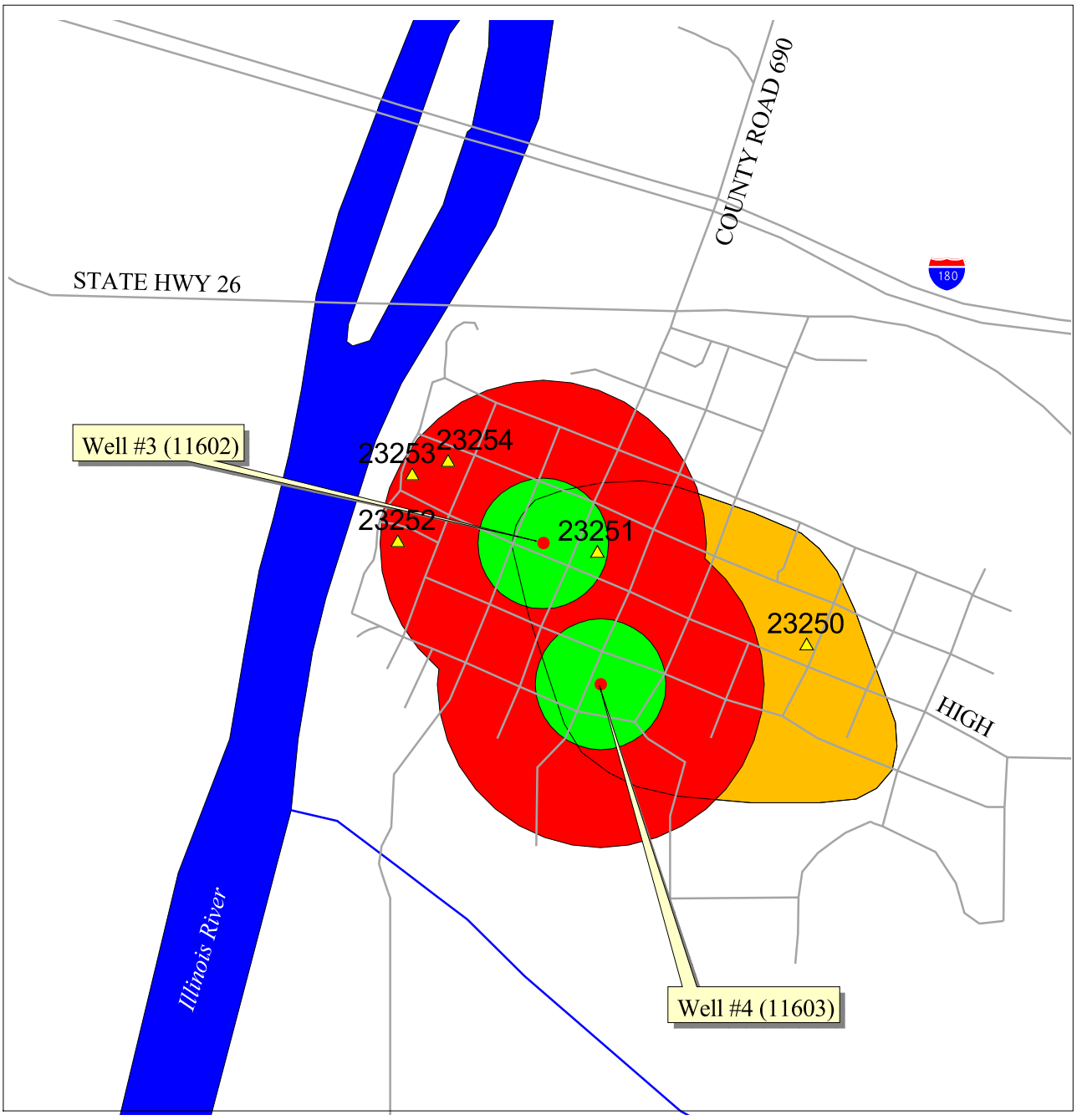
SOURCE WATER PROTECTION EFFORTS:

The Illinois Environmental Protection Act provides minimum protection zones of 400 feet for Hennepin's wells. These minimum protection zones are regulated by the Illinois EPA. To further reduce the risk to the source water, a maximum protection zone may be established, which is authorized by the Illinois Environmental Protection Act and allows county and municipal officials the opportunity to provide additional potential source prohibitions up to 1,000 feet from their wells.

To further minimize the risk to the village's groundwater supply, the Illinois EPA recommends the following additional activities be considered. First, the water supply staff may wish to conduct contingency planning. Contingency planning documents are a primary means to ensure that, through emergency preparedness, a community will minimize their risk of being without safe or adequate water. Second, the water supply staff is encouraged to conduct a biennial cross connection survey of the distribution system as outlined in the cross connection control ordinance [Section 18 of the Environmental Protection Act 415 ILCS 5/1 et seq. (Act); 35 Illinois Act Code, Sections 607.104d, 653.801c] and to review their cross connection control ordinance to ensure that it remains current and viable. Cross connections to either the water treatment plant (for example, at bulk water loading stations) or in the distribution system may negate all source water protection initiatives. Finally, the Illinois EPA recommends that the village investigate additional source water protection management options to address the land use activities within the wells' recharge area. Specifically, these management options should address potential impacts from non-point sources related to agricultural land uses.

To further reduce the risk to source water, Hennepin may wish to implement a wellhead protection program, which includes the proper abandonment of potential routes of groundwater contamination within the recharge area, management of potential sources of contamination and correction of any sanitary defects that might be present at the water treatment facility. This effort may result in the community water supply receiving a special exception permit from the Illinois EPA, which allows a reduction in monitoring and laboratory analysis costs.

FIGURE 1: WELLHEAD PROTECTION PLANNING MAP FOR HENNEPIN (FACILITY #1555100)



Legend

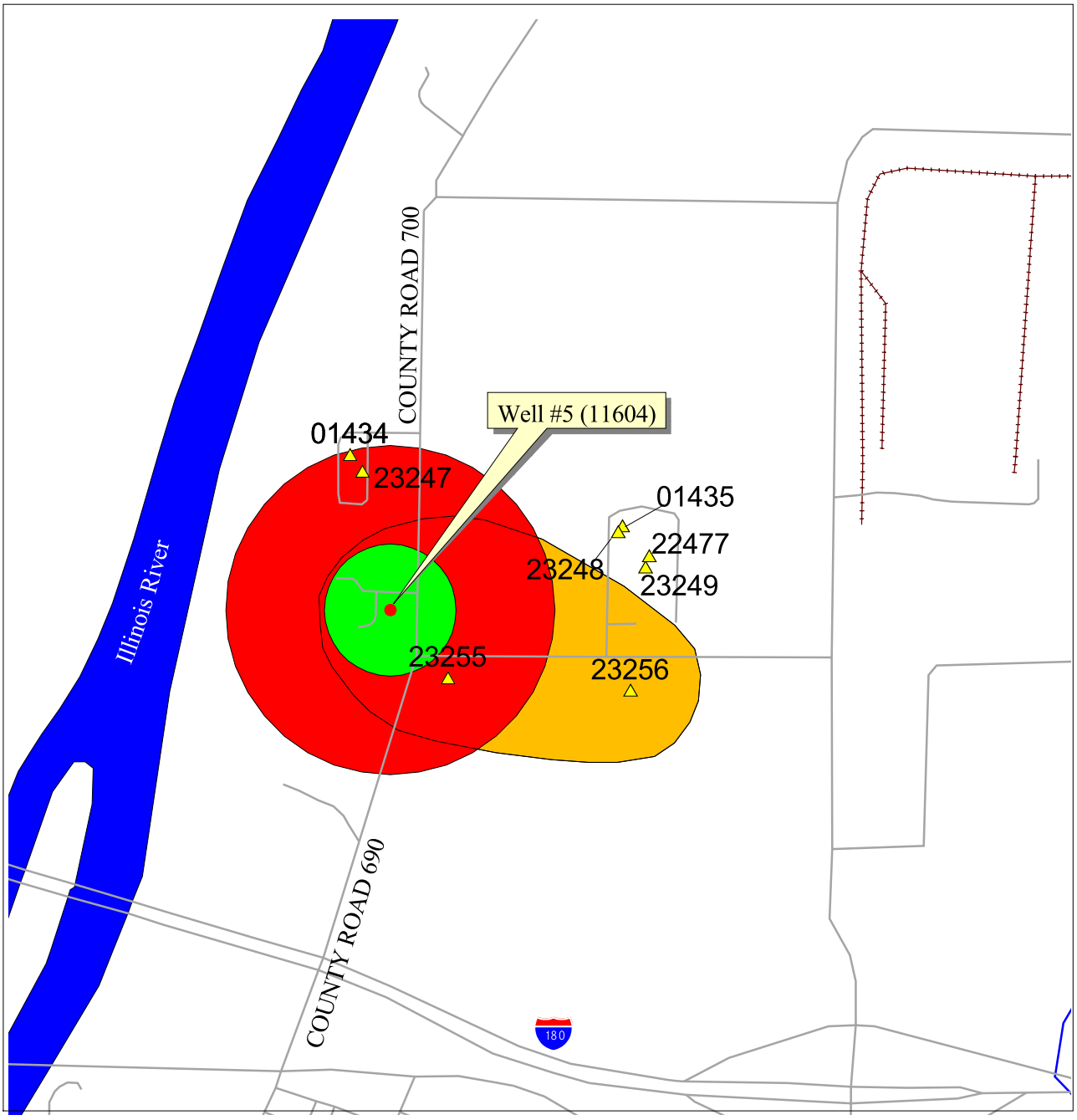
- CWS Wells
- Potential Sources Of Contamination
- Rails
- Roads
- Streams
- Minimum Setback Zone
- Existing or Potential Maximum Setback Zone
- Recharge Area

FOR MORE INFORMATION CONTACT:

Groundwater Section, Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, IL 62794-9276
Ph# (217)785-4787

Source Information
Roads, Rails, and Streams from Illinois DNR.
CWS Wells and Potential Sources from Illinois EPA.
Map compiled by Groundwater Section, Illinois EPA.

FIGURE 2: WELLHEAD PROTECTION PLANNING MAP FOR HENNEPIN (FACILITY #1555100)



Legend

- CWS Wells
- Potential Sources Of Contamination
- Rails
- Roads
- Streams
- Minimum Setback Zone
- Existing or Potential Maximum Setback Zone
- Recharge Area

FOR MORE INFORMATION CONTACT:

Groundwater Section, Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, IL 62794-9276
Ph# (217)785-4787

Source Information
Roads, Rails, and Streams from Illinois DNR.
CWS Wells and Potential Sources from Illinois EPA.
Map compiled by Groundwater Section, Illinois EPA.

Illinois Environmental Protection Agency

Source Water Assessment Program

FACT SHEET

BUREAU JUNCTION

BUREAU COUNTY

Prepared in cooperation with the U.S. Geological Survey.

Information and data used in the preparation of this Fact Sheet are provided by the Illinois EPA and are subject to revision.

IMPORTANCE OF SOURCE WATER:

The Village of Bureau Junction (Facility Number 0110150) has two public water supply wells. Wells #4 (Illinois EPA #11327) and #5 (Illinois EPA #00729) produce 32,088 gallons per day on average to an estimated population of 340 through 131 service connections.

WATER SUPPLIES THAT OBTAIN SOURCE WATER FROM THIS FACILITY:

No connected water supplies existed at the time this Source Water Assessment fact sheet was completed.

SOURCE OF WATER SUPPLY:

Well #4 is located on Kansas Street between Miller and North Streets. Well #5 is located 300 feet northeast of Well #4. The water from both wells is blended and treated before distribution. Wells #4 and #5 pump 50 and 190 gallons per minute, respectively and the facility has a production capacity of 345,600 gallons per day. Well #4 is 334 feet deep and utilizes a shallow bedrock aquifer and Well #5 is 1,545 feet deep and utilizes a deep bedrock aquifer which are overlain by permeable alluvial deposits and bedrock formations of variable permeability. Permeability is the ability of a soil or sediment to transmit fluids. Permeability is a measure of the ability of a soil or sediment to transmit fluids. Both aquifers utilized are considered confined by the Illinois EPA, therefore are not considered geologically sensitive.

WELL DATA FOR THIS FACILITY:

Well ID	Well Description	Status	Depth (Feet)	Min Setback (Feet)	Aquifer Description
00729	WELL 5	A	1545	200	Cambrian/Ordovician
11326	WELL 2	B	305	400	Devonian/Silurian
11327	WELL 4	A	334	200	Devonian/Silurian

SOURCE WATER QUALITY:

The Well #4 at Bureau Junction has been sampled regularly as part of a Statewide Ambient Groundwater Monitoring Program since March 1, 1994. Well #5 was sampled in 1997. The samples were analyzed for volatile organic compounds (VOC) and inorganic chemicals (IOC). Well #4 has been sampled for synthetic organic chemical and pesticides (SOC). The VOC analyses detected no contaminants. The IOC analyses have indicated a elevated level of chlorides, which is naturally occurring. The IOC results show levels up to 796 part per billion (ppb) in Well #4, and 201 in Well #5, which is above the groundwater standard of 200 ppb. At this time there is no drinking water standard for chlorides established in 35 Illinois Administrative Code Part 620.410. The Illinois EPA considers these chlorides concentrations the result of natural mineralization in the aquifer.

FINISHED WATER QUALITY:

Further information on finished water quality, including data tables of monitored parameters, contaminants detected, health advisory information, drinking water standards and maximum contaminant levels is available at http//www.epa.gov/ogwdw. Similar information is also available in the Consumer Confidence Report supplied by the water supply to its customers. A review of this information does not indicate levels of organic compounds or inorganic chemicals which exceed the drinking water quality standards. Radium were detected in radio nuclide analyses done in 1999. Alpha emitters were detected at a levels ranging from 20 to 23 picoCuries per liter (pCi/l), the maximum contaminant levels (MCL) for combined Alpha emitters is 15 pCi/l. Combined radium was detected at a levels ranging from 4.7 to 8.8 picoCuries per liter (pCi/l), the maximum contaminant levels (MCL) for combined Radium is 5 pCi/l.

POTENTIAL SOURCES OF CONTAMINATION:

The sites labeled on the Wellhead Protection Planning Map and described in the following tables are considered "potential" sources of contamination. (Maps and tables are not available in the Visually Impaired Accessible version. However, the information presented in the maps and tables is summarized within the following text sections of this fact sheet.) The Illinois EPA performed a detailed Well Site Survey in 1994 to identify potential sources of contamination to the water supply's wells. These sources are identified based on the nature of their activity, the availability of data in electronic databases, and their geographic proximity to the source water protection area. In addition, the Illinois EPA made use of information from its leaking underground storage tank database (http://epadata.epa.state.il.us/land/ust/search.asp) and site remediation program database (http://epadata.epa.state.il.us/land/srp/search.asp) to further assess potential sources of contamination to the water supply's source water. These databases include information from the Illinois EPA Division of Land Pollution Control (LPC) and the Illinois Emergency Management Agency (IEMA). The following is a list of facilities contained within these databases. As a result of multiple possible contamination sources, individual sites may be listed in the table more than once in relation to a well.

IEMA # LPC # Site Name Address City ZIP Code
920807 0118995005 Bureau, Village of 101 East Nebraska St. Bureau 61315
992314 0118995011 Bureau Service Co. 107 North Main Bureau 61315

SITE DATA FOR THIS FACILITY:

Well ID	Map Code	Site Name	Site Description	Distance (Feet)
00729	02912	BILL'S GAS & GENERAL STORE	BELOW GROUND STORAGE (PET	650
00729	02913	VILLAGE OF BUREAU VILLAGE H	BELOW GROUND STORAGE (PET	550
00729	02914	UNKNOWN ABANDONED GAS ST	BELOW GROUND STORAGE (PET	750
11327	02913	VILLAGE OF BUREAU VILLAGE H	BELOW GROUND STORAGE (PET	700
11327	02914	UNKNOWN ABANDONED GAS ST	BELOW GROUND STORAGE (PET	850
11327	02912	BILL'S GAS & GENERAL STORE	BELOW GROUND STORAGE (PET	600

OTHER IDENTIFIED POTENTIAL SOURCES:

For this community water supply, no additional potential sources of contamination have been identified beyond those in Illinois EPA databases.

SUSCEPTIBILITY TO CONTAMINATION:

Based on information obtained in a Well Site Survey published in 1994 by the Illinois EPA, several potential secondary sources are located within 1,000 feet of the wells.

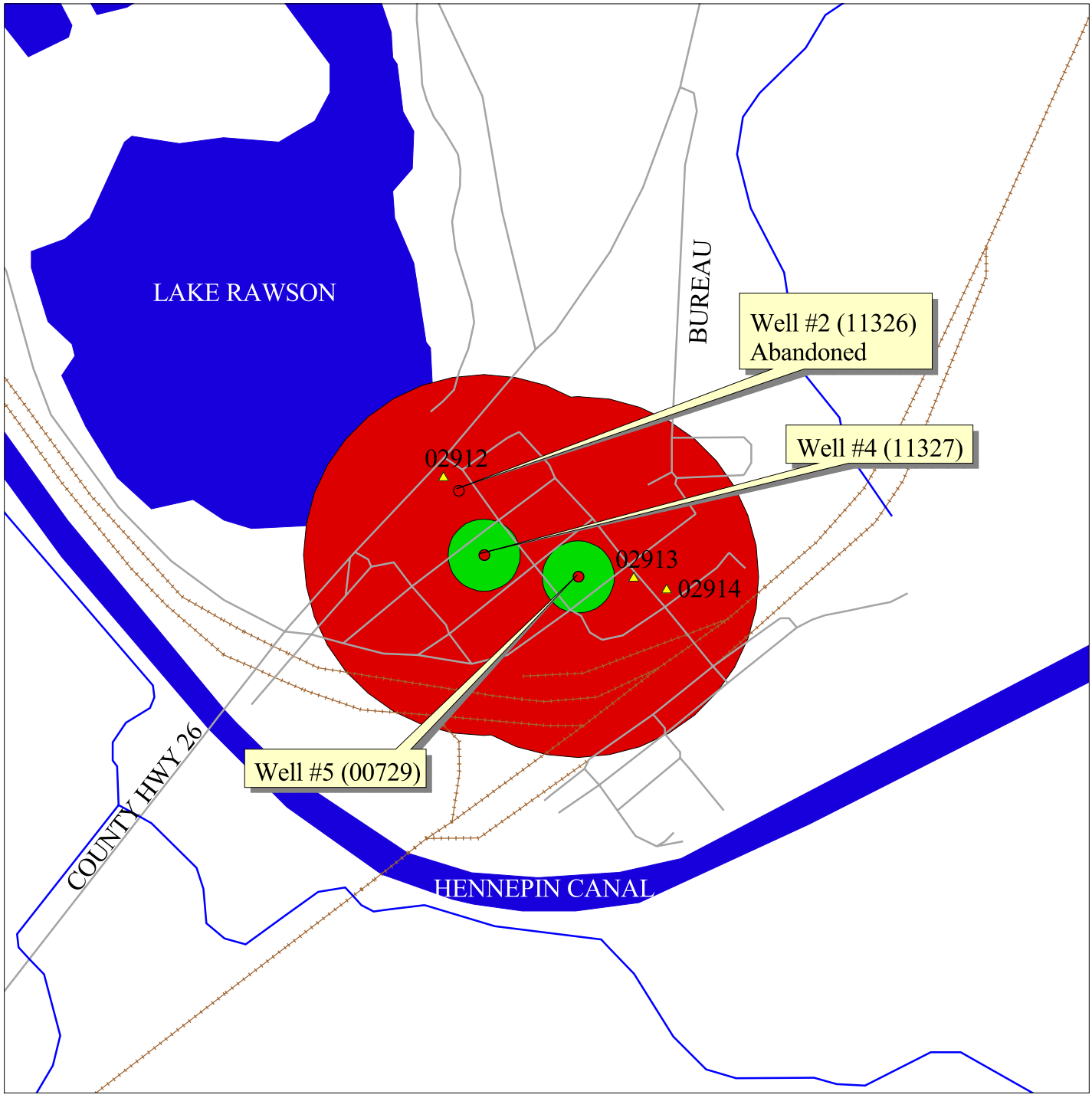
The Illinois EPA has determined that the Bureau Junction Community Water Supply's source water is not susceptible to contamination. This determination is based on a number of criteria including; monitoring conducted at the wells; monitoring conducted at the entry point to the distribution system; and available hydro geologic data on the wells.

SOURCE WATER PROTECTION EFFORTS:

The Illinois Environmental Protection Act provides minimum protection zones of 200 feet for Wells #4 and #5. These minimum protection zones are regulated by the Illinois EPA.

To further minimize the risk to the facility's groundwater supply, the Illinois EPA recommends that three additional activities be assessed. First, the water supply may wish to work with village officials to enact a "maximum setback zone" ordinance. These ordinances are authorized by the Illinois Environmental Protection Act and allow county and municipal officials the opportunity to provide additional protection up to a fixed distance, normally 1,000 feet from their wells. Second, the water supply staff may wish to revisit their contingency planning documents. Contingency planning documents are a primary means to ensure that, through emergency preparedness, a community will minimize their risk of being without safe and adequate water. Finally, the water supply staff is encouraged to review their cross connection control program to ensure that it remains current and viable. Cross connections to either the water treatment plant (for example, at bulk water loading stations) or in the distribution system may negate all source water protection initiatives provided by the community..

FIGURE 1: WELLHEAD PROTECTION PLANNING MAP FOR BUREAU JUNCTION (FACILITY #0110150)



500 0 500 1000 1500 2000 Feet

Legend

- CWS Wells
- Potential Sources Of Contamination
- Rails
- Roads
- Streams
- Minimum Setback Zone
- Existing or Potential Maximum Setback Zone
- Recharge Area

FOR MORE INFORMATION CONTACT:

Groundwater Section, Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, IL 62794-9276
Ph# (217)785-4787

Source Information
Roads, Rails, and Streams from Illinois DNR.
CWS Wells and Potential Sources from Illinois EPA.
Map compiled by Groundwater Section, Illinois EPA.

Illinois Environmental Protection Agency

Source Water Assessment Program

FACT SHEET

GRANVILLE

PUTNAM COUNTY

Prepared in cooperation with the U.S. Geological Survey.

Information and data used in the preparation of this Fact Sheet are provided by the Illinois EPA and are subject to revision.

IMPORTANCE OF SOURCE WATER:

The Viallage of Granville (Facility #1550050) has two public water supply wells. Well #1 (IEPA #11590) and Well #2 (IEPA #11591) produce 186,500 gallons per day to an estimated population of 1,402 through 644 service connections. The facility provides water to the Village of Mark and Oak Park Estates MHP.

WATER SUPPLIES THAT OBTAIN SOURCE WATER FROM THIS FACILITY:

Facility Number	Facility Name	Status	Population
1550010	OAK PARK ESTATES	A	150
1550250	MARK	A	500

SOURCE OF WATER SUPPLY:

Well #1 is located at the village garage at the southeast corner of Main and High Streets. Well #2 is located on the south of the intersection of Tomlinson and Colby Streets. Wells #1 and #2 pump 135 and 170 gallons per minute and have a production capacity of 439,200 gallons per day. The wells are 1,742 and 1,782 feet deep and utilize deep bedrock aquifer, which are overlain by relatively impermeable till interbedded within sand and gravel. Permeability is the ability of a soil or sediment to transmit fluids. The aquifer utilized is considered confined by the Illinois EPA, therefore is not considered geologically sensitive.

WELL DATA FOR THIS FACILITY:

Well ID	Well Description	Status	Depth (Feet)	Min Setback (Feet)	Aquifer Description
11590	WELL NO 1 IN CITY GARAGE	A	1742	200	DEEP BEDROCK
11591	WELL NO 2	A	1782	200	DEEP BEDROCK

SOURCE WATER QUALITY:

The public water supply wells at Granville were sampled as part of the Statewide Groundwater Monitoring Network on June 9, 1987. The well samples were analyzed for volatile organic compounds (VOC) and inorganic chemicals (IOC). The VOC analyses performed detected no quantifiable levels of organic chemicals in either well. The IOC analyses performed found the water from both wells to have an elevated level of total chlorides, which is naturally occurring. Total Chloride was detected at a level of 304 and 308 parts per billion (ppb), in Wells #1 and #2, respectively which is above the Groundwater Quality Standards of 200 ppb for chloride established in 35 Illinois Administrative Code Part 620.410.

FINISHED WATER QUALITY:

Finished water quality data tables of monitored parameters, contaminants detected, health advisory information,

drinking water standards or maximum contaminant levels are available at http//www.epa.gov/ogwdw. Similar information is also available in the Consumer Confidence Report supplied by the water supply to its customers. A review of this information does not indicate levels of organic or inorganic compounds which exceed the drinking water quality standards. Radium and Alpha emitters were detected in radionuclide analyses done in 1999. Alpha emitters were detect at a level of 39 picoCuries per liter (pCi/l) and combined radium was detected at a level of 12.2 pCi/l, the maximum contaminant levels (MCL) are 15 and 5 pCi/l respectively.

POTENTIAL SOURCES OF CONTAMINATION:

The sites labeled on the Wellhead Protection Planning Map and described in the following tables are considered "potential" sources of contamination. (Maps and tables are not available in the Visually Impaired Accessible version. However, the information presented in the maps and tables is summarized within the following text sections of this fact sheet.) The Illinois EPA performed a detailed Well Site Survey in 1992 to identify potential sources of contamination to the community's wells. These sources are identified based on the nature of their activity, the availability of data in electronic databases, and their geographic proximity to the source water protection area. In addition, the Illinois EPA made use of information from its leaking underground storage tank database (http://epadata.epa.state.il.us/land/ust/search.asp) and site remediation program database (http://epadata.epa.state.il.us/land/srp/search.asp) to further assess potential sources of contamination to the community's source water. These databases include information from the Illinois EPA Division of Land Pollution Control (LPC) and the Illinois Emergency Management Agency (IEMA). The following is a list of facilities contained within these databases. As a result of multiple possible contamination sources, individual sites may be listed in the table more than once in relation to a well.

IEMA # - LPC # - Site Name Address City ZIP Code
20002181 - 1550055009 - Maupin Trucking & Excavating Rt. 71 Granville 61326
901786 - 1550050001 - Salsman, Coy 102 McCoy St. Granville 61326
921597 - 1550055002 - Putnam County C.U.S.D. #535 400 East Silverspoon St. Granville 61326
930911 - 1550050001 - Salsman, Coy 101 South McCoy St. Granville 61326
932022 - 1550055003 - Petro-Line Rt. 89, R.R. 1, Box 36 Granville 61326
941345 - 1550055001 - Mid-American Growers Inc. R.R. 1, Rt. 89 Granville 61326
972212 - 1550055007 - Toedter Oil Co. RFD Rt. 89 1 1/4 Mile South Spring Valley Granville 61326

SITE DATA FOR THIS FACILITY:

Well ID	Map Code	Site Name	Site Description	Distance (Feet)
11590	07317	COYE'S SUNOCO SERVICE	BELOW GROUND STORAGE (PET	350
11590	07318	DONALDSON BUSINESS FORMS	PRINTING	800
11590	07321	OSSOLA CONSTRUCTION CO.	PILES OF MATERIAL (e.g. SAND A	2300
11590	07320	UNKNOWN FORMER GAS STATI	BELOW GROUND STORAGE (PET	2100
11590	07319	UNKNOWN FORMER GAS STATI	BELOW GROUND STORAGE (PET	1000
11591	07318	DONALDSON BUSINESS FORMS	PRINTING	1500
11591	07321	OSSOLA CONSTRUCTION CO.	PILES OF MATERIAL (e.g. SAND A	300
11591	07320	UNKNOWN FORMER GAS STATI	BELOW GROUND STORAGE (PET	775
11591	07319	UNKNOWN FORMER GAS STATI	BELOW GROUND STORAGE (PET	1580
11591	07317	COYE'S SUNOCO SERVICE	BELOW GROUND STORAGE (PET	2000

OTHER IDENTIFIED POTENTIAL SOURCES:

For this community water supply, no additional potential sources of contamination have been identified beyond those in Illinois EPA databases.

SUSCEPTIBILITY TO CONTAMINATION:

Based on information obtained in a Well Site Survey published in 1992 by the Illinois EPA, several potential sources are located within 1,000 feet of the wells.

The Illinois EPA has determined that the Granville Community Water Supply's source water is not suspectibile to contamination. This determination is based on a number of criteria including; monitoring conducted at the wells; monitoring conducted at the entry point to the distribution system; and available hydrogeologic data on the wells.

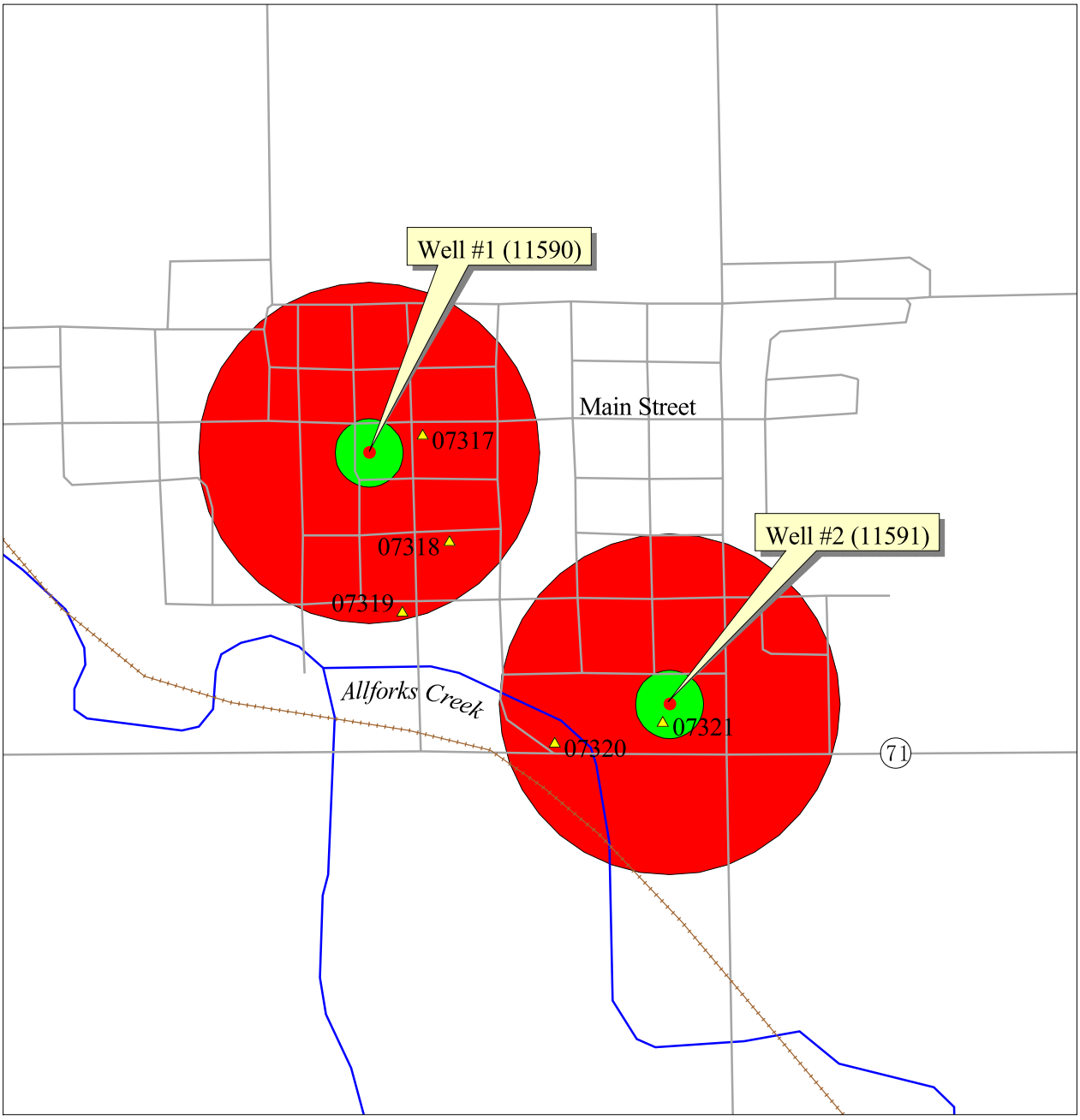
Furthermore, in anticipation of the U.S. EPA's proposed Ground Water Rule, the Illinois EPA has determined that the Granville Community Water Supply is not vulnerable to viral contamination. This determination is based upon the evaluation of the following criteria during the Vulnerability Waiver Process: the community's wells are properly constructed with sound integrity and proper siting conditions; a hydraulic barrier exists which should prevent pathogen movement; all potential routes and sanitary defects have been mitigated such that the source water is adequately protected; monitoring data did not indicate a history of disease outbreak; and the sanitary survey of the water supply did not indicate a viral contamination threat. Because the community's wells are constructed in a confined aquifer, which should prevent the movement of pathogens into the wells, well hydraulics were not considered to be a significant factor in the susceptibility determination. Hence, well hydraulics were not evaluated for this system ground water supply.

SOURCE WATER PROTECTION EFFORTS:

The Illinois Environmental Protection Act provides minimum protection zones of 200 feet for your wells. These minimum protection zones are regulated by the Illinois EPA. To further reduce the risk to source water, the Facility has implemented a wellhead protection program which includes the proper abandonment of potential routes of groundwater contamination and correction of sanitary defects at the water treatment facility. This effort resulted in the community water supply receiving a special exception permit from the Illinois EPA which allows a reduction in monitoring. The outcome of this monitoring reduction has saved the community considerable laboratory analysis costs.

To further minimize the risk to the facility's groundwater supply, the Illinois EPA recommends that three additional activities be assessed. First, the water supply may wish to enact a "maximum setback zone" ordinance. These ordinances are authorized by the Illinois Environmental Protection Act and allow county and municipal officials the opportunity to provide additional protection up to a fixed distance, normally 1,000 feet from their wells. Second, the water supply staff may wish to revisit their contingency planning documents. Contingency planning documents are a primary means to ensure that, through emergency preparedness, a community will minimize their risk of being without safe and adequate water. Finally, the water supply staff is encouraged to review their cross connection control program to ensure that it remains current and viable. Cross connections to either the water treatment plant (for example, at bulk water loading stations) or in the distribution system may negate all source water protection initatives provided by the community.

WELLHEAD PROTECTION PLANNING MAP FOR GRANVILLE (FACILITY #1550050)



Legend

- CWS Wells
- Potential Sources Of Contamination
- Rails
- Roads
- Streams
- Minimum Setback Zone
- Existing or Potential Maximum Setback Zone

FOR MORE INFORMATION CONTACT:

Groundwater Section, Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, IL 62794-9276
Ph# (217)785-4787

Source Information
Roads, Rails, and Streams from Illinois DNR.
CWS Wells and Potential Sources from Illinois EPA.
Map compiled by Groundwater Section, Illinois EPA.

Illinois Environmental Protection Agency

Source Water Assessment Program

FACT SHEET

MARK

PUTNAM COUNTY

Prepared in cooperation with the U.S. Geological Survey.

Information and data used in the preparation of this Fact Sheet are provided by the Illinois EPA and are subject to revision.

Illinois EPA PWS Number: **1550250**

For the purpose of the Source Water Assessment Program (SWAP), this community water supply (CWS) purchases water from another CWS. The current procedure for a purchasing water supply indicates that the source water information for this CWS is presented in the SWAP Fact Sheet of the parent supply (the water supply from which the water originates). Therefore, please refer to the parent supply's SWAP Fact Sheet for an assessment of this CWS's source water. The parent CWS for the supply you requested is listed below with its source water type and county. Some CWSs that purchase their water have wells as back-up supplies; however, these wells are not the primary source of water supply and are not considered as part of this assessment program.

INFORMATION FOR THE SOURCE OF THIS FACILITY'S WATER

Parent IEPA Number:	1550050
Parent Name:	GRANVILLE
Parent Water Type:	GROUND
Parent Supply County:	PUTNAM

APPENDIX D

RECORD OF COMMUNICATIONS

Stuart Cravens

From: "Bell, Scott S." <Scott.S.Bell@Illinois.gov>
To: <kelron@egix.net>
Cc: "Smet, John" <John.Smet@Illinois.gov>
Sent: Wednesday, March 18, 2009 12:18 PM
Subject: attn Stuart Cravens

According to our records, the only active NCPWS within one mile of Dynegy Hennepin Power Station is Washington Mills (fka Exolon, Esk).

J. Scott Bell, LEHP
Illinois Department of Public Health
Peoria Regional Office
5415 N. University
Peoria, IL 61614
309 693 5373
fax 309 693 5118
scott.s.bell@illinois.gov

Stuart Cravens

From: "Andrea Gress" <agress@bchealthdepartment.org>
To: "Stuart Cravens" <kelron@egix.net>
Sent: Tuesday, March 17, 2009 2:26 PM
Subject: RE: Community and Non-Community Water Supplies - Putnam Counry

Dear Stu,

As far as the non-communities we are responsible for at the local level, none of them are located in that area. However, the state also covers non-community wells in our area because they fall in a different category so I am forwarding this email to our Regional State Health Department in Peoria, IL. The contact is John Smet. Email: john.smet@illinois.gov. Hopefully he will get back to you regarding the non-community wells the state is responsible for.

Sincerely,

Andrea Gress

Andrea Gress, BS, LEHP, REHS/RS
Environmental Health Sanitarian
Bureau-Putnam County Health Department
526 Bureau Valley Parkway
Princeton, IL 61356
Phone: 815-872-5091
Fax: 815-872-5092

From: Stuart Cravens [mailto:kelron@egix.net]
Sent: Thursday, March 12, 2009 9:05 AM
To: Andrea Gress
Subject: Community and Non-Community Water Supplies - Putnam Counry

To: Bureau and Putnam County Health Department

As required by the IEPA, and on behalf of the Hennepin Power Station, located in Putnam County, Illinois (Township 33 North, Range, 2 West, Section 26) Kelron Environmental is conducting a water well survey of potable wells within 1 mile of the property.

I have done the web database searches and obtained information from the IEPA, ISGS, and ISWS and wanted to confirm that there are no community water supply wells within 1 mile of the Hennepin Power Station and the only non-community water supply well(s) are located at the Exolon Corporation in the southeast quarter of Section 26. The IEPA website showed there to be one non-community water supply well on Exolon property used for potable purposes, although there are apparently at least two other wells which may be active or inactive for industrial (non-potable) use.

I would appreciate it if you could confirm this information or provide me with a contact person in your office with whom I can communicate via mail or phone.

Thank you very much.

Stu Cravens, Senior Hydrogeologist

Stuart J. Cravens
Kelron Environmental
kelron@egix.net
217-390-1503 phone

Stuart Cravens

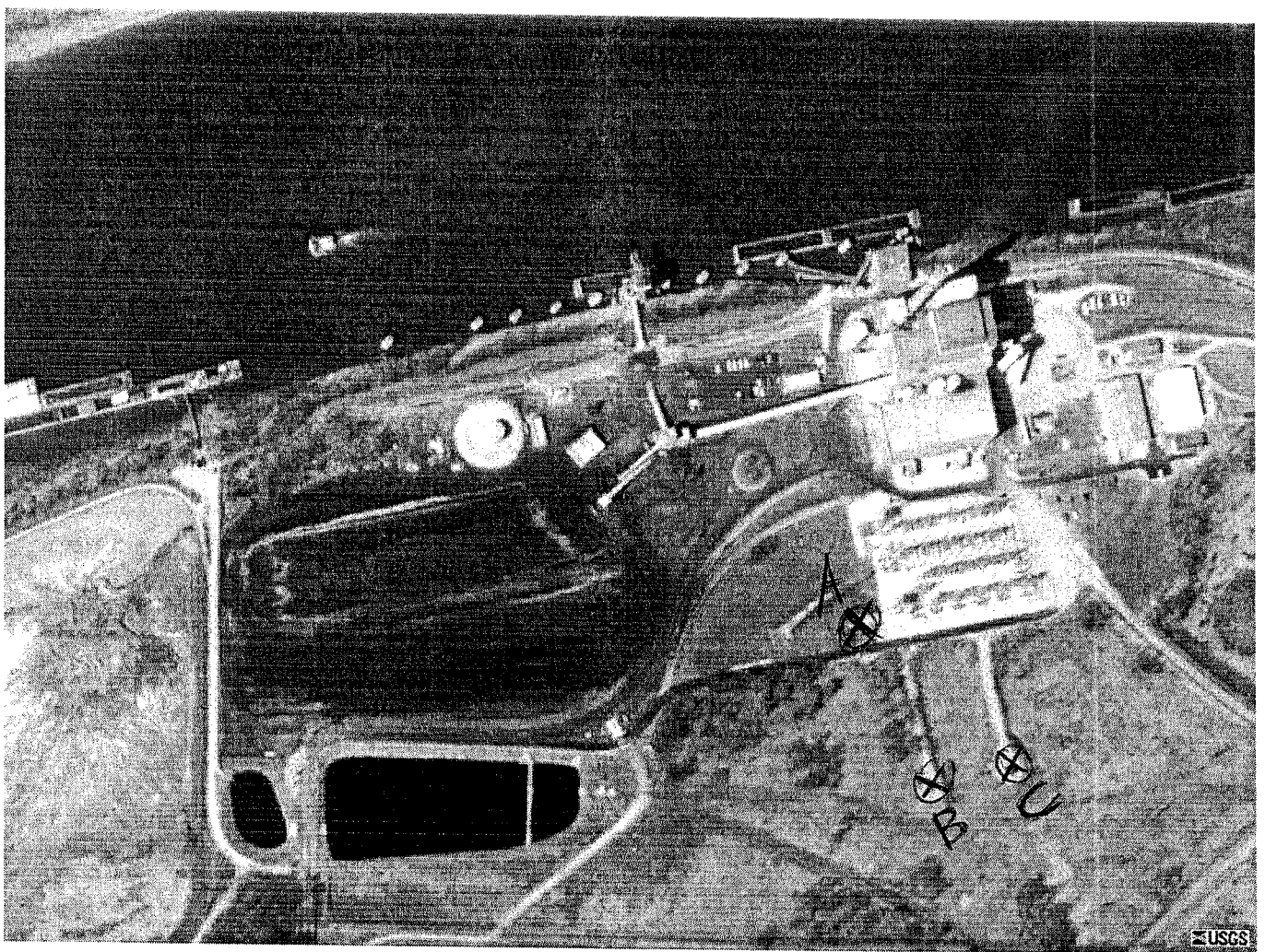
From: "Stuart Cravens" <kelron@egix.net>
To: "John P Augspols" <john_augspols@dynegy.com>
Sent: Tuesday, February 03, 2009 3:12 PM
Attach: Hen Power Plant 2.jpg
Subject: Industrial Well locations

John,

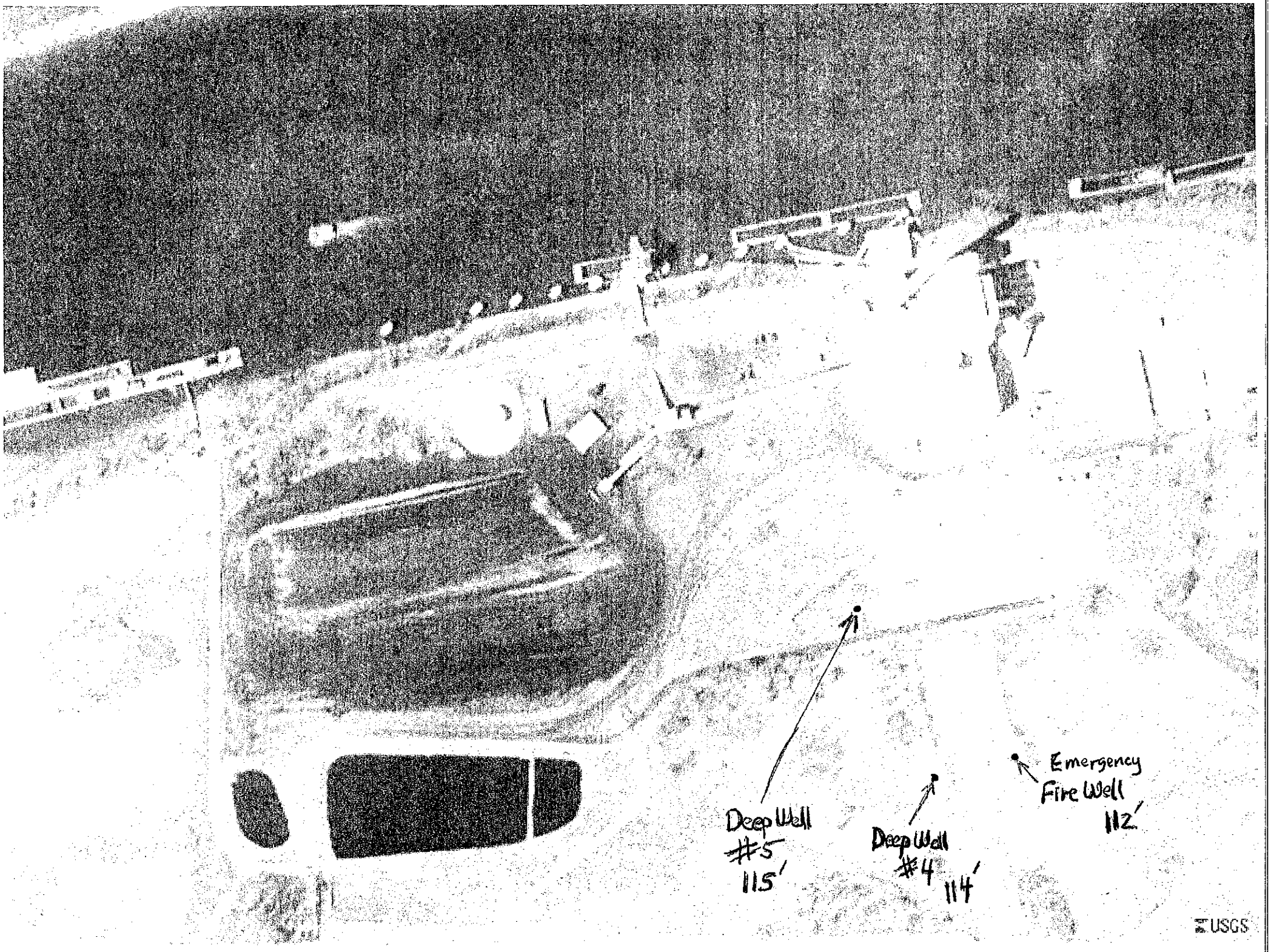
Are any of your industrial water wells at Hennepin active? Can you show on the attached jpeg map the locations of those wells and their designations? Call if this is a problem or any questions.

Thanks. Stu

Stuart J. Cravens
Kelron Environmental
kelron@egix.net
217-390-1503 phone



A = Dry well #5 (115') #28
B = Dry well #4 (114') #26
C = Fire well (112') ? #29??

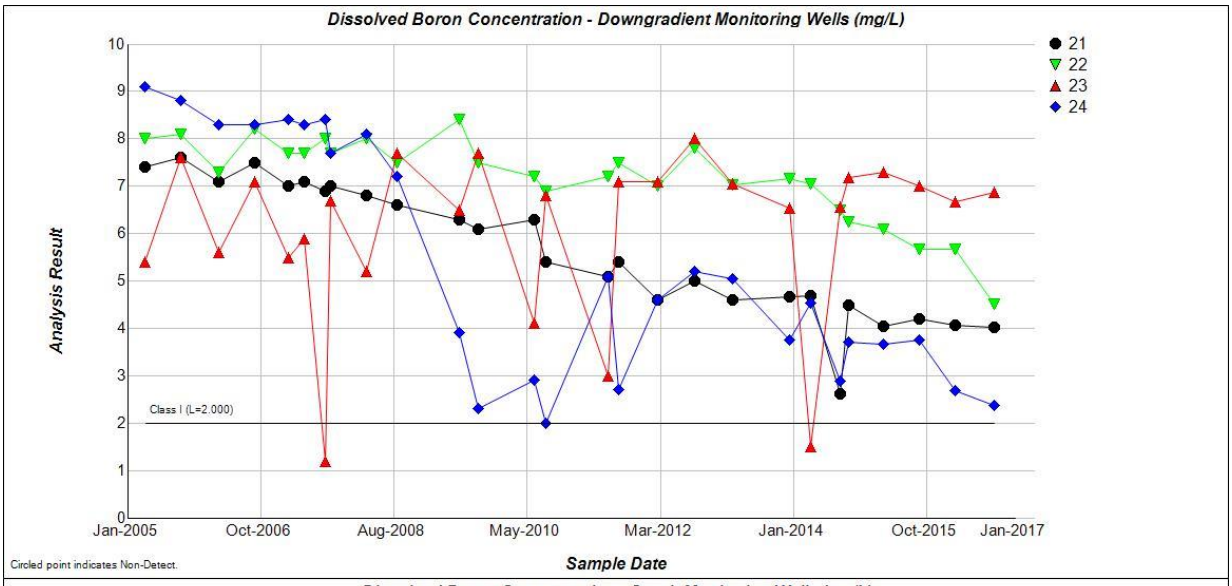

Deep Well
#5
115'
Deep Well
#4
114'
Emergency
Fire Well
112'
USGS

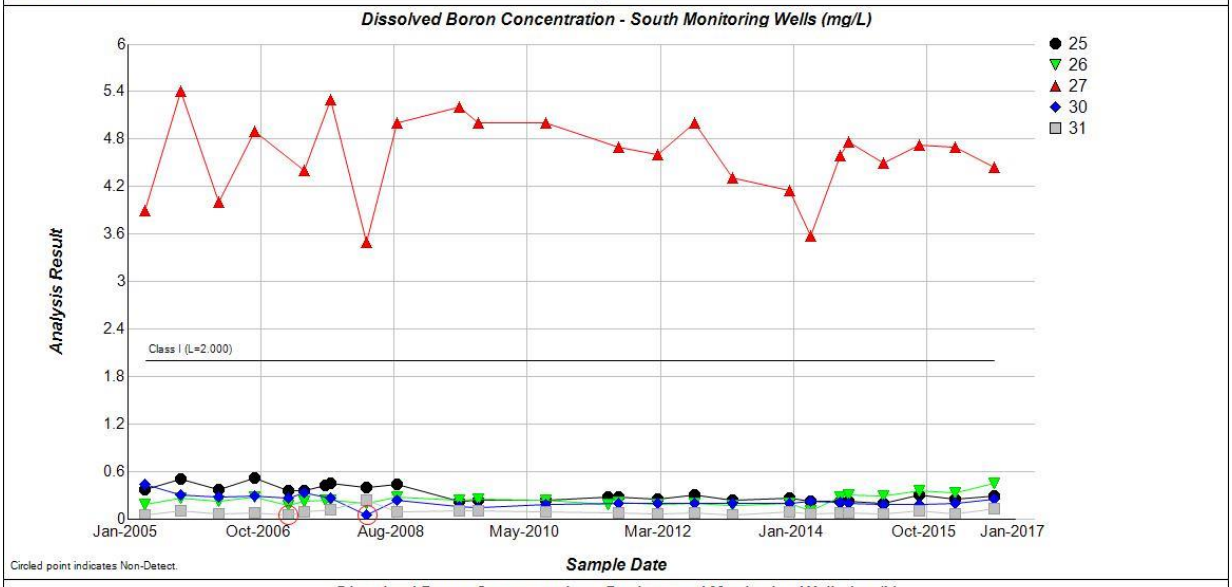
Appendix G

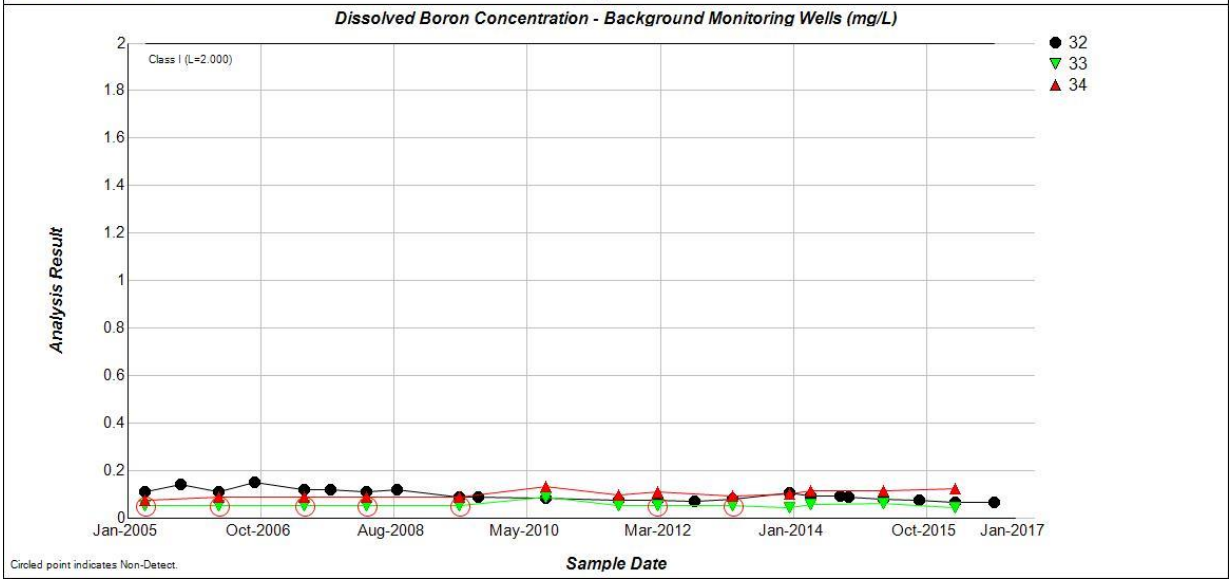
Groundwater Quality Monitoring Data

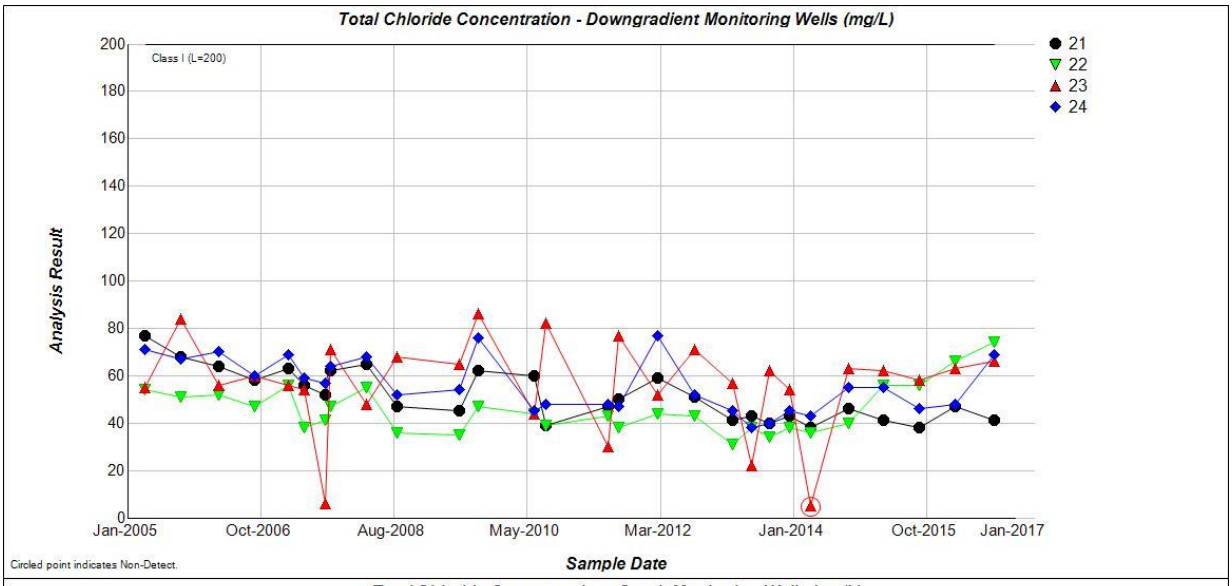
Appendix G1

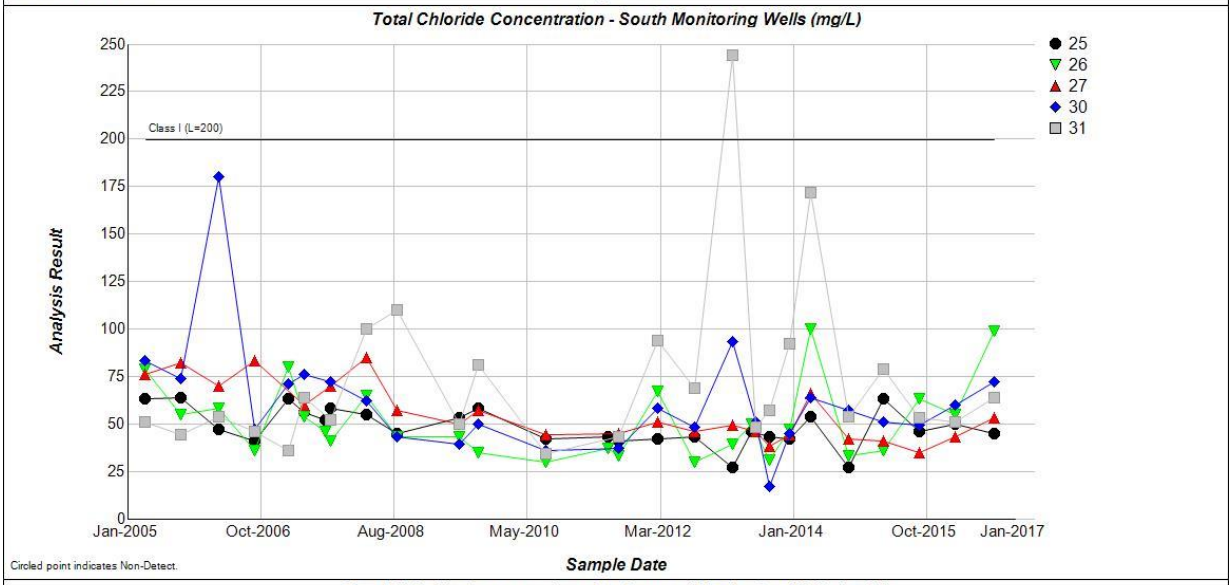
Time Concentration Plots 2005 through 2016

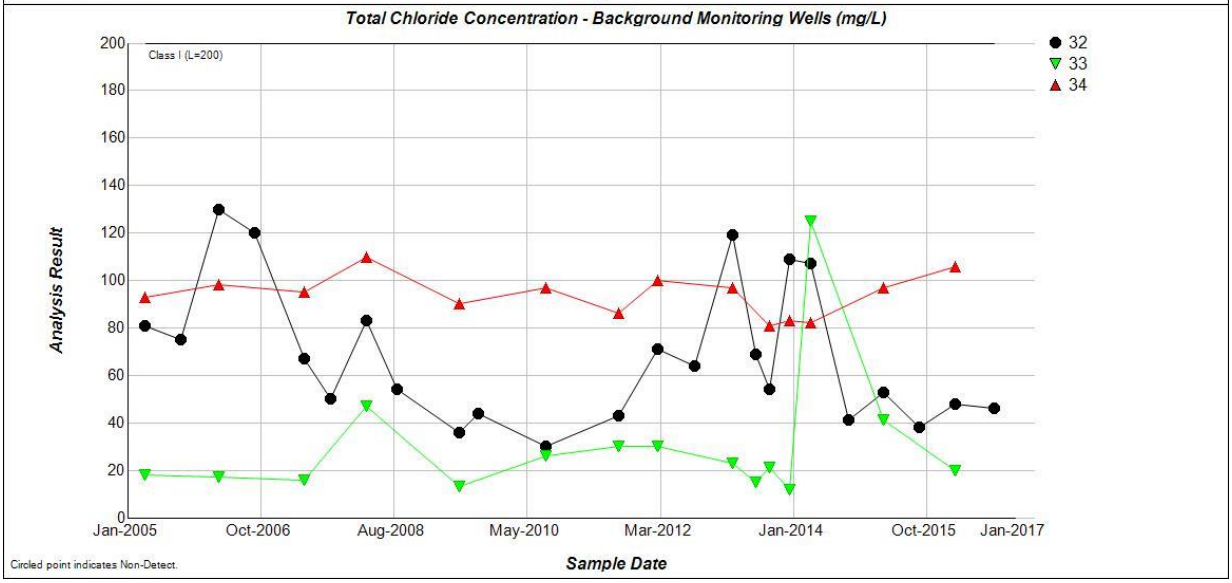

Dissolved Boron Concentration - Downgradient Monitoring Wells (mg/L)
Analysis Result
Sample Date
Class I (L=2.000)
21
22
23
24
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Circled point indicates Non-Detect.

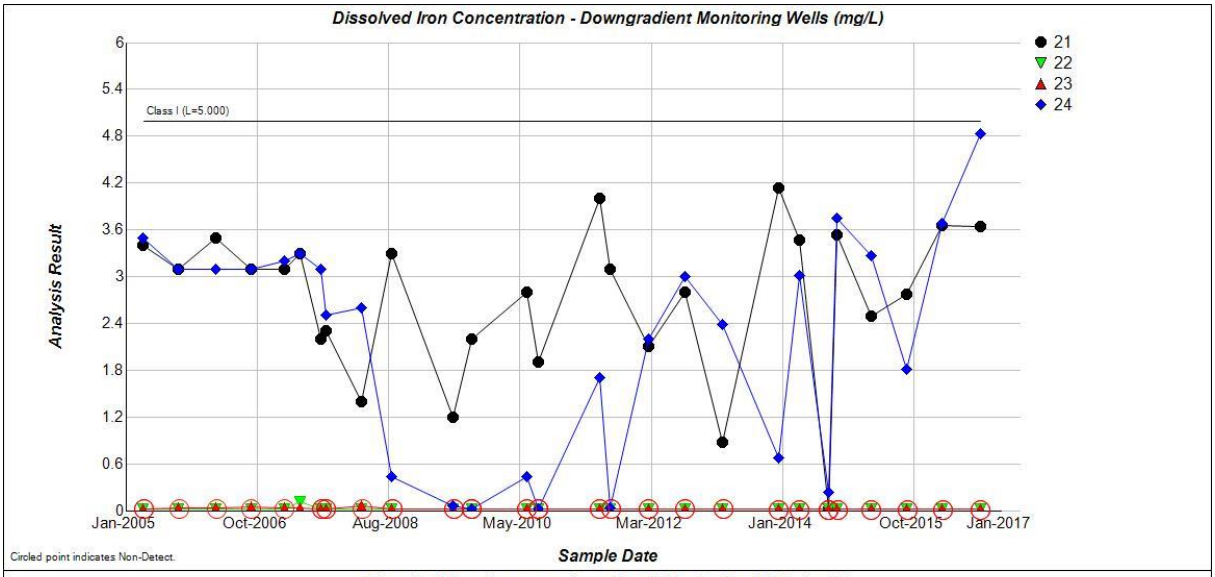

Dissolved Boron Concentration - South Monitoring Wells (mg/L)
Analysis Result
Sample Date
Class I (L=2.000)
25
26
27
30
31
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Circled point indicates Non-Detect.

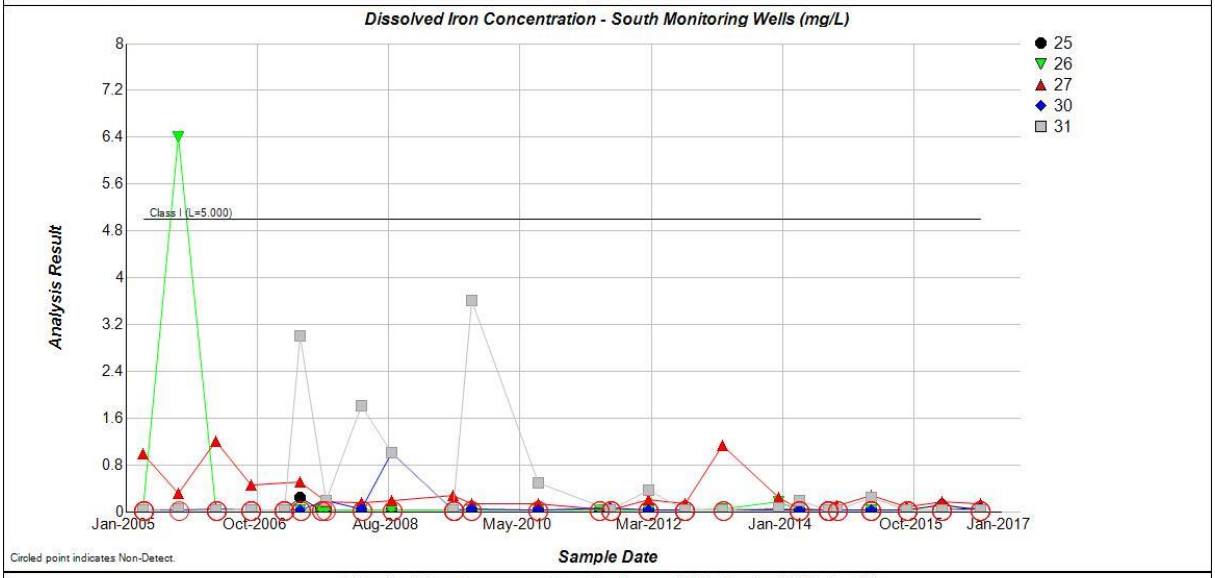

Dissolved Boron Concentration - Background Monitoring Wells (mg/L)
Analysis Result
Sample Date
Class I (L=2.000)
32
33
34
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Circled point indicates Non-Detect.

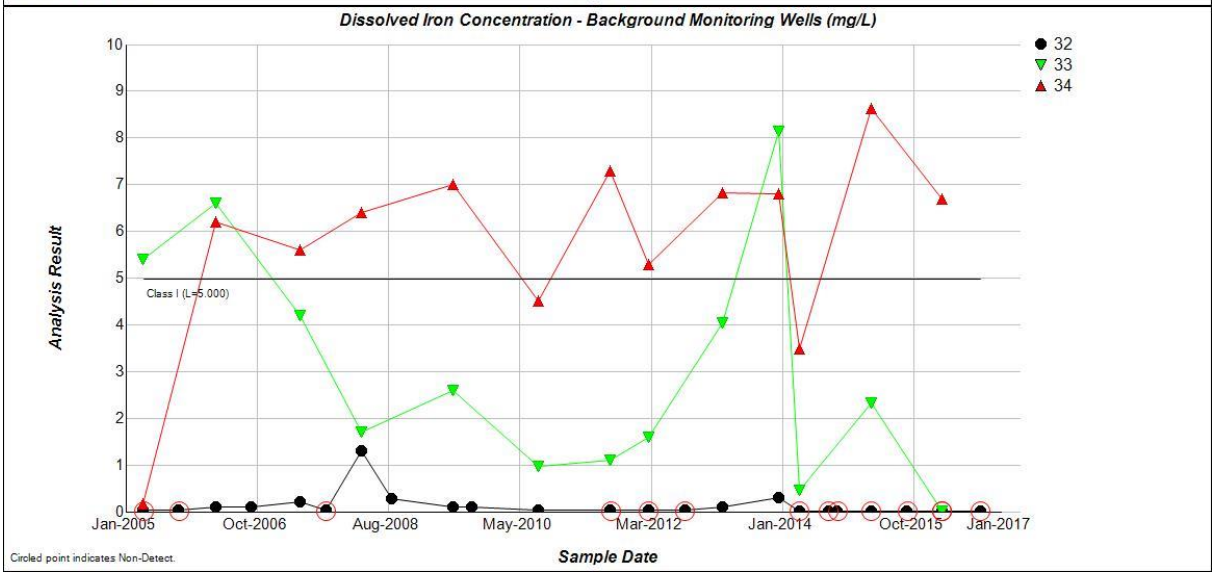

Total Chloride Concentration - Downgradient Monitoring Wells (mg/L)
Class I (L=200)
21
22
23
24
Analysis Result
Sample Date
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Circled point indicates Non-Detect.

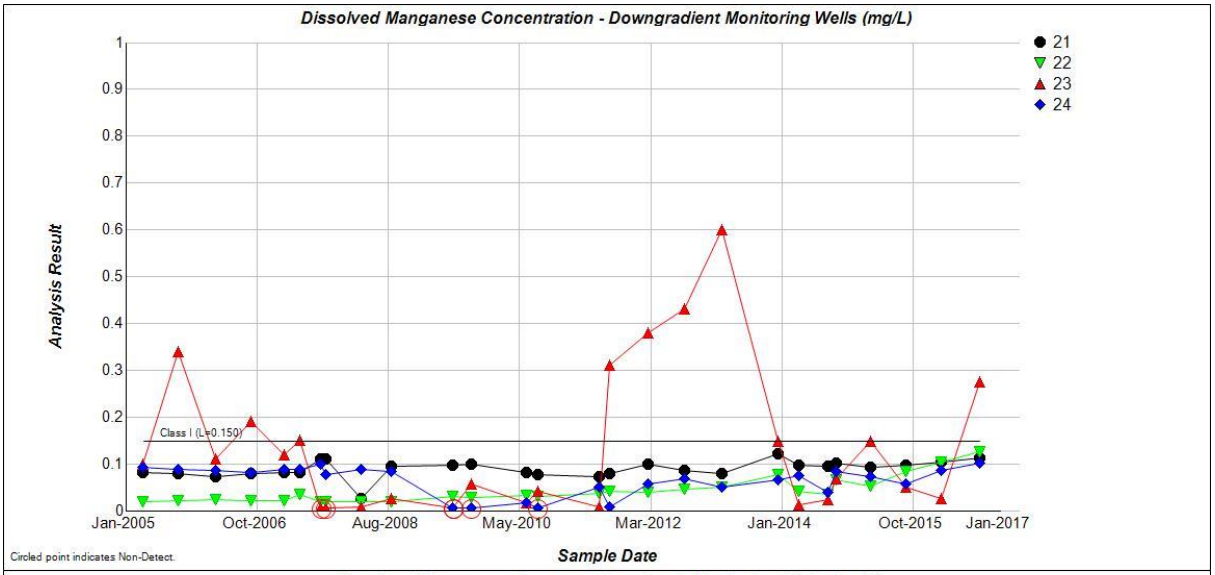

Total Chloride Concentration - South Monitoring Wells (mg/L)
Class I (L=200)
25
26
27
30
31
Analysis Result
Sample Date
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Circled point indicates Non-Detect.

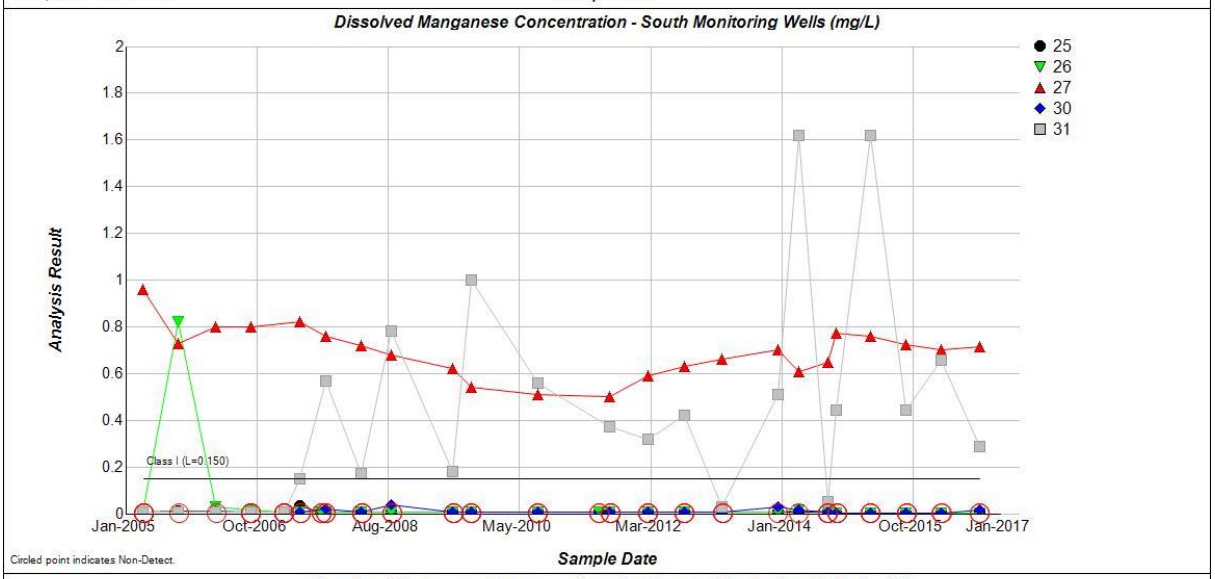

Total Chloride Concentration - Background Monitoring Wells (mg/L)
Class I (L=200)
32
33
34
Analysis Result
Sample Date
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Circled point indicates Non-Detect.

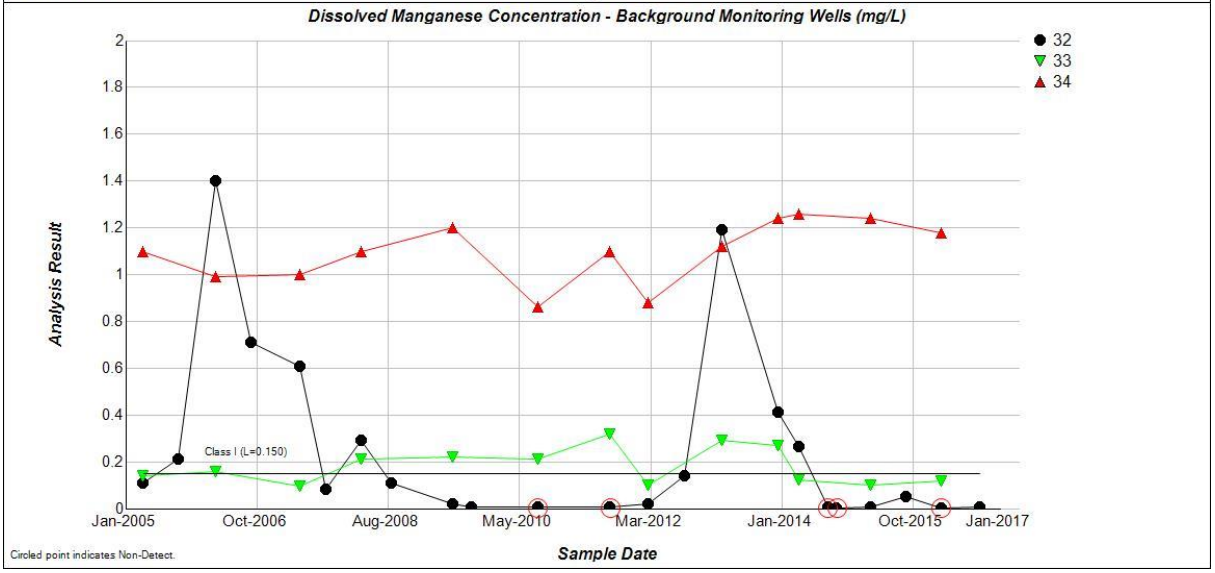

Dissolved Iron Concentration - Downgradient Monitoring Wells (mg/L)
Analysis Result
Sample Date
Class I (L=5.000)
21
22
23
24
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Circled point indicates Non-Detect.

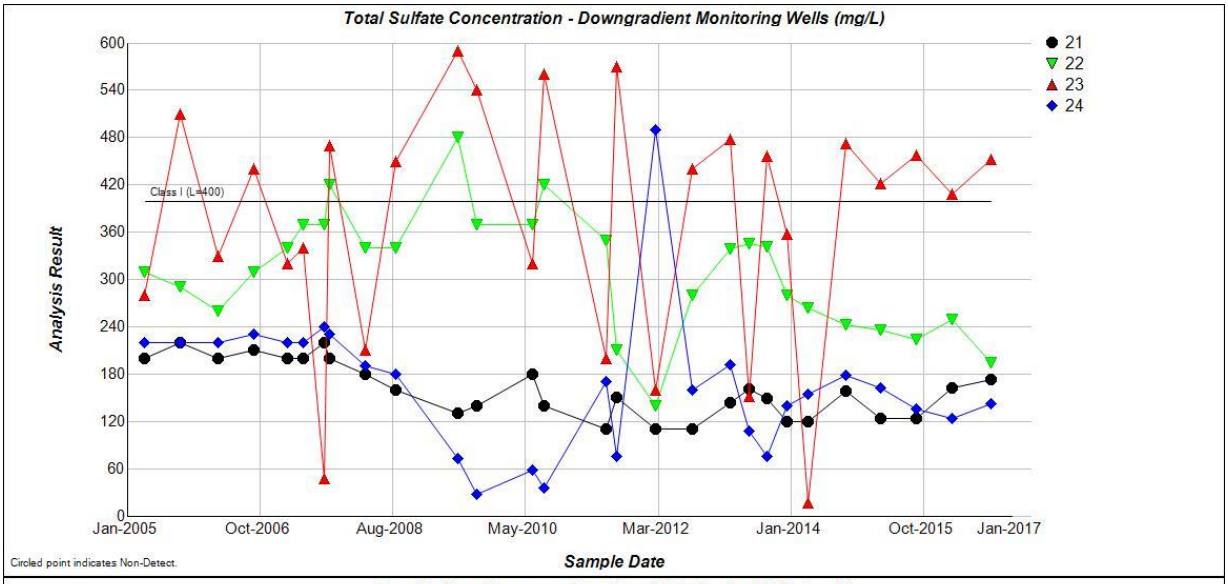

Dissolved Iron Concentration - South Monitoring Wells (mg/L)
Analysis Result
Sample Date
Class I (L=5.000)
25
26
27
30
31
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Circled point indicates Non-Detect.

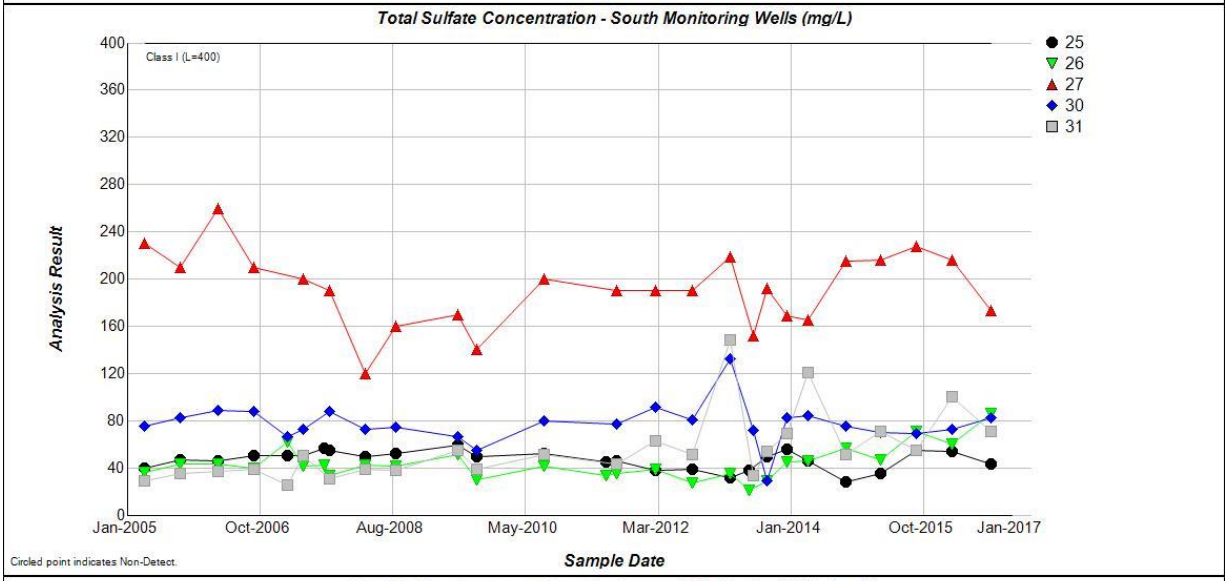

Dissolved Iron Concentration - Background Monitoring Wells (mg/L)
Analysis Result
Sample Date
Class I (L=5.000)
32
33
34
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Circled point indicates Non-Detect.

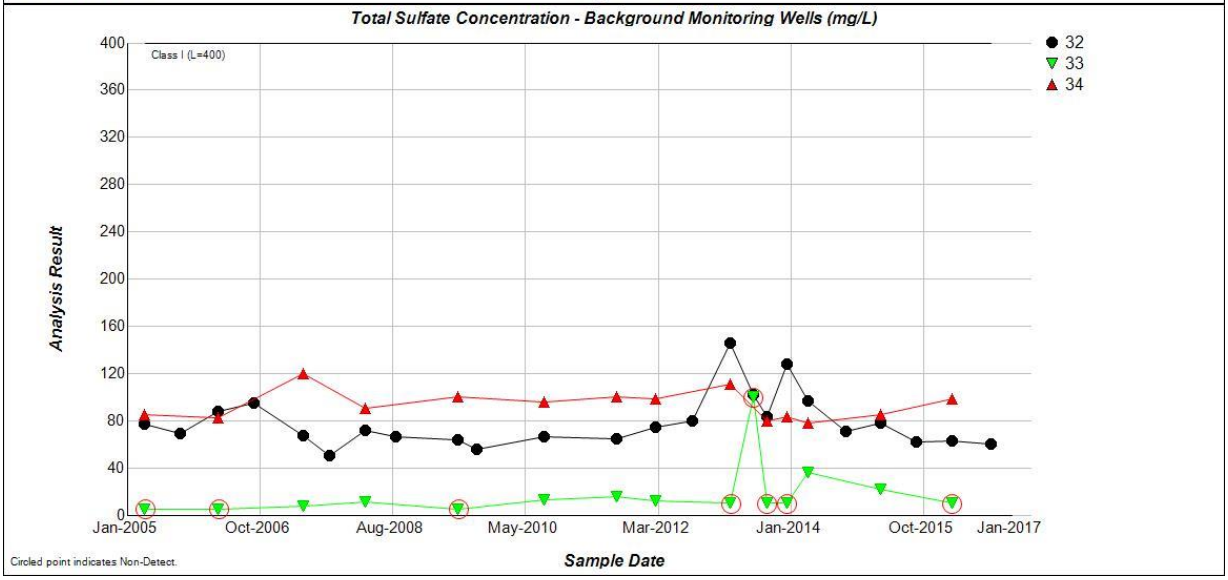

Dissolved Manganese Concentration - Downgradient Monitoring Wells (mg/L)
Analysis Result
Sample Date
Class I (L=0.150)
Circled point indicates Non-Detect.
21
22
23
24
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017

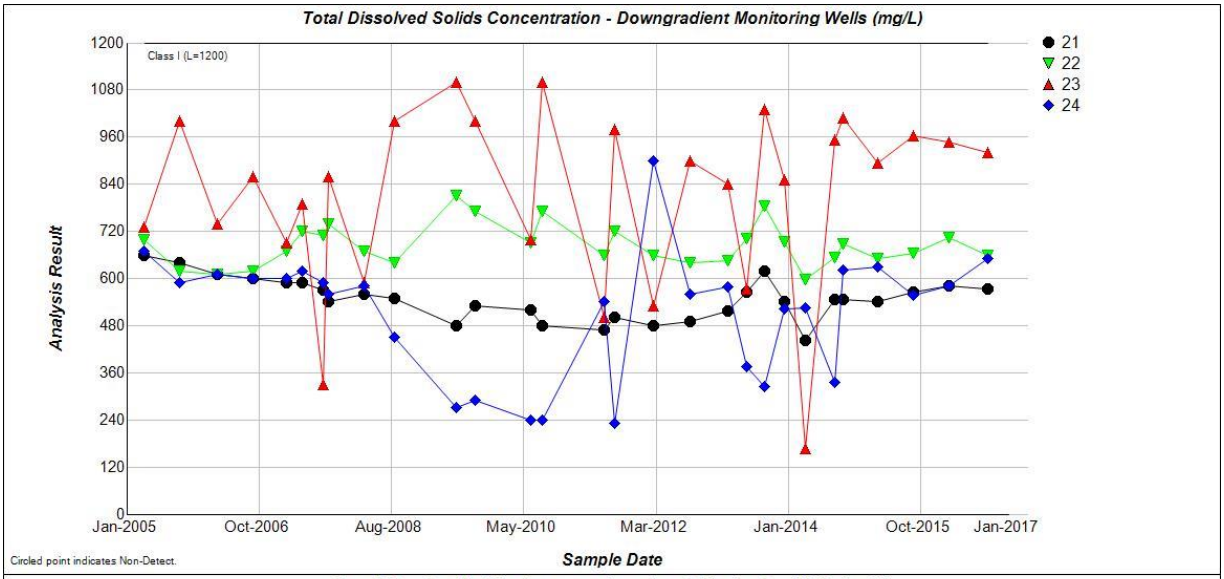

Dissolved Manganese Concentration - South Monitoring Wells (mg/L)
Analysis Result
Sample Date
Class I (L=0.150)
Circled point indicates Non-Detect.
25
26
27
30
31
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017

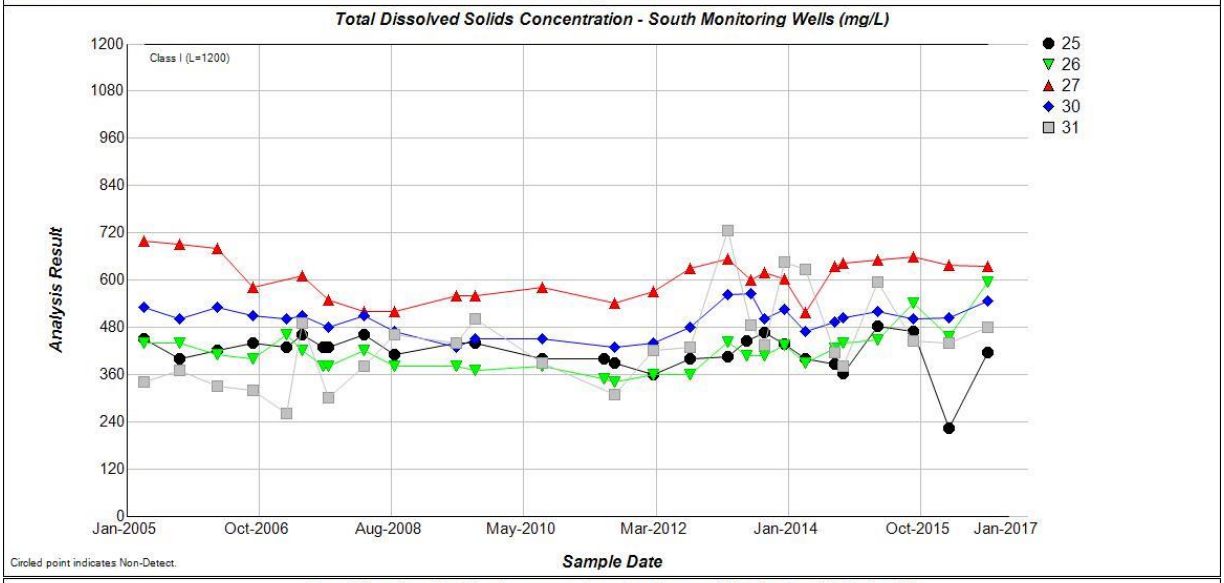

Dissolved Manganese Concentration - Background Monitoring Wells (mg/L)
Analysis Result
Sample Date
Class I (L=0.150)
Circled point indicates Non-Detect.
32
33
34
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017

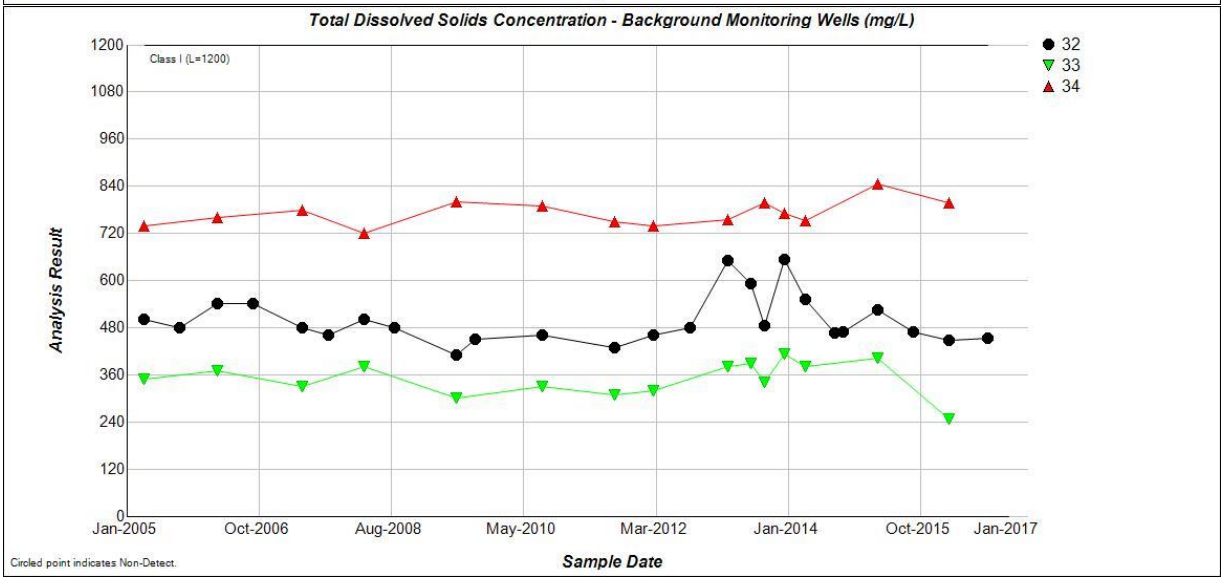

Total Sulfate Concentration - Downgradient Monitoring Wells (mg/L)
Analysis Result
Class I (L=400)
21
22
23
24
600
540
480
420
360
300
240
180
120
60
0
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
Circled point indicates Non-Detect.

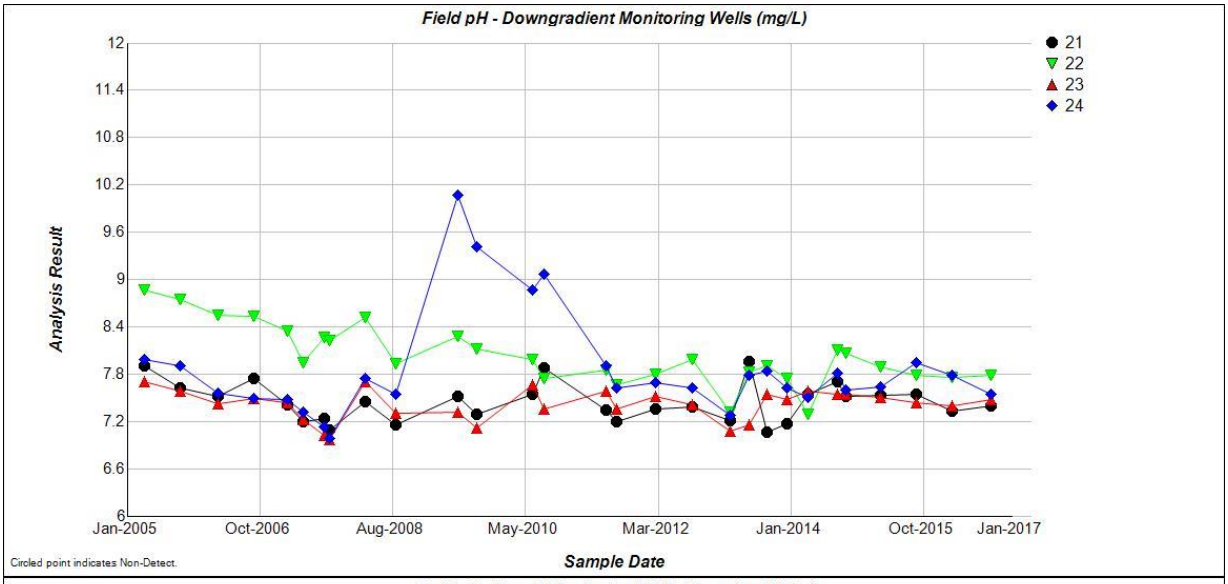

Total Sulfate Concentration - South Monitoring Wells (mg/L)
Analysis Result
Class I (L=400)
25
26
27
30
31
400
360
320
280
240
200
160
120
80
40
0
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
Circled point indicates Non-Detect.

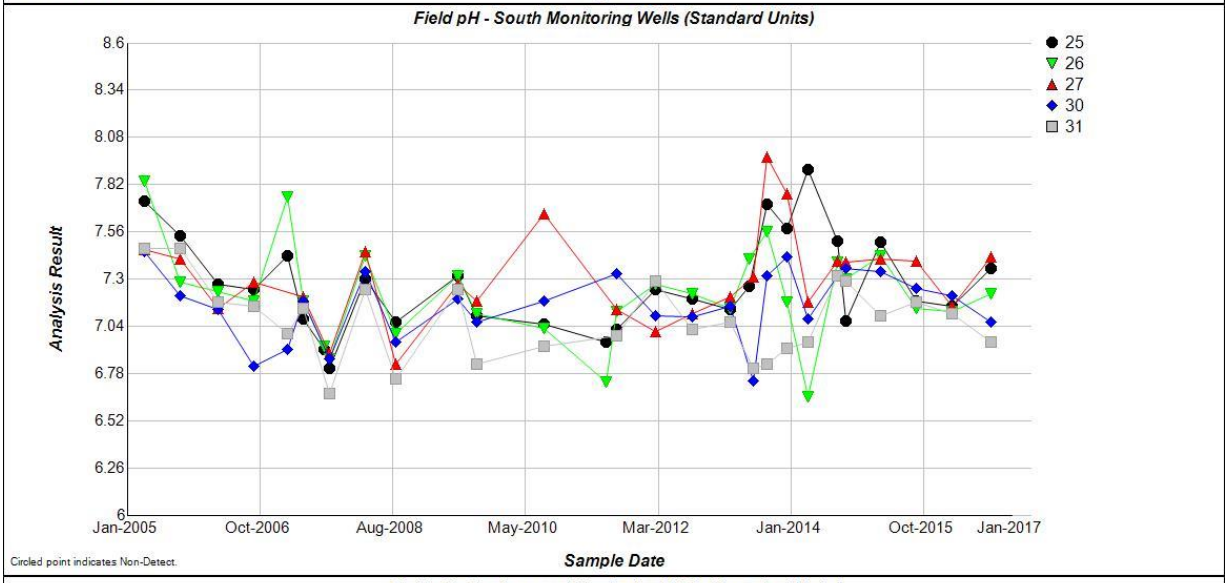

Total Sulfate Concentration - Background Monitoring Wells (mg/L)
Analysis Result
Class I (L=400)
32
33
34
400
360
320
280
240
200
160
120
80
40
0
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
Circled point indicates Non-Detect.

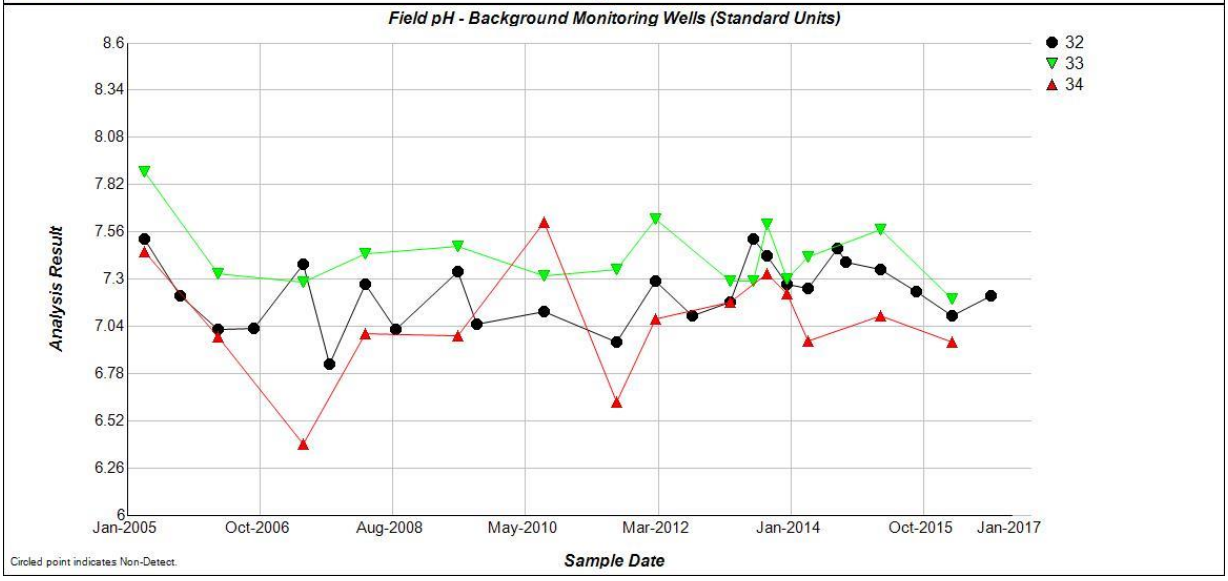

Total Dissolved Solids Concentration - Downgradient Monitoring Wells (mg/L)
Class I (L=1200)
21
22
23
24
Analysis Result
1200
1080
960
840
720
600
480
360
240
120
0
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
Circled point indicates Non-Detect.

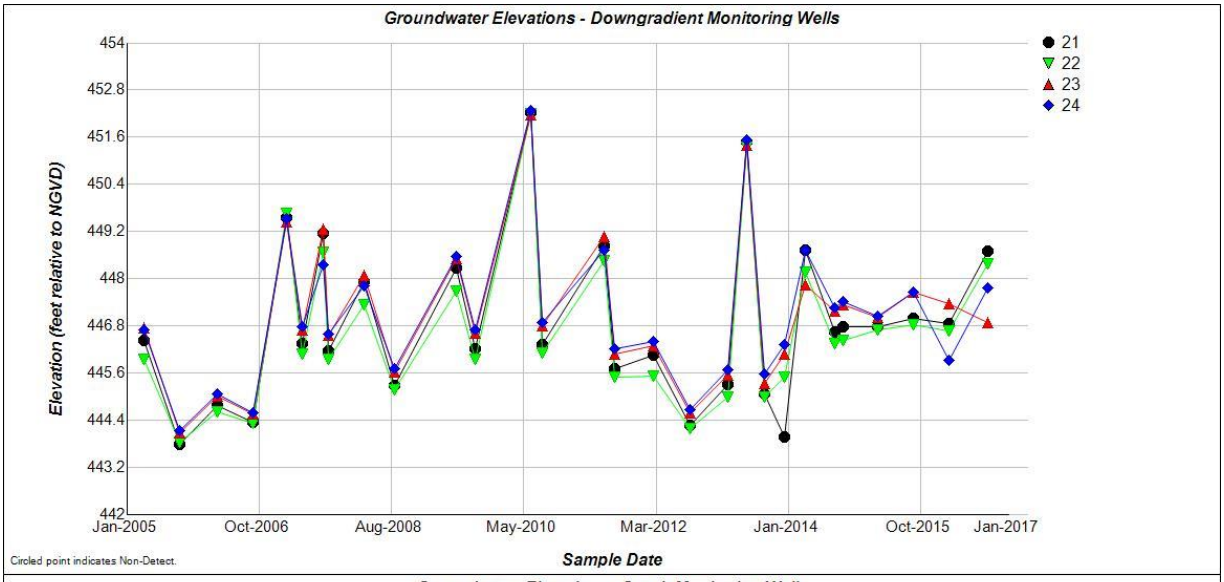

Total Dissolved Solids Concentration - South Monitoring Wells (mg/L)
Class I (L=1200)
25
26
27
30
31
Analysis Result
1200
1080
960
840
720
600
480
360
240
120
0
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
Circled point indicates Non-Detect.

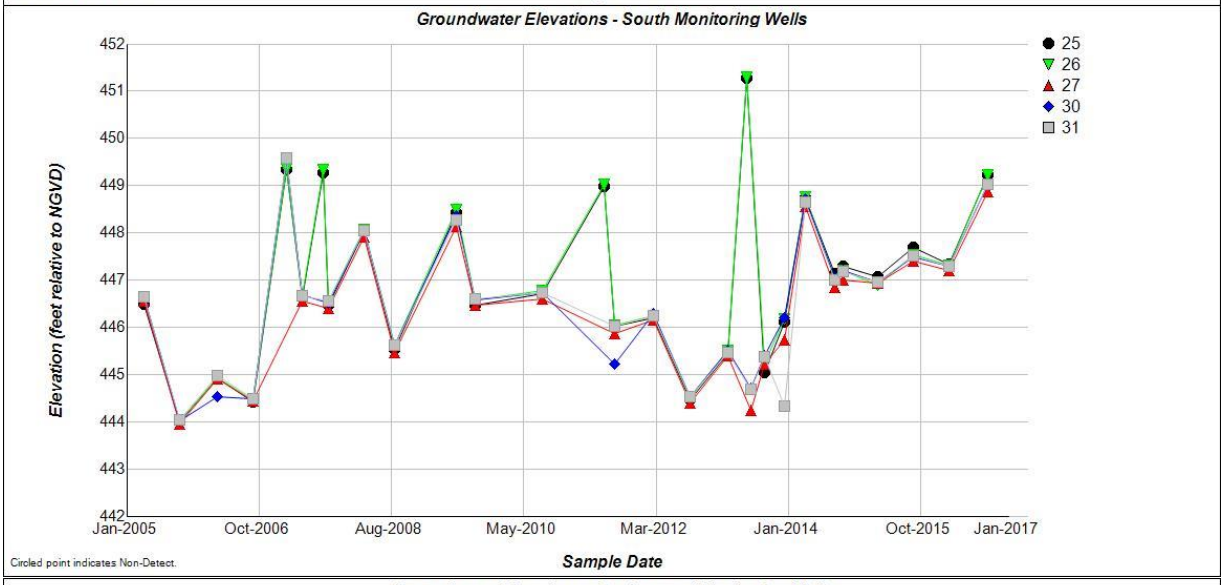

Total Dissolved Solids Concentration - Background Monitoring Wells (mg/L)
Class I (L=1200)
32
33
34
Analysis Result
1200
1080
960
840
720
600
480
360
240
120
0
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
Circled point indicates Non-Detect.

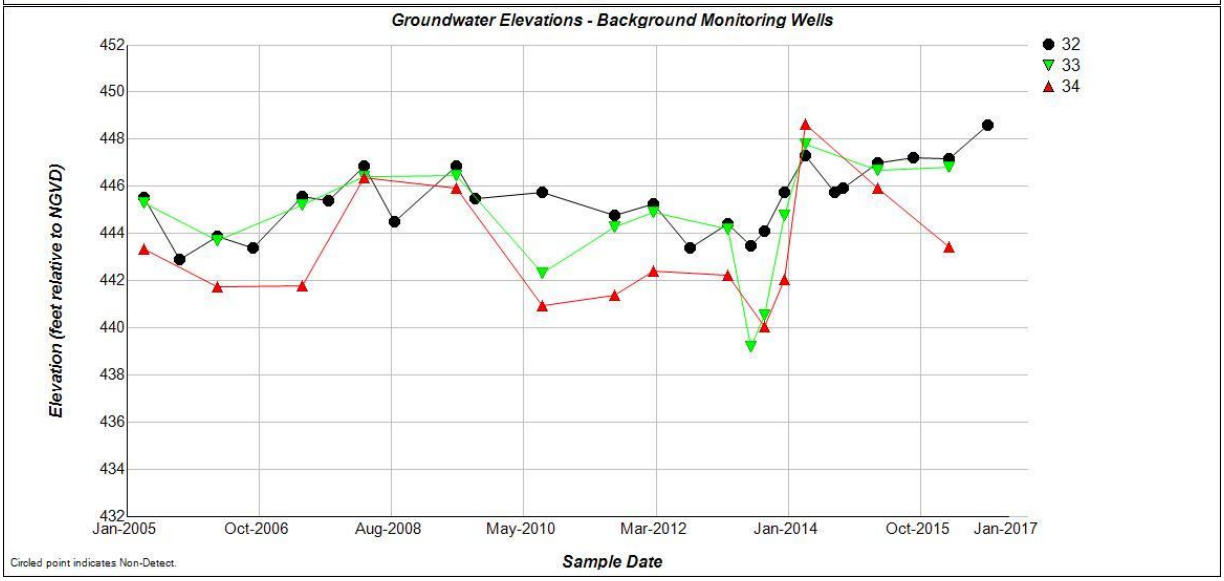

Field pH - Downgradient Monitoring Wells (mg/L)
Analysis Result
12
11.4
10.8
10.2
9.6
9
8.4
7.8
7.2
6.6
6
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
21
22
23
24
Circled point indicates Non-Detect.


Field pH - South Monitoring Wells (Standard Units)
Analysis Result
8.6
8.34
8.08
7.82
7.56
7.3
7.04
6.78
6.52
6.26
6
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
25
26
27
30
31
Circled point indicates Non-Detect.


Field pH - Background Monitoring Wells (Standard Units)
Analysis Result
8.6
8.34
8.08
7.82
7.56
7.3
7.04
6.78
6.52
6.26
6
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
32
33
34
Circled point indicates Non-Detect.


Groundwater Elevations - Downgradient Monitoring Wells
Elevation (feet relative to NGVD)
454
452.8
451.6
450.4
449.2
448
446.8
445.6
444.4
443.2
442
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
21
22
23
24
Circled point indicates Non-Detect.


Groundwater Elevations - South Monitoring Wells
Elevation (feet relative to NGVD)
452
451
450
449
448
447
446
445
444
443
442
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
25
26
27
30
31
Circled point indicates Non-Detect.


Groundwater Elevations - Background Monitoring Wells
Elevation (feet relative to NGVD)
452
450
448
446
444
442
440
438
436
434
432
Jan-2005
Oct-2006
Aug-2008
May-2010
Mar-2012
Jan-2014
Oct-2015
Jan-2017
Sample Date
32
33
34
Circled point indicates Non-Detect.

Appendix G2

Class I Groundwater Quality Standards Monitoring Results Inorganic Parameters

Appendix G2: Inorganic Parameter Groundwater Quality Results June 2013 – March 2014
Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameter	Method Used	Units	Standard Limit	Well 21				Well 22				Well 23			
Date				06/07/13	09/03/13	12/10/13	03/25/14	06/07/13	09/03/13	12/10/13	03/25/14	06/07/13	09/03/13	12/10/13	03/25/14
pH-field	SM 21st ed. 4500-H^+	s.u.	6.5-9.0	7.96	7.06	7.17	7.55	7.83	7.91	7.75	7.29	7.15	7.55	7.48	7.58
GW Elevation	EWLI	ft.	- -	451.48	445.07	443.97	448.73	451.34	444.98	445.50	448.17	451.40	445.32	446.07	447.85
Spec Cond-field	SM 21st ed. 2520-B	micromhos/cm	ns	556	571	526	633	946	884	1,000	634	640	1,140	925	526
Temp-field	SM 21st ed. 2550	C°	ns	15.1	16.8	10.3	10.3	13.6	13.6	10.1	10.5	12.7	14.3	9.9	10.4
Sulfate (d)	SM 21st ed. 4500-SO_4 E	mg/L	400	161	149	121	127	346 S	341	269	254	152	**456**	329	17
Chloride (d)	ASTM D512-04 C	mg/L	200	43	40	43	37	38	34	38	35	22	62	54	<5.0
Fluoride (t)	EPA method 74	mg/L	4.0	0.22	0.17	0.18	0.12	0.22	0.17	0.18	0.14	0.24	0.17	0.19	0.18
Nitrate (t)	SM 21st ed. 4500-NO_3 D	mg/L	10.0	0.034 J	0.205	0.17	0.39	6.42	5.95	5.56	5.52	0.15	<0.05	<0.05	1.91
Perchlorate (t)	EPA 314.0	mg/L	0.0049	<0.004	- - - -	- - - -	- - - -	<0.004	- - - -	- - - -	- - - -	<0.004	- - - -	- - - -	- - - -
TDS	SM 21st ed 2540 C	mg/L	1,200	564	618	540	442	702	784	694	596	574	1,030	852	166
Cyanide (t)	SW-846 9012A	mg/L	0.2	<0.007	<0.007	<0.007	<0.008	<0.007	<0.007	<0.007	<0.008	<0.007	<0.007	<0.008	<0.007
Antimony (t/d)*	SW-846 3020A	mg/L	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005 S	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic (t/d)*	SW-846 3005A, 6010B	mg/L	0.01	0.007	0.009	0.008	**0.0104**	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Barium (t/d)*	SW-846 3005A, 6010B	mg/L	2.0	0.20	0.18	0.18	0.15	0.06	0.07	0.06	0.05	0.12	0.05	0.04	0.03
Beryllium (t/d)*	SW-846 3005A, 6010B	mg/L	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (t/d)*	SW-846 3005A, 6010B	mg/L	2.0	**5.18**	**5.09**	**4.66**	**4.68**	**7.66**	**7.51**	**7.16**	**7.05**	**2.88**	**7.43**	**6.54**	1.51
Cadmium (t/d)*	SW-846 3005A, 6010B	mg/L	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (t/d)*	SW-846 3005A, 6010B	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (t/d)*	SW-846 3005A, 6010B	mg/L	1.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper (t/d)*	SW-846 3005A, 6010B	mg/L	0.65	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (t/d)*	SW-846 3005A, 6010B	mg/L	5.0	3.18	3.88	4.13	3.47	0.12	0.07	<0.02	<0.02	0.46	0.16	<0.02	<0.02
Lead (t/d)*	SW-846 3020A	mg/L	0.0075	<0.0075	<0.0075	<0.0075	<0.008	<0.0075	<0.0075	<0.0075	<0.008	<0.0075	<0.0075	<0.0075	<0.008
Manganese (t/d)*	SW-846 3005A, 6010B	mg/L	0.15	0.118	0.112	0.121	0.090	0.142	0.093	0.078	0.040	0.096	0.068	0.148	0.010
Mercury (t/d)*	SW-846 7470A	mg/L	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel (t/d)*	SW-846 3005A, 6010B	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (t/d)*	SW-846 3020A	mg/L	0.05	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Silver (t/d)*	SW-846 3005A, 6010B	mg/L	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium (t/d)*	SW-846 3020A	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (t/d)*	SW-846 3020A	mg/L	0.049	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (t/d)*	SW-846 3005A, 6010B	mg/L	5.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.021	<0.01	<0.01	<0.01

Notes:

Data do not include Field Replicates. Available upon request.
EWLI - electronic water level indicator.

(d) dissolved
(t) total
(t/d)* Total analyses Quarter's 2 and 3, 2013; dissolved analyses Quarter 4, 2013 and Quarter 1, 2014.
** Sulfate measured as total in samples from wells 33 and 34 during Quarter 4, 2013.

- - Not applicable.
- - - - Not sampled or insufficient groundwater for sampling and/or anlalysis.
ns No standard.

< ND - Not detected at the Reporting Limit

0.42 Parameter concentration exceeds Class I groundwater standard (IAC Part 620 Section 410)

Appendix G2: Inorganic Parameter Groundwater Quality Results .
Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameter	Method Used	Units	Standard Limit	Well 24				Well 25				Well 26			
Date				06/07/13	09/03/13	12/10/13	03/25/14	06/07/13	09/03/13	12/10/13	03/25/14	06/07/13	09/03/13	12/10/13	03/25/14
pH-field	SM 21st ed. 4500-H^+	s.u.	6.5-9.0	7.78	7.84	7.63	7.50	7.26	7.71	7.58	7.90	7.41	7.56	7.17	6.65
GW Elevation	EWLI	ft.	- -	451.53	445.56	446.32	448.73	451.27	445.05	446.10	448.74	451.30	445.24	446.17	448.76
Spec Cond-field	SM 21st ed. 2520-B	micromhos/cm	ns	567	507	527	856	689	696	649	738	754	627	736	874
Temp-field	SM 21st ed. 2550	C°	ns	13.2	15.3	9.9	10.2	13.5	13.1	10.6	8.9	12.0	15.0	10.4	5.8
Sulfate (d)	SM 21st ed. 4500-SO_4 E	mg/L	400	108	75	138	164	38	49	41	41	21	29	41	44
Chloride (d)	ASTM D512-04 C	mg/L	200	38	40	45	46	46	43	42	51	50	31	47	90
Fluoride (t)	EPA method 74	mg/L	4.0	0.26	0.21	0.21	0.16	0.17	0.13	0.15	<0.10	0.20	0.16	0.18	0.12
Nitrate (t)	SM 21st ed. 4500-NO_3 D	mg/L	10.0	.036 J	<0.05	0.07	<0.05	**10.1**	8.28	**12.2**	8.71	7.91	**15.1**	6.59	2.87
Perchlorate (t)	EPA 314.0	mg/L	0.0049	<0.004	- - - -	- - - -	- - - -	<0.004	- - - -	- - - -	- - - -	<0.004	- - - -	- - - -	- - - -
TDS	SM 21st ed 2540 C	mg/L	1,200	376	324	522	526	444	466	436	400	408	408	434	390
Cyanide (t)	SW-846 9012A	mg/L	0.2	<0.007	<0.007	0.008	0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Antimony (t/d)*	SW-846 3020A	mg/L	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic (t/d)*	SW-846 3005A, 6010B	mg/L	0.01	0.009	0.009	**0.023**	**0.030**	<0.003	<0.003	<0.003 S	<0.003	<0.003	<0.003	<0.003	<0.003
Barium (t/d)*	SW-846 3005A, 6010B	mg/L	2.0	0.04	0.04	0.04	0.04	0.08	0.08	0.07	0.07	0.08	0.08	0.09	0.06
Beryllium (t/d)*	SW-846 3005A, 6010B	mg/L	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (t/d)*	SW-846 3005A, 6010B	mg/L	2.0	**3.02**	**2.9**	**3.76**	**4.53**	0.24	0.29	0.26	0.21	0.18	0.20	0.19	0.09
Cadmium (t/d)*	SW-846 3005A, 6010B	mg/L	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (t/d)*	SW-846 3005A, 6010B	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (t/d)*	SW-846 3005A, 6010B	mg/L	1.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper (t/d)*	SW-846 3005A, 6010B	mg/L	0.65	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (t/d)*	SW-846 3005A, 6010B	mg/L	5.0	0.69	0.59	0.68	3.02	**5.06**	1.36	0.05	<0.02	0.58	0.90	0.17	<0.02
Lead (t/d)*	SW-846 3020A	mg/L	0.0075	<0.0075	<0.0075	<0.0075	<0.008	**0.009**	<0.0075	<0.0075	<0.008	<0.0075	<0.0075	<0.0075	<0.008
Manganese (t/d)*	SW-846 3005A, 6010B	mg/L	0.15	0.036	0.022	0.066	0.070	**0.192**	0.050	<0.005	0.005	0.029	0.040	0.009	0.010
Mercury (t/d)*	SW-846 7470A	mg/L	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel (t/d)*	SW-846 3005A, 6010B	mg/L	0.1	0.0127	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (t/d)*	SW-846 3020A	mg/L	0.05	<0.04	<0.04	**0.073**	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Silver (t/d)*	SW-846 3005A, 6010B	mg/L	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium (t/d)*	SW-846 3020A	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (t/d)*	SW-846 3020A	mg/L	0.049	<0.01	<0.01	<0.01	<0.01	0.011	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (t/d)*	SW-846 3005A, 6010B	mg/L	5.0	0.026	0.011	<0.01	<0.01	0.048	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

Data do not include Field Replicates. Available upon request.
EWLI - electronic water level indicator.

(d) dissolved
(t) total
(t/d)* Total analyses Quarter's 2 and 3, 2013; dissolved analyses Quarter 4, 2013 and Quarter 1, 2014.
** Sulfate measured as total in samples from wells 33 and 34 during Quarter 4, 2013.

- - Not applicable.
- - - - Not sampled or insufficient groundwater for sampling and/or anlalysis.
ns No standard.

< ND - Not detected at the Reporting Limit

0.42 Parameter concentration exceeds Class I groundwater standard (IAC Part 620 Section 410)

Appendix G2: Inorganic Parameter Groundwater Quality Results .
Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameter	Method Used	Units	Standard Limit	Well 27				Well 30				Well 31			
Date				06/26/13	09/03/13	12/10/13	03/25/14	06/26/13	09/03/13	12/10/13	03/25/14	06/26/13	09/03/13	12/10/13	03/25/14
pH-field	SM 21st ed. 4500-H^+	s.u.	6.5-9.0	7.31	7.97	7.77	7.17	6.74	7.32	7.42	7.08	6.81	6.83	6.92	6.95
GW Elevation	EWLI	ft.	- -	444.23	445.22	445.74	448.56	444.70	445.40	446.20	448.71	444.69	445.38	444.32	448.65
Spec Cond-field	SM 21st ed. 2520-B	micromhos/cm	ns	840	863	930	851	881	761	831	851	873	741	751	780
Temp-field	SM 21st ed. 2550	C°	ns	12.8	12.9	10.0	9.9	12.3	12.9	10.0	10.6	12.7	15.1	15.2	10.4
Sulfate (d)	SM 21st ed. 4500-SO_4 E	mg/L	400	152	192	184	151	72	29	78	74	33	54	64	110
Chloride (d)	ASTM D512-04 C	mg/L	200	46	38	44	54	51	17	45	56	48	57	92	105
Fluoride (t)	EPA method 74	mg/L	4.0	0.21	0.19	0.19	0.15	0.15	0.13	0.14	<0.01	0.28	0.26	0.23	0.21
Nitrate (t)	SM 21st ed. 4500-NO_3 D	mg/L	10.0	0.632	<0.05	0.55	<0.05	4.13	7.73	5.49	3.03	0.552	0.506	<0.05	<0.05
Perchlorate (t)	EPA 314.0	mg/L	0.0049	<0.004	- - - -	- - - -	- - - -	<0.004	- - - -	- - - -	- - - -	<0.004	- - - -	- - - -	- - - -
TDS	SM 21st ed 2540 C	mg/L	1,200	600	618	602	518	564	502	524	470	486	434	646	626
Cyanide (t)	SW-846 9012A	mg/L	0.2	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Antimony (t/d)*	SW-846 3020A	mg/L	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic (t/d)*	SW-846 3005A, 6010B	mg/L	0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Barium (t/d)*	SW-846 3005A, 6010B	mg/L	2.0	0.13	0.09	0.09	0.07	0.07	0.07	0.06	0.05	0.04	0.03	0.04	0.03
Beryllium (t/d)*	SW-846 3005A, 6010B	mg/L	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (t/d)*	SW-846 3005A, 6010B	mg/L	2.0	**3.98**	**4.68**	**4.15**	**3.58**	0.24	0.20	0.20	0.22	0.09	0.09	0.08	0.05
Cadmium (t/d)*	SW-846 3005A, 6010B	mg/L	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (t/d)*	SW-846 3005A, 6010B	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (t/d)*	SW-846 3005A, 6010B	mg/L	1.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper (t/d)*	SW-846 3005A, 6010B	mg/L	0.65	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (t/d)*	SW-846 3005A, 6010B	mg/L	5.0	4.32	0.81	0.24	0.04	1.37	1.09	0.03	<0.02	0.95	0.19	0.06	0.18
Lead (t/d)*	SW-846 3020A	mg/L	0.0075	<0.0075	<0.0075	<0.0075	<0.008	<0.0075	<0.0075	<0.0075	<0.008	<0.0075	<0.0075	<0.0075	<0.008
Manganese (t/d)*	SW-846 3005A, 6010B	mg/L	0.15	**0.544**	**0.723**	**0.702**	**0.600**	0.058	0.038	0.030	0.010	0.123	**0.191**	**0.51**	**1.62**
Mercury (t/d)*	SW-846 7470A	mg/L	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel (t/d)*	SW-846 3005A, 6010B	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (t/d)*	SW-846 3020A	mg/L	0.05	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Silver (t/d)*	SW-846 3005A, 6010B	mg/L	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium (t/d)*	SW-846 3020A	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (t/d)*	SW-846 3020A	mg/L	0.049	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (t/d)*	SW-846 3005A, 6010B	mg/L	5.0	0.023	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

Data do not include Field Replicates. Available upon request.
EWLI - electronic water level indicator.

(d) dissolved
(t) total
(t/d)* Total analyses Quarter's 2 and 3, 2013; dissolved analyses Quarter 4, 2013 and Quarter 1, 2014.
** Sulfate measured as total in samples from wells 33 and 34 during Quarter 4, 2013.

- - Not applicable.
- - - - Not sampled or insufficient groundwater for sampling and/or anlalysis.
ns No standard.

< ND - Not detected at the Reporting Limit

0.42 Parameter concentration exceeds Class I groundwater standard (IAC Part 620 Section 410)

Appendix G2: Inorganic Parameter Groundwater Quality Results .
Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameter	Method Used	Units	Standard Limit	Well 32				Well 33				Well 34			
Date				06/26/13	09/03/13	12/10/13	03/25/14	06/26/13	09/03/13	12/10/13	03/25/14	6/7;6/26/13	09/04/13	12/10/13	03/25/14
pH-field	SM 21st ed. 4500-H^+	s.u.	6.5-9.0	7.52	7.43	7.27	7.25	7.29	7.60	7.30	7.42	- - - -	7.33	7.22	6.96
GW Elevation	EWLI	ft.	- -	443.45	444.10	445.76	447.28	439.18	440.51	444.77	447.77	- - - -	440.04	442.04	448.64
Spec Cond-field	SM 21st ed. 2520-B	micromhos/cm	ns	851	767	785	945	594	517	581	756	- - - -	1,180	1,060	986
Temp-field	SM 21st ed. 2550	C°	ns	12.8	12.9	10.5	5.9	13.1	13.8	10.3	9.7	- - - -	13.0	9.8	11.0
Sulfate (d)	SM 21st ed. 4500-SO_4 E	mg/L	400	102	83	112	95	<100 S	<10	<10**	25	- - - -	80	83**	73
Chloride (d)	ASTM D512-04 C	mg/L	200	69	54	109	87	15	21	12	81	- - - -	81	83	71
Fluoride (t)	EPA method 74	mg/L	4.0	0.18	0.18	0.16	0.13	0.26	0.25	0.22	0.22	- - - -	0.20	0.19	0.17
Nitrate (t)	SM 21st ed. 4500-NO_3 D	mg/L	10.0	5.54	8.72	<0.05	1.04	0.139	<0.05	<0.05	2.26	- - - -	<0.05	<0.05	<0.05
Perchlorate (t)	EPA 314.0	mg/L	0.0049	<0.004	- - - -	- - - -	- - - -	<0.004	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
TDS	SM 21st ed 2540 C	mg/L	1,200	592	486	654	552	388	342	412	382	- - - -	798	772	752
Cyanide (t)	SW-846 9012A	mg/L	0.2	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	- - - -	<0.007	<0.007	<0.007
Antimony (t/d)*	SW-846 3020A	mg/L	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	- - - -	<0.005 S	<0.005	<0.005
Arsenic (t/d)*	SW-846 3005A, 6010B	mg/L	0.01	<0.003	<0.003	<0.003	<0.003	0.008	0.007	**0.017**	<0.003	- - - -	<0.003	<0.003	<0.003
Barium (t/d)*	SW-846 3005A, 6010B	mg/L	2.0	0.04	0.04	0.04	0.03	0.17	0.13	0.17	0.05	- - - -	0.13	0.11	0.10
Beryllium (t/d)*	SW-846 3005A, 6010B	mg/L	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	- - - -	<0.001	<0.001	<0.001
Boron (t/d)*	SW-846 3005A, 6010B	mg/L	2.0	0.08	0.09	0.10	0.09	0.04	0.05	0.04	0.05	- - - -	0.10	0.09	0.11
Cadmium (t/d)*	SW-846 3005A, 6010B	mg/L	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	- - - -	<0.002	<0.002	<0.002
Chromium (t/d)*	SW-846 3005A, 6010B	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	- - - -	<0.01	<0.01	<0.01
Cobalt (t/d)*	SW-846 3005A, 6010B	mg/L	1.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	- - - -	<0.01	<0.01	<0.01
Copper (t/d)*	SW-846 3005A, 6010B	mg/L	0.65	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	- - - -	<0.01	<0.01	<0.01
Iron (t/d)*	SW-846 3005A, 6010B	mg/L	5.0	1.24	2.18	0.29	<0.02	4.92	2.59	**8.13**	0.45	- - - -	**7.97**	**6.81**	3.49
Lead (t/d)*	SW-846 3020A	mg/L	0.0075	<0.0075	<0.0075	<0.0075	<0.008	<0.0075	<0.0075	<0.0075	<0.008	- - - -	<0.0075	<0.0075	<0.008
Manganese (t/d)*	SW-846 3005A, 6010B	mg/L	0.15	0.118	**0.235**	**0.411**	**0.26**	0.146	**0.292**	**0.268**	0.120	- - - -	**1.33**	**1.24**	**1.26**
Mercury (t/d)*	SW-846 7470A	mg/L	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	- - - -	<0.0002	<0.0002	<0.0002
Nickel (t/d)*	SW-846 3005A, 6010B	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	- - - -	<0.01	<0.01	<0.01
Selenium (t/d)*	SW-846 3020A	mg/L	0.05	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	- - - -	<0.04	<0.04	<0.04
Silver (t/d)*	SW-846 3005A, 6010B	mg/L	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	- - - -	<0.01	<0.01	<0.01
Thallium (t/d)*	SW-846 3020A	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	- - - -	<0.002	<0.002	<0.002
Vanadium (t/d)*	SW-846 3020A	mg/L	0.049	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	- - - -	<0.01	<0.01	<0.01
Zinc (t/d)*	SW-846 3005A, 6010B	mg/L	5.0	<0.01	0.011	<0.01	<0.01	0.010	0.014	<0.01	<0.01	- - - -	<0.01	<0.01	<0.01

Notes:

Data do not include Field Replicates. Available upon request.
EWLI - electronic water level indicator.

(d) dissolved
(t) total
(t/d)* Total analyses Quarter's 2 and 3, 2013; dissolved analyses Quarter 4, 2013 and Quarter 1, 2014.
** Sulfate measured as total in samples from wells 33 and 34 during Quarter 4, 2013.

- - Not applicable.
- - - - Not sampled or insufficient groundwater for sampling and/or anlalysis.
ns No standard.

< ND - Not detected at the Reporting Limit

0.42 Parameter concentration exceeds Class I groundwater standard (IAC Part 620 Section 410)

Appendix G3

Class I Groundwater Quality Standards Monitoring Results Organic Parameters

Appendix G3: Organic Parameter Groundwater Quality Results June 2013 – March 2014
Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameter (Organic Chemicals)	Units	Standard Limit (Class I: Potable Resource Groundwater)	Well 21				Well 22			
			6/7/2013	9/3/2013	12/10/2013	3/25/2014	6/7/2013	9/3/2013	12/10/2013	3/25/2014
Acenapthene	mg/L	0.42	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acetone	mg/L	6.3	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Alachlor	mg/L	0.002	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Aldicarb	mg/L	0.003	< 0.0004	< 0.0004	< 0.001	< 0.001	< 0.0004	< 0.0004	< 0.001	< 0.001
Anthracene	mg/L	2.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Atrazine	mg/L	0.003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzene	mg/L	0.005	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Benzo(a)anthracene	mg/L	0.00013	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(b)fluoranthene	mg/L	0.00018	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(k)fluroanthene	mg/L	0.00017	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(a)pyrene	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzoic Acid	mg/L	28.0	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	mg/L	4.2	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Carbofuran	mg/L	0.04	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006
Carbon Disulfide	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Carbon Tetrachloride	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chlordane	mg/L	0.002	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Chloroform	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chrysene	mg/L	0.012	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dalapon	mg/L	0.2	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013
Dibenzo(a,h)anthracene	mg/L	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dicamba	mg/L	0.21	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Dichlorodifluoromethane	mg/L	1.4	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dichloromethane (Methylene Chloride)	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Di [bis](2-ethylhexyl)phthlate	mg/L	0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	**0.005 J**
Diethyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Di-n-butyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dinoseb	mg/L	0.007	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Endothall	mg/L	0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Endrin	mg/L	0.002	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Ethylene Dibromide [EDB] (1,2-Dibromoethane)	mg/L	0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Fluoranthene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fluorene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor	mg/L	0.004	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Heptachlor Epoxide	mg/L	0.0002	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Hexachlorocyclopentadiene	mg/L	0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Indeno(1,2,3-cd)pyrene	mg/L	0.00043	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Isopropylbenzene (Cumene)	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Lindane (Gamma-Hexachlorocyclohexasne)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
2,4-D	mg/L	0.07	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
ortho-Dichlorobenzene	mg/L	0.6	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
para-Dichlorobenzene	mg/L	0.075	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dibromo-3-Chloropropane (DBCB)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
1,1-Dichlorethane	mg/L	1.4	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,1-Dichloroethylene	mg/L	0.007	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
cis-1,2-Dichloroethylene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
trans-1,2-Dichloroethylene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichloropropane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,4-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ethylbenzene	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
MCPP (Mecoprop)	mg/L	0.007	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Methoxychlor	mg/L	0.04	< 0.01	< 0.01	< 0.00005	< 0.00005	< 0.01	< 0.01	< 0.00005	< 0.00005
2-Methylnaphthalene	mg/L	0.028	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2-Methylphenol (o-cresol)	mg/L	0.35	< 0.005	< 0.005	< 0.01	< 0.01	< 0.005	< 0.005	< 0.01	< 0.01
MTBE (methyl tert-butyl ether)	mg/L	0.07	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methylene Chloride	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Monochlorobenzene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	mg/L	0.14	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
P-Dioxane (1,4-Dioxane)	mg/L	0.0077	< 0.0001	< 0.0001	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001
Pentachlorophenol	mg/L	0.001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Phenol	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Picloram	mg/L	0.5	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Pyrene	mg/L	0.21	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
PCBs*	mg/L	0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
alpha-BHC (alpha-Benzene-hexachloride)	mg/L	0.00011	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
gamma-BHC	mg/L	- -	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Simazine	mg/L	0.004	< 0.0006	< 0.0006	< 0.00055	< 0.00055	< 0.0006	< 0.0006	< 0.00055	< 0.00055
Styrene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2,4,5-TP (Silvex)	mg/L	0.05	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Tetrachloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Toluene	mg/L	1.0	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Toxaphene	mg/L	0.003	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	mg/L	0.2	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,1,2-Trichloroethane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2,4-Trichlorobenzene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichloroethane	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trichloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trichlorofluoromethane	mg/L	2.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Vinyl Chloride	mg/L	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Xylenes	mg/L	10.0	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005

Notes:

mg/L Milligrams per Liter.

< ND - Not detected at the Reporting Limit.

J Analyte detected below Reporting Limit.

- - No Class I Groundwater Quality Standard for the listed constituent in IAC Section 620.410, Chapter I, Subtitle F, Title 35.

---- Not sampled or insufficient groundwater for sampling and analysis.

* PCBs - Polychlorinated Biphenyls. Individual PCB compounds (Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260) are each <0.0005 mg/L.

0.42 Parameter concentration exceeds Class I groundwater standard (IAC Part 620 Section 410).

Appendix G3: Organic Parameter Groundwater Quality Results June 2013 - Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameter (Organic Chemicals)	Units	Standard Limit (Class I: Potable Resource Groundwater)	Well 23				Well 24			
			6/7/2013	9/3/2013	12/10/2013	3/25/2014	6/7/2013	9/3/2013	12/10/2013	3/25/2014
Acenapthene	mg/L	0.42	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acetone	mg/L	6.3	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	**0.006 J**	< 0.025	< 0.025
Alachlor	mg/L	0.002	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Aldicarb	mg/L	0.003	< 0.0004	< 0.0004	< 0.001	< 0.001	< 0.0004	< 0.0004	< 0.001	< 0.001
Anthracene	mg/L	2.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Atrazine	mg/L	0.003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzene	mg/L	0.005	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Benzo(a)anthracene	mg/L	0.00013	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(b)fluoranthene	mg/L	0.00018	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(k)fluroanthene	mg/L	0.00017	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(a)pyrene	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzoic Acid	mg/L	28.0	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	mg/L	4.2	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Carbofuran	mg/L	0.04	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006
Carbon Disulfide	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Carbon Tetrachloride	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chlordane	mg/L	0.002	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Chloroform	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chrysene	mg/L	0.012	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dalapon	mg/L	0.2	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013
Dibenzo(a,h)anthracene	mg/L	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dicamba	mg/L	0.21	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Dichlorodifluoromethane	mg/L	1.4	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dichloromethane (Methylene Chloride)	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Di [bis](2-ethylhexyl)phthlate	mg/L	0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006
Diethyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Di-n-butyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dinoseb	mg/L	0.007	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Endothall	mg/L	0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Endrin	mg/L	0.002	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Ethylene Dibromide [EDB] (1,2-Dibromoethane)	mg/L	0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Fluoranthene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fluorene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor	mg/L	0.004	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Heptachlor Epoxide	mg/L	0.0002	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Hexachlorocyclopentadiene	mg/L	0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Indeno(1,2,3-cd)pyrene	mg/L	0.00043	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Isopropylbenzene (Cumene)	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Lindane (Gamma-Hexachlorocyclohexasne)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
2,4-D	mg/L	0.07	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
ortho-Dichlorobenzene	mg/L	0.6	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
para-Dichlorobenzene	mg/L	0.075	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dibromo-3-Chloropropane (DBCB)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
1,1-Dichlorethane	mg/L	1.4	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,1-Dichloroethylene	mg/L	0.007	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
cis-1,2-Dichloroethylene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
trans-1,2-Dichloroethylene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichloropropane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,4-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ethylbenzene	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
MCPP (Mecoprop)	mg/L	0.007	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Methoxychlor	mg/L	0.04	< 0.01	< 0.01	< 0.00005	< 0.00005	< 0.01	< 0.01	< 0.00005	< 0.00005
2-Methylnaphthalene	mg/L	0.028	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2-Methylphenol (o-cresol)	mg/L	0.35	< 0.005	< 0.005	< 0.01	< 0.01	< 0.005	< 0.005	< 0.01	< 0.01
MTBE (methyl tert-butyl ether)	mg/L	0.07	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methylene Chloride	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Monochlorobenzene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	mg/L	0.14	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
P-Dioxane (1,4-Dioxane)	mg/L	0.0077	< 0.0001	< 0.0001	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	**0.00069 J**
Pentachlorophenol	mg/L	0.001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Phenol	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	**0.052**	< 0.005	< 0.005
Picloram	mg/L	0.5	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Pyrene	mg/L	0.21	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
PCBs*	mg/L	0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
alpha-BHC (alpha-Benzene-hexachloride)	mg/L	0.00011	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
gamma-BHC	mg/L	- -	< 0.0001	< 0.0001	< 0.00005	< 0.00005	< 0.0001	< 0.0001	< 0.00005	< 0.00005
Simazine	mg/L	0.004	< 0.0006	< 0.0006	< 0.00055	< 0.00055	< 0.0006	< 0.0006	< 0.00055	< 0.00055
Styrene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2,4,5-TP (Silvex)	mg/L	0.05	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Tetrachloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Toluene	mg/L	1.0	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Toxaphene	mg/L	0.003	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	mg/L	0.2	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	**0.001 J**	< 0.005	**0.0084**
1,1,2-Trichloroethane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2,4-Trichlorobenzene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichloroethane	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trichloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trichlorofluoromethane	mg/L	2.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	**.0044 J**
Vinyl Chloride	mg/L	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Xylenes	mg/L	10.0	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005

Notes:
mg/L Milligrams per Liter.
< ND - Not detected at the Reporting Limit.
J Analyte detected below Reporting Limit.
- - No Class I Groundwater Quality Standard for the listed constituent in IAC Section 620.410, Chapter I, Subtitle F, Title 35.
---- Not sampled or insufficient groundwater for sampling and analysis.
* PCBs - Polychlorinated Biphenyls. Individual PCB compounds (Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260) are each <0.0005 mg/L.
0.42 Parameter concentration exceeds Class I groundwater standard (IAC Part 620 Section 410).

Appendix G3: Organic Parameter Groundwater Quality Results June 2013 - Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameter (Organic Chemicals)	Units	Standard Limit (Class I: Potable Resource Groundwater)	Well 25				Well 26			
			6/7/2013	9/3/2013	12/10/2013	3/25/2014	6/7/2013	9/3/2013	12/10/2013	3/25/2014
Acenapthene	mg/L	0.42	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acetone	mg/L	6.3	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Alachlor	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Aldicarb	mg/L	0.003	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Anthracene	mg/L	2.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Atrazine	mg/L	0.003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	**0.0004**	< 0.0001	**0.00008 J**	< 0.0001
Benzene	mg/L	0.005	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01
Benzo(a)anthracene	mg/L	0.00013	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.025	< 0.025
Benzo(b)fluoranthene	mg/L	0.00018	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(k)fluroanthene	mg/L	0.00017	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0004	< 0.0004
Benzo(a)pyrene	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.01	< 0.01
Benzoic Acid	mg/L	28.0	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	mg/L	4.2	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Carbofuran	mg/L	0.04	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006
Carbon Disulfide	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Carbon Tetrachloride	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chlordane	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Chloroform	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chrysene	mg/L	0.012	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dalapon	mg/L	0.2	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013
Dibenzo(a,h)anthracene	mg/L	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dicamba	mg/L	0.21	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Dichlorodifluoromethane	mg/L	1.4	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dichloromethane (Methylene Chloride)	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Di [bis](2-ethylhexyl)phthlate	mg/L	0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006
Diethyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Di-n-butyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dinoseb	mg/L	0.007	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Endothall	mg/L	0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Endrin	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Ethylene Dibromide [EDB] (1,2-Dibromoethane)	mg/L	0.00005	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fluoranthene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fluorene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor	mg/L	0.004	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor Epoxide	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Hexachlorocyclopentadiene	mg/L	0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Indeno(1,2,3-cd)pyrene	mg/L	0.00043	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Isopropylbenzene (Cumene)	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Lindane (Gamma-Hexachlorocyclohexasne)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
2,4-D	mg/L	0.07	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
ortho-Dichlorobenzene	mg/L	0.6	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
para-Dichlorobenzene	mg/L	0.075	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dibromo-3-Chloropropane (DBCB)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
1,1-Dichlorethane	mg/L	1.4	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,1-Dichloroethylene	mg/L	0.007	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
cis-1,2-Dichloroethylene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
trans-1,2-Dichloroethylene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichloropropane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,4-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ethylbenzene	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
MCPP (Mecoprop)	mg/L	0.007	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Methoxychlor	mg/L	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2-Methylnaphthalene	mg/L	0.028	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2-Methylphenol (o-cresol)	mg/L	0.35	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
MTBE (methyl tert-butyl ether)	mg/L	0.07	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methylene Chloride	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Monochlorobenzene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	mg/L	0.14	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
P-Dioxane (1,4-Dioxane)	mg/L	0.0077	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Pentachlorophenol	mg/L	0.001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Phenol	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Picloram	mg/L	0.5	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Pyrene	mg/L	0.21	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
PCBs*	mg/L	0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
alpha-BHC (alpha-Benzene-hexachloride)	mg/L	0.00011	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
gamma-BHC	mg/L	- -	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Simazine	mg/L	0.004	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006
Styrene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2,4,5-TP (Silvex)	mg/L	0.05	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Tetrachloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Toluene	mg/L	1.0	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Toxaphene	mg/L	0.003	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	mg/L	0.2	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,1,2-Trichloroethane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2,4-Trichlorobenzene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichloroethane	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trichloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trichlorofluoromethane	mg/L	2.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Vinyl Chloride	mg/L	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Xylenes	mg/L	10.0	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005	< 0.005

Notes:

mg/L Milligrams per Liter.

< ND - Not detected at the Reporting Limit.

J Analyte detected below Reporting Limit.

- - No Class I Groundwater Quality Standard for the listed constituent in IAC Section 620.410, Chapter I, Subtitle F, Title 35.

---- Not sampled or insufficient groundwater for sampling and analysis.

* PCBs - Polychlorinated Biphenyls. Individual PCB compounds (Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260) are each <0.0005 mg/L.

0.42 Parameter concentration exceeds Class I groundwater standard (IAC Part 620 Section 410).

Appendix G3: Organic Parameter Groundwater Quality Results June 2013 - Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameter (Organic Chemicals)	Units	Standard Limit (Class I: Potable Resource Groundwater)	Well 27				Well 30			
			6/26/2013	9/3/2013	12/10/2013	3/25/2014	6/26/2013	9/3/2013	12/10/2013	3/25/2014
Acenapthene	mg/L	0.42	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acetone	mg/L	6.3	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Alachlor	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Aldicarb	mg/L	0.003	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Anthracene	mg/L	2.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Atrazine	mg/L	0.003	**0.0005**	**0.0001**	**0.00011**	**0.00008 J**	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzene	mg/L	0.005	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Benzo(a)anthracene	mg/L	0.00013	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(b)fluoranthene	mg/L	0.00018	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(k)fluroanthene	mg/L	0.00017	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(a)pyrene	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzoic Acid	mg/L	28.0	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	mg/L	4.2	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Carbofuran	mg/L	0.04	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006
Carbon Disulfide	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Carbon Tetrachloride	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chlordane	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Chloroform	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chrysene	mg/L	0.012	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dalapon	mg/L	0.2	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013
Dibenzo(a,h)anthracene	mg/L	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dicamba	mg/L	0.21	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Dichlorodifluoromethane	mg/L	1.4	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dichloromethane (Methylene Chloride)	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Di [bis](2-ethylhexyl)phthlate	mg/L	0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006
Diethyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Di-n-butyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dinoseb	mg/L	0.007	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Endothall	mg/L	0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Endrin	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Ethylene Dibromide [EDB] (1,2-Dibromoethane)	mg/L	0.00005	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fluoranthene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fluorene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor	mg/L	0.004	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor Epoxide	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Hexachlorocyclopentadiene	mg/L	0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Indeno(1,2,3-cd)pyrene	mg/L	0.00043	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Isopropylbenzene (Cumene)	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Lindane (Gamma-Hexachlorocyclohexasne)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
2,4-D	mg/L	0.07	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
ortho-Dichlorobenzene	mg/L	0.6	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
para-Dichlorobenzene	mg/L	0.075	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dibromo-3-Chloropropane (DBCB)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
1,1-Dichlorethane	mg/L	1.4	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,1-Dichloroethylene	mg/L	0.007	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
cis-1,2-Dichloroethylene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
trans-1,2-Dichloroethylene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichloropropane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,4-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ethylbenzene	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
MCPP (Mecoprop)	mg/L	0.007	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Methoxychlor	mg/L	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2-Methylnaphthalene	mg/L	0.028	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2-Methylphenol (o-cresol)	mg/L	0.35	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
MTBE (methyl tert-butyl ether)	mg/L	0.07	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methylene Chloride	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Monochlorobenzene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	mg/L	0.14	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
P-Dioxane (1,4-Dioxane)	mg/L	0.0077	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Pentachlorophenol	mg/L	0.001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Phenol	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Picloram	mg/L	0.5	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Pyrene	mg/L	0.21	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
PCBs*	mg/L	0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
alpha-BHC (alpha-Benzene-hexachloride)	mg/L	0.00011	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
gamma-BHC	mg/L	- -	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Simazine	mg/L	0.004	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006
Styrene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2,4,5-TP (Silvex)	mg/L	0.05	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Tetrachloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Toluene	mg/L	1.0	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Toxaphene	mg/L	0.003	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	mg/L	0.2	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,1,2-Trichloroethane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2,4-Trichlorobenzene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichloroethane	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trichloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trichlorofluoromethane	mg/L	2.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Vinyl Chloride	mg/L	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Xylenes	mg/L	10.0	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005

Notes:
mg/L Milligrams per Liter.
< ND - Not detected at the Reporting Limit.
J Analyte detected below Reporting Limit.
- - No Class I Groundwater Quality Standard for the listed constituent in IAC Section 620.410, Chapter I, Subtitle F, Title 35.
---- Not sampled or insufficient groundwater for sampling and analysis.
* PCBs - Polychlorinated Biphenyls. Individual PCB compounds (Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260) are each <0.0005 mg/L.
0.42 Parameter concentration exceeds Class I groundwater standard (IAC Part 620 Section 410).

Appendix G3: Organic Parameter Groundwater Quality Results June 2013 - Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameter (Organic Chemicals)	Units	Standard Limit (Class I: Potable Resource Groundwater)	Well 31				Well 32			
			6/26/2013	9/3/2013	12/10/2013	3/25/2014	6/26/2013	9/3/2013	12/10/2013	3/25/2014
Acenapthene	mg/L	0.42	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acetone	mg/L	6.3	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	**0.007 J**	< 0.025	< 0.025
Alachlor	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Aldicarb	mg/L	0.003	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Anthracene	mg/L	2.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Atrazine	mg/L	0.003	**0.0002**	< 0.0001	**0.0001**	< 0.0001	**0.0001 J**	< 0.0001	**0.00006 J**	< 0.0001
Benzene	mg/L	0.005	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01
Benzo(a)anthracene	mg/L	0.00013	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.025	< 0.025
Benzo(b)fluoranthene	mg/L	0.00018	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzo(k)fluroanthene	mg/L	0.00017	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0004	< 0.0004
Benzo(a)pyrene	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.01	< 0.01
Benzoic Acid	mg/L	28.0	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.0001	< 0.0001
2-Butanone (MEK)	mg/L	4.2	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Carbofuran	mg/L	0.04	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006
Carbon Disulfide	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Carbon Tetrachloride	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chlordane	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Chloroform	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chrysene	mg/L	0.012	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dalapon	mg/L	0.2	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013
Dibenzo(a,h)anthracene	mg/L	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dicamba	mg/L	0.21	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Dichlorodifluoromethane	mg/L	1.4	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dichloromethane (Methylene Chloride)	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Di [bis](2-ethylhexyl)phthlate	mg/L	0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006
Diethyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Di-n-butyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dinoseb	mg/L	0.007	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Endothall	mg/L	0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Endrin	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Ethylene Dibromide [EDB] (1,2-Dibromoethane)	mg/L	0.00005	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fluoranthene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fluorene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor	mg/L	0.004	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor Epoxide	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Hexachlorocyclopentadiene	mg/L	0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Indeno(1,2,3-cd)pyrene	mg/L	0.00043	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Isopropylbenzene (Cumene)	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Lindane (Gamma-Hexachlorocyclohexasne)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
2,4-D	mg/L	0.07	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
ortho-Dichlorobenzene	mg/L	0.6	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
para-Dichlorobenzene	mg/L	0.075	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dibromo-3-Chloropropane (DBCB)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
1,1-Dichlorethane	mg/L	1.4	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,1-Dichloroethylene	mg/L	0.007	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
cis-1,2-Dichloroethylene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
trans-1,2-Dichloroethylene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichloropropane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,4-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ethylbenzene	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
MCPP (Mecoprop)	mg/L	0.007	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Methoxychlor	mg/L	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2-Methylnaphthalene	mg/L	0.028	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2-Methylphenol (o-cresol)	mg/L	0.35	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
MTBE (methyl tert-butyl ether)	mg/L	0.07	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methylene Chloride	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Monochlorobenzene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	mg/L	0.14	**0.00011**	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	**0.00013**	< 0.0001
P-Dioxane (1,4-Dioxane)	mg/L	0.0077	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	**.00068 J**
Pentachlorophenol	mg/L	0.001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Phenol	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Picloram	mg/L	0.5	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Pyrene	mg/L	0.21	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
PCBs*	mg/L	0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
alpha-BHC (alpha-Benzene-hexachloride)	mg/L	0.00011	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
gamma-BHC	mg/L	- -	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Simazine	mg/L	0.004	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006
Styrene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2,4,5-TP (Silvex)	mg/L	0.05	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Tetrachloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Toluene	mg/L	1.0	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Toxaphene	mg/L	0.003	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	mg/L	0.2	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,1,2-Trichloroethane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2,4-Trichlorobenzene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
1,2-Dichloroethane	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trichloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trichlorofluoromethane	mg/L	2.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Vinyl Chloride	mg/L	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Xylenes	mg/L	10.0	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005

Notes:
mg/L Milligrams per Liter.
< ND - Not detected at the Reporting Limit.
J Analyte detected below Reporting Limit.
- - No Class I Groundwater Quality Standard for the listed constituent in IAC Section 620.410, Chapter I, Subtitle F, Title 35.
---- Not sampled or insufficient groundwater for sampling and analysis.
* PCBs - Polychlorinated Biphenyls. Individual PCB compounds (Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260) are each <0.0005 mg/L.
0.42 Parameter concentration exceeds Class I groundwater standard (IAC Part 620 Section 410).

Appendix G3: Organic Parameter Groundwater Quality Results June 2013 - Hydrogeologic Site Characterization Report
West Ash Pond System, Hennepin Power Station

Parameter (Organic Chemicals)	Units	Standard Limit (Class I: Potable Resource Groundwater)	Well 33				Well 34			
			6/26/2013	9/3/2013	12/10/2013	3/25/2014	6/7/13; 6/26/13	9/4/2013	12/10/2013	3/25/2014
Acenapthene	mg/L	0.42	< 0.01	< 0.01	< 0.01	< 0.01	- - - -	< 0.01	< 0.01	< 0.01
Acetone	mg/L	6.3	< 0.025	**0.007 J**	< 0.025	< 0.025	- - - -	**0.007 J**	< 0.025	< 0.025
Alachlor	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Aldicarb	mg/L	0.003	< 0.0004	< 0.0004	< 0.0004	< 0.0004	- - - -	< 0.0004	< 0.0004	< 0.0004
Anthracene	mg/L	2.1	< 0.01	< 0.01	< 0.01	< 0.01	- - - -	< 0.01	< 0.01	< 0.01
Atrazine	mg/L	0.003	< 0.0001	**0.0002**	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Benzene	mg/L	0.005	< 0.002	< 0.002	< 0.002	< 0.002	- - - -	< 0.002	< 0.002	< 0.002
Benzo(a)anthracene	mg/L	0.00013	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Benzo(b)fluoranthene	mg/L	0.00018	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Benzo(k)fluroanthene	mg/L	0.00017	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Benzo(a)pyrene	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Benzoic Acid	mg/L	28.0	< 0.05	< 0.05	< 0.05	< 0.05	- - - -	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	mg/L	4.2	< 0.025	< 0.025	< 0.025	< 0.025	- - - -	< 0.025	< 0.025	< 0.025
Carbofuran	mg/L	0.04	< 0.0006	< 0.0006	< 0.0006	< 0.0006	- - - -	< 0.0006	< 0.0006	< 0.0006
Carbon Disulfide	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Carbon Tetrachloride	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Chlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Chlordane	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Chloroform	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Chrysene	mg/L	0.012	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Dalapon	mg/L	0.2	< 0.0013	< 0.0013	< 0.0013	< 0.0013	- - - -	< 0.0013	< 0.0013	< 0.0013
Dibenzo(a,h)anthracene	mg/L	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Dicamba	mg/L	0.21	< 0.0002	< 0.0002	< 0.0002	< 0.0002	- - - -	< 0.0002	< 0.0002	< 0.0002
Dichlorodifluoromethane	mg/L	1.4	< 0.01	< 0.01	< 0.01	< 0.01	- - - -	< 0.01	< 0.01	< 0.01
Dichloromethane (Methylene Chloride)	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Di [bis](2-ethylhexyl)phthlate	mg/L	0.006	< 0.006	< 0.006	< 0.006	< 0.006	- - - -	< 0.006	< 0.006	< 0.006
Diethyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	- - - -	< 0.01	< 0.01	< 0.01
Di-n-butyl phthalate	mg/L	- -	< 0.01	< 0.01	< 0.01	< 0.01	- - - -	< 0.01	< 0.01	< 0.01
Dinoseb	mg/L	0.007	< 0.0002	< 0.0002	< 0.0002	< 0.0002	- - - -	< 0.0002	< 0.0002	< 0.0002
Endothall	mg/L	0.1	< 0.01	< 0.01	< 0.01	< 0.01	- - - -	< 0.01	< 0.01	< 0.01
Endrin	mg/L	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Ethylene Dibromide [EDB] (1,2-Dibromoethane)	mg/L	0.00005	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Fluoranthene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Fluorene	mg/L	0.28	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Heptachlor	mg/L	0.004	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Heptachlor Epoxide	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Hexachlorocyclopentadiene	mg/L	0.1	< 0.02	< 0.02	< 0.02	< 0.02	- - - -	< 0.02	< 0.02	< 0.02
Indeno(1,2,3-cd)pyrene	mg/L	0.00043	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Isopropylbenzene (Cumene)	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Lindane (Gamma-Hexachlorocyclohexasne)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
2,4-D	mg/L	0.07	< 0.0002	< 0.0002	< 0.0002	**0.000207**	- - - -	< 0.0002	< 0.0002	< 0.0002
ortho-Dichlorobenzene	mg/L	0.6	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
para-Dichlorobenzene	mg/L	0.075	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
1,2-Dibromo-3-Chloropropane (DBCB)	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
1,1-Dichlorethane	mg/L	1.4	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
1,1-Dichloroethylene	mg/L	0.007	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
cis-1,2-Dichloroethylene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
trans-1,2-Dichloroethylene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
1,2-Dichloropropane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
1,4-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Ethylbenzene	mg/L	0.7	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
MCPP (Mecoprop)	mg/L	0.007	< 0.01	< 0.01	< 0.01	< 0.01	- - - -	< 0.01	< 0.01	< 0.01
Methoxychlor	mg/L	0.04	< 0.01	< 0.01	< 0.01	< 0.01	- - - -	< 0.01	< 0.01	< 0.01
2-Methylnaphthalene	mg/L	0.028	< 0.01	< 0.01	< 0.01	< 0.01	- - - -	< 0.01	< 0.01	< 0.01
2-Methylphenol (o-cresol)	mg/L	0.35	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
MTBE (methyl tert-butyl ether)	mg/L	0.07	< 0.002	< 0.002	< 0.002	< 0.002	- - - -	< 0.002	< 0.002	< 0.002
Methylene Chloride	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Monochlorobenzene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Naphthalene	mg/L	0.14	**0.00011**	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
P-Dioxane (1,4-Dioxane)	mg/L	0.0077	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	**0.00076 J**
Pentachlorophenol	mg/L	0.001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Phenol	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Picloram	mg/L	0.5	< 0.0002	< 0.0002	< 0.0002	< 0.0002	- - - -	< 0.0002	< 0.0002	< 0.0002
Pyrene	mg/L	0.21	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
PCBs*	mg/L	0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	- - - -	< 0.0005	< 0.0005	< 0.0005
alpha-BHC (alpha-Benzene-hexachloride)	mg/L	0.00011	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
gamma-BHC	mg/L	- -	< 0.0001	< 0.0001	< 0.0001	< 0.0001	- - - -	< 0.0001	< 0.0001	< 0.0001
Simazine	mg/L	0.004	< 0.0006	< 0.0006	< 0.0006	< 0.0006	- - - -	< 0.0006	< 0.0006	< 0.0006
Styrene	mg/L	0.1	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
2,4,5-TP (Silvex)	mg/L	0.05	< 0.0002	< 0.0002	< 0.0002	< 0.0002	- - - -	< 0.0002	< 0.0002	< 0.0002
Tetrachloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Toluene	mg/L	1.0	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Toxaphene	mg/L	0.003	< 0.0005	< 0.0005	< 0.0005	< 0.0005	- - - -	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	mg/L	0.2	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
1,1,2-Trichloroethane	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
1,2,4-Trichlorobenzene	mg/L	0.07	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
1,2-Dichlorobenzene	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
1,2-Dichloroethane	mg/L	- -	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Trichloroethylene	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Trichlorofluoromethane	mg/L	2.1	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005
Vinyl Chloride	mg/L	0.002	< 0.002	< 0.002	< 0.002	< 0.002	- - - -	< 0.002	< 0.002	< 0.002
Xylenes	mg/L	10.0	< 0.005	< 0.005	< 0.005	< 0.005	- - - -	< 0.005	< 0.005	< 0.005

Notes:
mg/L Milligrams per Liter.
< ND - Not detected at the Reporting Limit.
J Analyte detected below Reporting Limit.
- - No Class I Groundwater Quality Standard for the listed constituent in IAC Section 620.410, Chapter I, Subtitle F, Title 35.
---- Not sampled or insufficient groundwater for sampling and analysis.
* PCBs - Polychlorinated Biphenyls. Individual PCB compounds (Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260) are each <0.0005 mg/L.
0.42 Parameter concentration exceeds Class I groundwater standard (IAC Part 620 Section 410).

OBG

THERE'S A WAY

APPENDIX C
HISTORY OF CONSTRUCTION REPORT (845.220(a)(1))

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October 11, 2021

Dynegy Midwest Generation, LLC
13498 E. 800th Street
Hennepin, Illinois 61327

Subject: Periodic History of Construction Report Update Letter
USEPA Final CCR Rule, 40 CFR §257.73(c)
Hennepin Power Plant
Hennepin, Illinois

Hennepin

At the request of Dynegy Midwest Generation, LLC (DMG), Geosyntec Consultants (Geosyntec) has prepared this Letter to documents updates to the Initial History of Construction (HoC) report for the Hennepin Power Plant (HPP), also known as the Hennepin Power Station (HEN). The Initial HoC report was prepared by AECOM in October of 2016 [1] in accordance with 40 Code of Federal Regulations (CFR) §257.73(c) of the United States Environmental Protection Agency (USEPA) Coal Combustion Residuals Rule, known as the CCR Rule [2]. This letter also includes information required by Section 845.220(a)(1)(B) (Design and Construction Plans) of the state-specific Illinois Environmental Protection Agency (IEPA) Part 845 CCR Rule [3] that is not expressly required by §257.73(c).

BACKGROUND

The CCR Rule required that, by October 17, 2016, Initial HoC reports to be compiled for existing CCR surface impoundments with: (1) a height of five feet or more and a storage volume of 20 acre-feet or more, or (2) a height of 20 feet or more. The Initial HoC report was required to contain, to the extent feasible, the information specified in 40 CFR §257.73(c)(1)(i)-(xii). The Initial HoC report for HPP, which included four existing CCR surface impoundments, the Old West Polishing Pond (OWPP), Old West Ash Pond (Pond No. 1 and Pond No. 3, also known as the OWAP), Ash Pond No. 2 (AP2), and the East Ash Pond (EAP), was prepared and subsequently posted to DMG's CCR Website prior to October 17, 2016.

The CCR Rule requires that Initial HoC to be updated if there is a significant change to any information complied in the Initial HoC report, as listed below:

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§ 257.73(c)(2): If there is a significant change to any information complied under paragraph (c)(1) of this section, the owner or operator of the CCR unit must update the relevant information and place it in the facility's operating record as required by § 257.105(f)(9).

DMG retained Geosyntec to review the Initial HoC report, review reasonably and readily available information for the OWPP, OWAP, AP2, EAP generated since the Initial HoC report was prepared, and perform a site visit to HPP to evaluate if significant changes may have occurred since the Initial HoC report was prepared. This Letter contains the results of Geosyntec's evaluation and documents significant changes that have occurred at the OWPP, OWAP, AP2, and EAP, as they pertain the requirements of §257.73(c)(1)(i)-(xii)

UPDATES TO HISTORY OF CONSTRUCTION REPORT

Geosyntec's evaluation for the HPP OWPP, OWAP, AP2, and EAP determined that no known significant changes requiring updates to the information in the Initial HoC report pertaining to §257.73(c)(1)(ii), (iv), (v), (vi), (vii), (xi), and (xii) of the CCR Rule had occurred since the Initial HoC report was developed.

However, Geosyntec's evaluation determined that significant changes at the HPP EAP pertaining to §257.73(c)(1)(i), (iii), (viii), (ix), and (x) of the CCR Rule had occurred since the Initial HoC report had been developed. Additionally, information how long the CCR EAP and been operating and the types of CCR in the impoundment, as required by Section 845.220(a)(1)(B) of the Part 845 Rule were not included in the Initial HoC report, as this information is not required by the CCR Rule. Each change and the subsequent updates to the Initial HoC report is described within this section.

Hennepin

Section 845.220(a)(1)(B): A statement of ... how long the CCR surface impoundment has been in operation, and the types of CCR that have been placed in the surface impoundment.

East Ash Pond

The EAP was in operation from 1996 until the HPP was retired in December of 2019, for a total of approximately 23 years [1]. Since December of 2019 the EAP has not been actively receiving CCR but has not yet been closed. As of the date of this report, the EAP has been present for approximately 25 years.

CCR placed in the EAP has included bottom ash and fly ash, in addition to other non-CCR waste streams [1].

Old West Polishing Pond and Old West Ash Pond

The OWAP and OWPP were in operation from 1952 to approximately 1996, for a total of approximately 44 years. The OWAP and OWPP did not receive CCR after 1996 but was not closed until 2020. The OWAP and OWPP were present for a total of approximately 68 years prior to closure.

CCR placed in the OWAP and OWPP included fly ash and bottom ash.

Ash Pond No. 2

AP2 was in operation from 1958 until sometime between 2003 and 2009, for a total of approximately 45 to 51 years. AP2 did not receive CCR after sometime between 2003 and 2009, but was not closed until 2020. AP2 was present for a total of approximately 62 years.

CCR placed in AP2 included fly ash and bottom ash.

§ 257.73(c)(1)(i): The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

State identification numbers (IDs) for the OWPP, OWAP, AP2, and EAP have been assigned by the Illinois Environmental Protection Agency (IEPA). Each ID is listed in **Table 1**.

Table 1 – Results of Updated Discharge Capacity Calculations

CCR Surface Impoundment	State ID
Old West Polishing Pond (OWPP)	W1550100002-01
Old West Ash Pond (OWAP)	W1550100002-03
Ash Pond No. 2 (AP2)	W1550100002-04
East Ash Pond (EAP)	W1550100002-05

§ 257.73(c)(1)(iii): A statement of the purpose for which the CCR unit is being used.

The OWPP, OWAP, and EAP2 were closed in 2020, in substantial compliance with the written closure plans posted to DMG's CCR Website ([4], [5], [6]), and as documented by certified Notification of Completion of Closures posted to DMG's CCR Website ([7], [8]). Therefore, the OWAP and EAP2 are no longer capable of storing additional CCR or free liquids, and all CCR was removed from the OWPP as part of closure-by-removal.

The HPP was retired in December of 2019, with the generation of electricity ceased at that time. Therefore, the EAP is no longer being used to actively store and dispose of new CCR, as CCR is no longer being generated by the HPP. The EAP also received inflows from East

Hennepin

Ash Pond No. 2 and the Coal Pile Runoff Pond; these inflows have also ceased as part of plant closure.

§ 257.73(c)(1)(viii): A description of the type, purpose, and location of existing instrumentation.

Instrumentation monitoring at the OWPP, OWAP, and EAP is no longer required as these CCR surface impoundments were closed in accordance with §257.102 ([7], [8]), and the instrumentation network was modified at that time. Therefore, the instrumentation locations shown in Appendix C of the Initial HoC report are no longer applicable to the OWPP, OWAP, and EAP.

§ 257.73(c)(1)(ix): Area-capacity curves for the CCR unit.

An updated area-capacity curve was prepared for the EAP in 2021 and is provided in **Figure 1**.

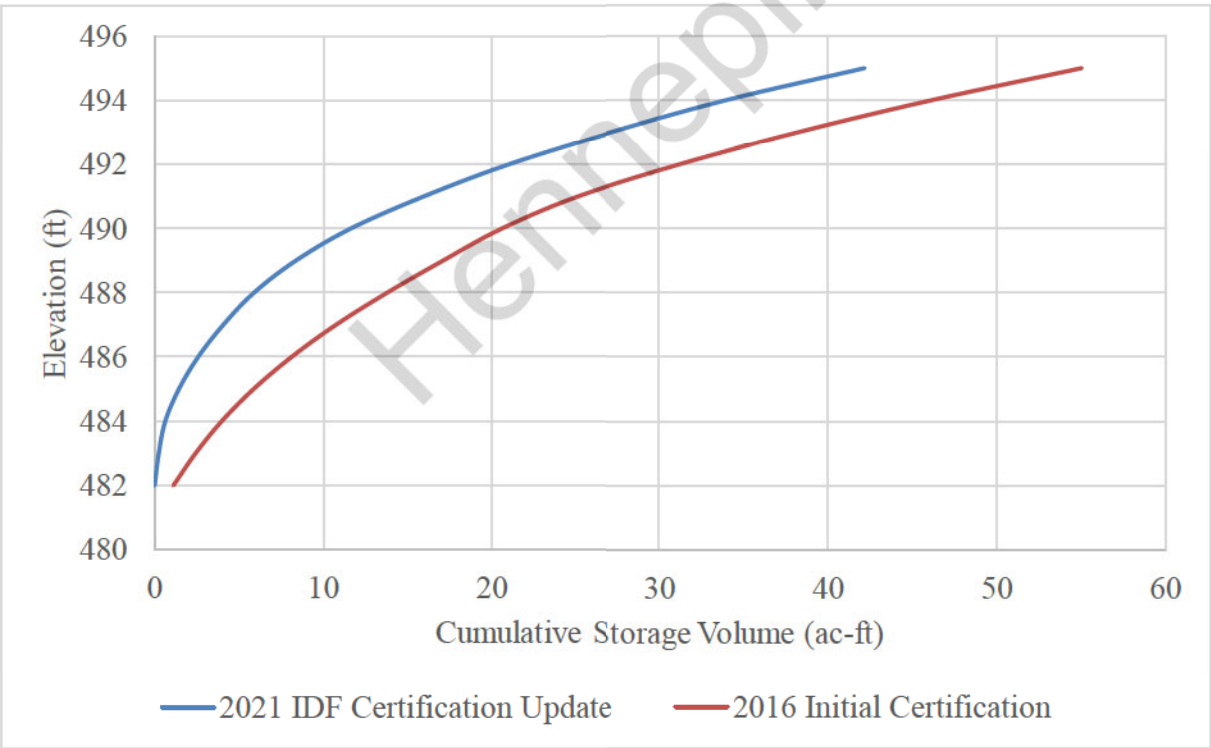

Figure 1 – Area-Capacity Curve for East Ash Pond

§ 257.73(c)(1)(x): A description of each spillway and diversion design features and capacities and calculations used in their determination.

Updated discharge capacity calculations for the existing spillways of the EAP were prepared in 2021 using HydroCAD 10 modeling software. The calculations indicate that the EAP has sufficient storage capacity and will not overtop the embankments during the 1,000-year, 24-hour, storm event. The results of the calculations are provided in **Table 2**.

Table 2 – Results of Updated Discharge Capacity Calculations

	East Ash Pond
Approximate Berm Minimum Elevation[1], ft	492.0
Approximate Emergency Spillway Elevation[1], ft	Not Applicable
Starting Water Surface Elevation[1] (SWSE), ft	490.0
Peak Water Surface Elevation[1] (PWSE), ft	491.4
Time to Peak, hr	16.8
Surface Area[2], ac	5.0
Storage[3], ac-ft	6.3

Notes:
[1]Elevations are based on the NAVD88 datum
[2]Surface area is defined as the water surface area at the PWSE
[3]Storage is defined as the volume between the SWSE and PWSE

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The OWPP, OWAP, and EAP2 no longer retain free water as both CCR surface impoundments were closed in 2020 ([7], [8]). Therefore, the spillways are no longer present and the information regarding the spillways of these structures, as presented in the Initial HoC report, is no longer applicable to the OWPP, OWAP, and EAP2.

CLOSING

This letter has been prepared to document Geosyntec's evaluation of changes that have occurred at the OWPP, OWAP, AP2, and EAP at the HPP since the Initial HoC was developed, based on reasonably and readily available information provided by DMG, observed by Geosyntec during the site visit, or generated by Geosyntec as part of subsequent calculations.

Sincerely,

Lucas P. Carr, P.E.
Senior Engineer

John Seymour, P.E.
Senior Principal

REFERENCES

[1] AECOM, "History of Construction, USEPA Final CCR Rule, 40 CFR § 257.73(c), Hennepin Power Station, Hennepin, Illinois," October 2016.

[2] United Stated Environmental Protection Agency, "40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 2015," 2015.

[3] Illinois Environmental Protection Agency, "35 Ill. Adm. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Springfield, IL, 2021.

[4] V. Modeer, "Closure Plan for Existing CCR Surface Impoundment, 40 CFR 257.102(b), Hennepin Power Station, Dynegy Midwest Generation, LLC, Old West Polishing Pond," October 17, 2016.

[5] V. Modeer, "Closure Plan for Existing CCR Surface Impoundment, 40 CFR 257.102(b), Hennepin Power Station, Dynegy Midwest Generation, LLC, Old West Ash Pond," December 17, 2020.

[6] V. Modeer, "Closure Plan for Existing CCR Surface Impoundment, 40 CFR 257.102(b), Hennepin Power Station, Dynegy Midwest Generation, LLC, East Ash Pond," October 17, 2016.

[7] D. Tickner, "Hennepin Power Station; Old West Polishing Pond, Notificaiton of Completion of Closure," Luminant, December 17, 2020.

[8] D. Tickner, "Hennepin Power Station; Old West Ash Pond, Ash Pond No. 2, Notificaiton of Completion of Closure," Luminant, December 17, 2020.

Hennepin

AECOM

October 2016

Dynegy Midwest Generation, LLC
13498 E 800th St.
Hennepin, IL 61327

RE: History of Construction
USEPA Final CCR Rule, 40 CFR § 257.73(c)
Hennepin Power Station
Hennepin, Illinois

On behalf of Dynegy Midwest Generation, LLC, AECOM has prepared the following history of construction for the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond at the Hennepin Power Station in accordance with 40 CFR § 257.73(c).

BACKGROUND

40 CFR § 257.73(c)(1) requires the owner or operator of an existing coal combustion residual (CCR) surface impoundment that either (1) has a height of five feet or more and a storage volume of 20 acre-feet or more, or (2) has a height of 20 feet or more to compile a history of construction by October 17, 2016 that contains, to the extent feasible, the information specified in 40 CFR § 257.73(c)(1)(i)–(xii).

The history of construction presented herein was compiled based on existing documentation, to the extent that it is reasonably and readily available (see 80 Fed. Reg. 21302, 21380 [April 17, 2015]), and AECOM's site experience. AECOM's document review included construction drawings, geotechnical investigations, operation and maintenance information, etc. for Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond at the Hennepin Power Station.

AECOM

HISTORY OF CONSTRUCTION

§ 257.73(c)(1)(i): The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

Owner: Dynegy Midwest Generation, LLC

Address: 1500 Eastport Plaza Drive
Collinsville, IL 62234

CCR Units: Old West Polishing Pond
Old West Ash Pond (Pond No. 1 and Pond No. 3)
Ash Pond No. 2
East Ash Pond, IDNR Dam ID No. IL50363

The Old West Polishing Pond, Old West Ash Pond, and Ash Pond No. 2 do not have a state assigned identification number.

§ 257.73(c)(1)(ii): The location of the CCR unit identified on the most recent USGS $7^1/_2$ or 15 minute topographic quadrangle map or a topographic map of equivalent scale if a USGS map is not available.

The locations of the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond have been identified on an USGS 7-1/2 minute topographic quadrangle map in **Appendix A**.

§ 257.73(c)(1)(iii): A statement of the purpose for which the CCR unit is being used.

The following captures the purpose of each CCR unit:

- The Old West Polishing Pond (inactive) was used to store and dispose fly ash and bottom ash and is currently being used to clarify stormwater runoff from the Old West Ash Pond prior to discharge in accordance with the station's NPDES permit.
- The Old West Ash Pond (inactive) was used to store and dispose fly ash and bottom ash.
- The Ash Pond No. 2 (inactive) was used to store and dispose fly ash, bottom ash, and other non-CCR waste streams including coal pile runoff.
- The East Ash Pond is being used to store and dispose bottom ash, fly ash, and other non-CCR waste and to clarify process water prior to discharge in accordance with the station's NPDES permit.

Notice of intent to close the Old West Polishing Pond, Old West Ash Pond, and Ash Pond No. 2 was provided in November 2015.[1]

[1] This history of construction report was prepared on a facility-wide basis for CCR surface impoundments at the Hennepin Power Station. The inclusion of the Old West Polishing Pond, Old West Ash Pond, and Ash Pond No. 2 in this history of construction report does not concede and should not be construed to concede that the Old

§ 257.73(c)(1)(iv): The name and size in acres of the watershed where the CCR unit is located.

The Hennepin Power Station and the above-referenced CCR units are located at the western edge of the Depue Lake-Illinois River Watershed with a 12-digit Hydrologic Unit Code (HUC) of 071300010804 and a drainage area of 44,525 acres (USGS 2016).

§ 257.73(c)(1)(v): A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is constructed.

Physical properties of the foundation materials for the Old West Polishing Pond and Old West Ash Pond are described as cohesive material underlain by granular material. The cohesive material consists of lean clay, gravelly clay, silt, clayey silt, and sandy silt. The consistency of the cohesive material varies from very soft to medium stiff. The granular material consists of silty sand and clayey gravel. The relative density of the granular materials varies from loose to very dense and generally increases with depth. An available summary of the engineering properties of the foundation materials for the Old West Polishing Pond and Old West Ash Pond is presented in **Table 1** below. The engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 1. Summary of Material Engineering Properties for the Old West Polishing Pond and Old West Ash Pond

Layer	Unit Weight (pcf)	Total (undrained) Shear Strength Parameters		Effective (drained) Shear Strength Parameters	
		ϕ (deg)	*c (psf)*	*ϕ′ (deg)*	*c′ (psf)*
CL (soft)	120	0	500	28	0
CL (medium stiff gravely clay)	120	28	0	28	0
ML (soft to medium stiff)	125	28	0	28	0
CL-ML (very soft)	120	0	400	26	0
SM (very loose)	125	28	0	28	0
GC (dense)	130	34	0	34	0
GC (very dense)	130	36	0	36	0
Fill: GC (very dense)	130	34	50	34	0

West Polishing Pond, Old West Ash Pond, and Ash Pond No. 2 are subject to the Design Criteria or all Operating Criteria in the CCR Rule.

The Old West Polishing Pond and Old West Ash Pond are enclosed impoundments with dikes and do not have abutments.

Physical properties of the foundation and abutment materials for Ash Pond No. 2 and the East Ash Pond are described as gravel materials with varying amounts of silt and clay. The relative density of the gravel is medium dense to very dense. An available summary of the engineering properties of the foundation materials for Ash Pond No. 2 and the East Ash Pond is presented in **Table 2** below. The engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 2. Summary of Foundation and Abutment Material Engineering Properties for the Ash Pond No. 2 and East Ash Pond

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c' (psf)	Φ' (°)	c (psf)	Φ (°)
Alluvial Foundation	135	0	38	0	38

§ 257.73(c)(1)(vi): A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; the method of site preparation and construction of each zone of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.

Physical properties of the embankment materials for the Old West Polishing Pond and Old West Ash Pond are described as gravel with occasional zones of clayey sand and lean clay. The gravel has a general relative density of very dense. An available summary of the engineering properties of the embankment materials for the Old West Polishing Pond and Old West Ash Pond is presented in **Table 1** above. The engineering properties are based on previous geotechnical explorations and laboratory testing.

The physical properties of Ash Pond No. 2 embankment construction materials are described in this paragraph. The original embankments are constructed of sand with varying amounts of coal pieces and gravel. The initial embankment raise is constructed of silty clay, clayey sand, sand, and gravel and the later embankment raise is constructed with layers of lean clay, silty clay, clayey silt, clayey, and gravel. An available summary of the engineering properties of the embankment materials for Ash Pond No. 2 is presented in **Table 3** below. The engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 3. Summary of Construction Material Engineering Properties for Ash Pond No. 2

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c' (psf)	Φ' (°)	c (psf)	Φ (°)
Fill: GP-GM (medium dense)	125	0	32	0	32
Fill: CL (hard)	120	0	32	4000	0
Fill: ML (hard)	120	0	32	4500	0
Fill: SC (medium dense)	120	0	28	0	28

Physical properties of the embankment materials for the East Ash Pond are described as clayey silt and clay. The consistency of both the clayey silt and clay ranges from stiff to hard. The original pond surface is lined with a 4-foot thick compacted clay layer of 1.0 x 10^{-7} cm/s underlain by a 1-foot thick sand layer. The liner system of the embankment raise consists of a (from top to bottom) 45 mil reinforced polyethylene geomembrane, a 1-foot thick clay layer, and an 8 oz/sy polypropylene geotextile. A typical cross section profile of the liner system is shown on drawing C-56 presented in **Appendix B**. An available summary of the construction material engineering properties for the East Ash Pond is presented in **Table 4** below. The engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 4. Summary of Construction Material Engineering Properties for the East Ash Pond

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c' (psf)	Φ' (°)	c (psf)	Φ (°)
Embankment Fill	105	30	32	2500	0
Liner System	120	60	30	2500	0

The method of site preparation and construction of the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and the original East Ash Pond are not reasonably and readily available. Site preparation and construction of the 2003 East Ash Pond liner raise were completed in accordance with the applicable construction specification (see § 257.73(c)(1)(xi) below).

Reasonably and readily available approximate dates of construction of each successive stage of construction of the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond are provided in **Table 5** below.

Table 5. Approximate dates of construction of each successive stage of construction.

Date	Event
1951 to 1952	Construction of historical Ash Pond No. 1
1958	Construction of Ash Pond No. 2
Late 1960's	Construction of historical Ash Pond No. 3
1978	Embankment raise of Ash Pond No. 2
1985	Embankment raise of Ash Pond No. 2 to elevation 484 feet and Ash Pond No. 3 (Old West Ash Pond) to elevation 460 feet
1988 to 1989	Embankment raise of Old West Ash Pond to elevation 465 feet that merged historical Ash Pond No. 1 and Ash Pond No. 3 into one single pond and created the Old West Polishing Pond
1989	Embankment raise of Ash Pond No. 2 to elevation 494 feet
1995 to 1996	Construction of East Ash Pond
2003	Embankment liner raise of East Ash Pond
2009 to 2010	Eastern portion of Ash Pond No. 2 was removed to facilitate construction of the Leachate Pond
2011	Landfill Cell 1 was constructed over placed CCR in Ash Pond No. 2 adjacent to the Leachate Pond
2014	North Embankment tree removal, grading, and vegetation re-establishment of Ash Pond No. 2

§ 257.73(c)(1)(vii): At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR unit due to malfunction or mis-operation.

Drawings that contain items pertaining to the requested information for the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond are listed in **Table 6** below. Items marked as "Not Available" are items not found during a review of the reasonably and readily available record documentation.

Table 6. List of drawings containing items pertaining to the information requested in § 257.73(c)(1)(vii).

	Old West Polishing Pond	Old West Ash Pond	Ash Pond No. 2	East Ash Pond
Dimensional plan view (all zones)	HEN1-B460-2	HEN1-B460-1 to 2	HEN1-B461, HEN1-C117	HEN1-C55
Dimensional cross sections	HEN1-B452 to B457	HEN1-B452 to B457	HEN1-B458-1 to 7, Berm Modification Drawings 7 to 9	HEN1-C56 to C59
Foundation Improvements	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Drainage Provisions	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Spillways and Outlets	Not Available	Not Available	Not Applicable	HEN1-C8 to C9, HEN1-C109, HEN1-C113
Diversion Ditches	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Instrument Locations	Figure 2D	Figure 2C	Figure 2A	Figure 2B
Slope Protection	Not Available	Not Available	Berm Modification Drawings 3 to 9	HEN1-C56 to C59
Normal Operating Pool Elevation	Not Available	Not Available	Not Available	Not Available
Maximum Pool Elevation	Not Available	Not Available	Not Available	Not Available
Approximate Maximum Depth of CCR in 2016	11 feet	15 feet	46 feet	35 feet

All drawings referenced in **Table 6** above can be found in **Appendix B** and **Appendix C**.

Based on the review of the drawings listed above, no natural or manmade features that could adversely affect operation of these CCR units due to malfunction or mis-operation were identified.

§ 257.73(c)(1)(viii): A description of the type, purpose, and location of existing instrumentation.

Existing instrumentation consists of open-standpipe piezometers installed in 2015. The purpose of the piezometers is to measure the pore water pressures within the embankments of the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond. There are seven (7) existing piezometers within the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond. A location map of the existing instrumentation is presented in **Appendix C**.

§ 257.73(c)(1)(ix): Area-capacity curves for the CCR unit.

Area-capacity curves for the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond are not reasonably and readily available.

§ 257.73(c)(1)(x): A description of each spillway and diversion design features and capacities and calculations used in their determination.

The Old West Polishing Pond contains a 24-inch diameter corrugated metal pipe (CMP) outlet that discharges stormwater to the Illinois River in accordance with the station's NPDES permit. Current capacity and calculation information for the Old West Polishing Pond's discharge capability is not reasonably and readily available.

The Old West Ash Pond contains a 24-inch dia. pipe culvert. Stormwater collected within the CCR unit drains via surface flow and through the pipe culvert into the Old West Polishing Pond. Current capacity and calculation information for the Old West Ash Pond's discharge capability is not reasonably and readily available.

The Ash Pond No. 2 does not contain a spillway or diversion feature. Stormwater collected within the CCR unit drains via surface flow into the East Ash Pond. Current capacity and calculation information for the Ash Pond No. 2's discharge capability is not reasonably and readily available.

The East Ash Pond contains two outlet structures. The southeast outlet is a 5-foot wide stop-log structure that is connected to a 36-inch diameter reinforced concrete pipe (RCP). The 36-inch diameter RCP discharges into the East Polishing Pond. The northeast outlet, located on the northeast corner of the East Ash Pond, is a headwall structure connected to an 18-inch diameter RCP. The 18-inch diameter RCP discharges into the East Leachate Pond. In 2016, the discharge capacity of the East Ash Pond was evaluated using HydroCAD 10 software modeling a 1,000-year, 24-hour rainfall event. The model results indicate that the East Ash Pond has enough storage capacity and will not overtop the embankment during the 1,000-year, 24-hour storm event. The results of the HydroCAD 10 analysis are presented below in **Table 7**.

Table 7. Results of HydroCAD 10 analysis

	East Ash Pond
Approximate Minimum Berm Elevation[1] (ft)	493.0
Approximate Emergency Spillway Elevation[1] (ft)	Not Applicable
Starting Pool Elevation[1] (ft)	490.4
Peak Elevation[1] (ft)	492..2
Time to Peak (hr)	12.5
Surface Area (ac)	6.5
Storage[2] (ac-ft)	8.4

Note: 1. Elevations are based on NAVD88 datum
2. Storage given is from Starting Pool Elevation to Peak Elevation.

§ 257.73(c)(1)(xi): The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.

The construction specifications for Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and the original East Ash Pond are not reasonably and readily available. The construction specification for the 2003 East Ash Pond liner raise is located in *Specification J-2616, Rev. A* (presented in **Appendix D**).

The provisions for surveillance, maintenance, and repair of the Old West Polishing Pond and Old West Ash Pond are located in *Hennepin Power Station; West Ash Disposal Pond Maintenance Plan* (2013) (presented in **Appendix E**). The provisions for surveillance, maintenance, and repair of Ash Pond No. 2 are located in *Hennepin Power Station; Old East Ash Disposal Pond Maintenance Plan* (2013) (presented in **Appendix F**). The provisions for surveillance, maintenance, and repair of the East Ash Pond are located in *Hennepin Power Station; East Ash Disposal Pond Maintenance Plan* (2014) (presented in **Appendix G**).

The operations and maintenance plans for the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond are currently being revised by Dynegy Midwest Generation, LLC.

§ 257.73(c)(1)(xii): Any record or knowledge of structural instability of the CCR unit.

There is no record or knowledge of structural instability of the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond at the Hennepin Power Station.

AECOM

LIMITATIONS

The signature of AECOM's authorized representative on this document represents that to the best of AECOM's knowledge, information and belief in the exercise of its professional judgment, it is AECOM's professional opinion that the aforementioned information is accurate as of the date of such signature. Any recommendation, opinion or decisions by AECOM are made on the basis of AECOM's experience, qualifications and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data and that actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

Sincerely,

Claudia Prado
Project Manager

Victor Modeer, P.E., D.GE
Senior Project Manager

REFERENCES

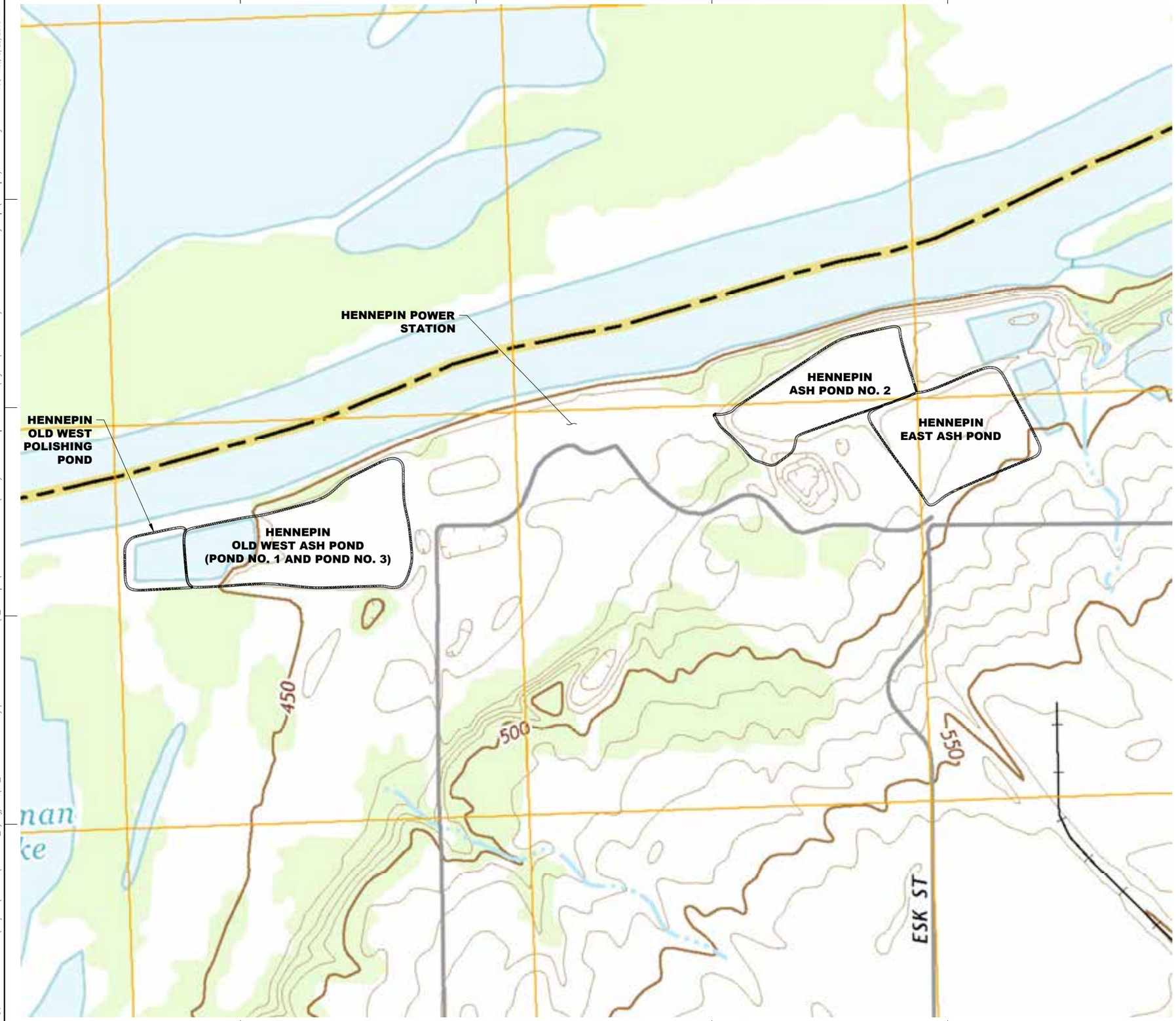
United States Environmental Protection Agency (USEPA). (2015). *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule.* 40 CFR Parts 257 and 261, 80 Fed. Reg. 21302, 21380 April 17, 2015.

United States Geological Survey (USGS). (2016). The National Map Viewer. http://viewer.nationalmap.gov/viewer/. USGS data first accessed in March of 2016.

APPENDICES

Appendix A: History of Construction Vicinity Map
Appendix B: Hennepin Power Station Drawings
Appendix C: Hennepin Power Station Piezometer Locations
Appendix D: Specification J-2616, Rev. A, Primary Ash Pond Modifications
Appendix E: Hennepin Power Station; West Ash Disposal Pond Maintenance Plan (2013)
Appendix F: Hennepin Power Station; Old East Ash Disposal Pond Maintenance Plan (2013)
Appendix G: Hennepin Power Station; East Ash Disposal Pond Maintenance Plan (2014)

Appendix A: History of Construction Vicinity Map



LEGEND

CCR UNITS

SOURCE:
MAP PROVIDED FROM ELECTRONIC USGS DIGITAL RASTER GRAPHIC 7.5 MINUTE TOPOGRAPHIC MAP OF DEPUE ILLINOIS, REVISED 2015.

QUADRANGLE LOCATION

N

0 400 800 1200

SCALE IN FEET

AECOM
1001 Highlands Plaza Drive, Suite 300
St. Louis, Mo. 63110
314 429-0100 (phone)
314-429-0462 (fax)

DYNEGY MIDWEST GENERATION, L.L.C.
13498 East 800th Street
Hennepin, IL 61327

HISTORY OF CONSTRUCTION

HENNEPIN POWER STATION
HENNEPIN, ILLINOIS

ISSUED FOR BIDDING DATE BY

ISSUED FOR CONSTRUCTION DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

AECOM PROJECT NO:	60489731
DRAWN BY:	DJD
DESIGNED BY:	DJD
CHECKED BY:	MN
DATE CREATED:	2016-04-13
PLOT DATE:	
SCALE:	1" = 400'
ACAD VER:	2014

SHEET TITLE

HISTORY OF CONSTRUCTION VICINITY MAP

01

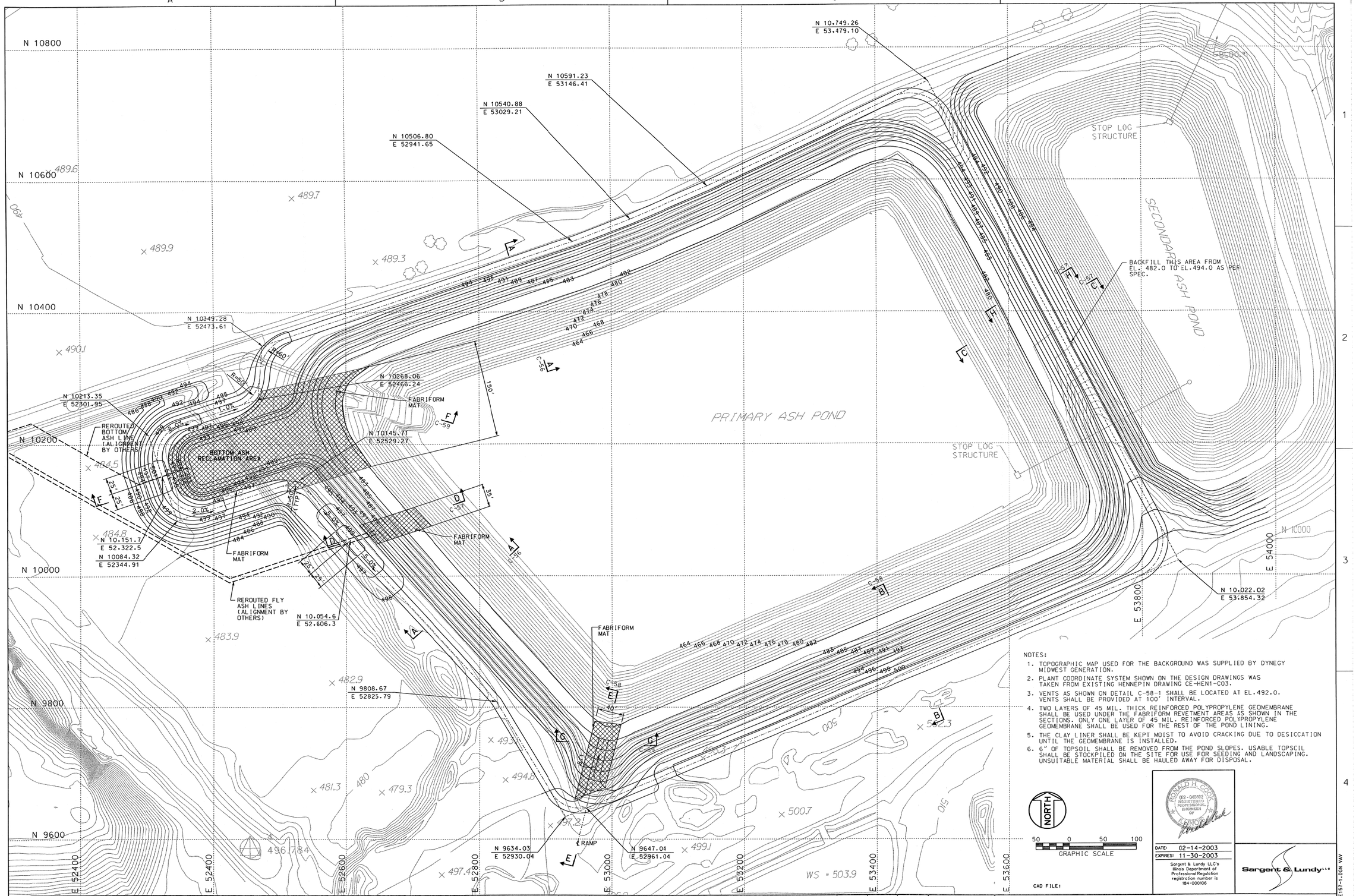
AECOM DRAWING PATH: P:\Projects\Geotech\60428794_DynegyCCR\13_Construction History\04 Technical Production\4_Hennepin\Reference Documents\Vicinity Location Map References\Figures\C-01 History of Construction Vicinity Map (Hennepin) - MAP.dwg NANAK, MATT, 9/28/2016 4:11 PM

Appendix B: Hennepin Power Station Drawings

1. “Plan of Primary Ash Pond, Modification to Primary Ash Pond”, Drawing No. C-55, Revision 0.1, 14 February, 2003, Sargent & Lundy, LLC.
2. “Sections and Details – Sheet 1, Modification to Primary Ash Pond”, Drawing No. C-56, Revision 0.1, 14 February, 2003, Sargent & Lundy, LLC.
3. “Sections and Details – Sheet 2, Modification to Primary Ash Pond”, Drawing No. C-57, Revision 0.1, 14 February, 2003, Sargent & Lundy, LLC.
4. “Sections and Details – Sheet 3, Modification to Primary Ash Pond”, Drawing No. C-58, Revision 0.1, 14 February, 2003, Sargent & Lundy, LLC.
5. “Sections and Details – Sheet 4, Modification to Primary Ash Pond”, Drawing No. C-59, Revision 0.1, 14 February, 2003, Sargent & Lundy, LLC.
6. “Cross Sections of Ash Pond Berm Extension, Sta 1+00, 5+00 & 9+50”, Drawing No. E-HEN1-B452, Revision 0, 4 November, 1997, Illinois Power Company.
7. “Cross Sections of Ash Pond Berm Extension, Sta 14+25, 20+80 & 26+00”, Drawing No. E-HEN1-B453, Revision 0, 4 November, 1997, Illinois Power Company.
8. “Cross Sections of Ash Pond Berm Extension, Sta 30+00, 35+00 & 39+00”, Drawing No. E-HEN1-B454, Revision 0, 4 November, 1997, Illinois Power Company.
9. “Cross Sections of Ash Pond Berm Extension, Sta 40+00, 42+00, 44+90”, Drawing No. E-HEN1-B455, Revision 0, 4 November, 1997, Illinois Power Company.
10. “Cross Sections of Ash Pond Berm Extension, Sta 47+00, 51+00 & 56+00”, Drawing No. E-HEN1-B456, Revision 0, 4 November, 1997, Illinois Power Company.
11. “Cross Sections of Ash Pond Berm Extension, Sta 61+50”, Drawing No. E-HEN1-B457, Revision 0, 4 November, 1997, Illinois Power Company.
12. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-1, Revision 0, 8 March, 1990, Illinois Power Company.
13. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-2, Revision 0, 8 March, 1990, Illinois Power Company.
14. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-3, Revision 0, 8 March, 1990, Illinois Power Company.
15. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-4, Revision 0, 8 March, 1990, Illinois Power Company.
16. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-5, Revision 0, 8 March, 1990, Illinois Power Company.
17. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-6, Revision 0, 8 March, 1990, Illinois Power Company.
18. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-7, Revision 0, 8 March, 1990, Illinois Power Company.
19. “Plan-Unit #1 Ash Pond Extension, Sheet #1”, Drawing No. E-HEN1-B460-1, 2 February, 1988, Illinois Power Company.
20. “Plan-Unit #1 Ash Pond Extension, Sheet #2”, Drawing No. E-HEN1-B460-2, 2 February, 1988, Illinois Power Company.

Appendix B: Hennepin Power Station Drawings (continued)

21. “Contour and Grading Plan, Unit #2 Ash Pond Extension”, Drawing No. CE-HEN1-B461, Revision 0, 8 March, 1990, Illinois Power Company.
22. “Pond 2 East, Flexible Membrane Liner and Structures”, Drawing No. HEN1-C109, Revision 0, 28 July, 2010, Civil & Environmental Consultants, Inc.
23. “Pond 2 East, Details”, Drawing No. HEN1-C113, Revision 0, 28 July, 2010, Civil & Environmental Consultants, Inc.
24. “Landfill Phase 1 Construction, Existing Conditions”, Drawing No. HEN1-C117, Revision 0, 28 November, 2010, Civil & Environmental Consultants, Inc.
25. “Layout-Pond Discharge Structures, 1995 Ash Facility”, Drawing No. CE-HEN1-C8, Revision 0, 17 September, 1996, Illinois Power Company.
26. “Details: Pond Discharge Structure, 1995 Ash Facility”, Drawing No. CE-HEN1-C9, Revision 0, 17 September, 1996, Illinois Power Company.
27. “East Berm Modification, Existing Site Conditions”, Drawing No. 3, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
28. “East Berm Modification, Proposed Site Plan”, Drawing No. 4, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
29. “East Berm Modification, Proposed Grading Plan 1 of 2”, Drawing No. 5, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
30. “East Berm Modification, Proposed Grading Plan 2 of 2”, Drawing No. 6, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
31. “East Berm Modification, Proposed Sections Sta 1+00 to 15+00”, Drawing No. 7, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
32. “East Berm Modification, Proposed Sections Sta 16+00 to 23+50”, Drawing No. 8, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
33. “East Berm Modification, Berm and Erosion Control Details”, Drawing No. 9, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.



NOTES:

1. TOPOGRAPHIC MAP USED FOR THE BACKGROUND WAS SUPPLIED BY DYNEGY MIDWEST GENERATION.
2. PLANT COORDINATE SYSTEM SHOWN ON THE DESIGN DRAWINGS WAS TAKEN FROM EXISTING HENNEPIN DRAWING CE-HEN1-C03.
3. VENTS AS SHOWN ON DETAIL C-58-1 SHALL BE LOCATED AT EL.492.0. VENTS SHALL BE PROVIDED AT 100' INTERVAL.
4. TWO LAYERS OF 45 MIL. THICK REINFORCED POLYPROPYLENE GEOMEMBRANE SHALL BE USED UNDER THE FABRIFORM REVETMENT AREAS AS SHOWN IN THE SECTIONS. ONLY ONE LAYER OF 45 MIL. REINFORCED POLYPROPYLENE GEOMEMBRANE SHALL BE USED FOR THE REST OF THE POND LINING.
5. THE CLAY LINER SHALL BE KEPT MOIST TO AVOID CRACKING DUE TO DESICCATION UNTIL THE GEOMEMBRANE IS INSTALLED.
6. 6" OF TOPSOIL SHALL BE REMOVED FROM THE POND SLOPES. USABLE TOPSCIL SHALL BE STOCKPILED ON THE SITE FOR USE FOR SEEDING AND LANDSCAPING. UNSUITABLE MATERIAL SHALL BE HAULED AWAY FOR DISPOSAL.

NORTH

50 0 50 100
GRAPHIC SCALE

CAD FILE:

RONALD H. COOK
062-045092
REGISTERED PROFESSIONAL ENGINEER OF ILLINOIS

DATE: 02-14-2003
EXPIRES: 11-30-2003

Sargent & Lundy LLC's Illinois Department of Professional Regulation registration number is 184-000106

Sargent & Lundy LLC

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REFERENCE DRAWINGS

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D
0.1	02-14-2003	FOR PERMIT	MED	VP	———

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D

SCALE:	1"=50'	
DWN. M.DOWNS	DATE	02-12-03
CHK. V.PATEL	DATE	02-14-03
APPV.	DATE	

DYNEGY

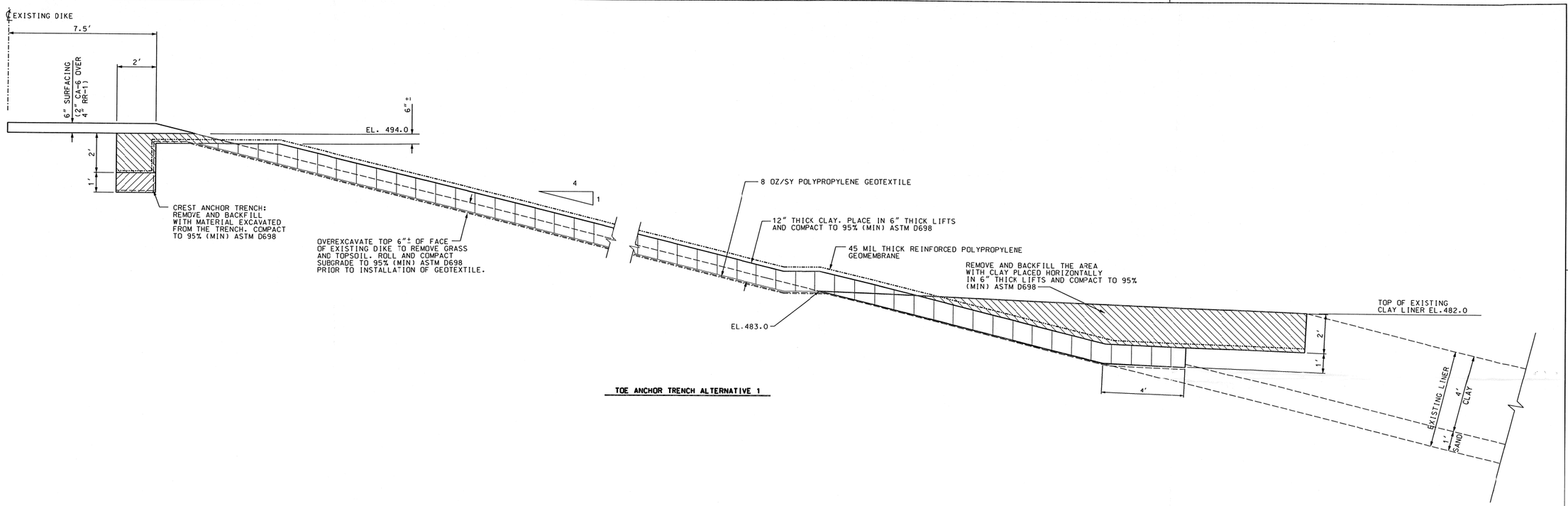
PLAN OF PRIMARY ASH POND

MODIFICATION TO PRIMARY ASH POND
HENNEPIN POWER STATION

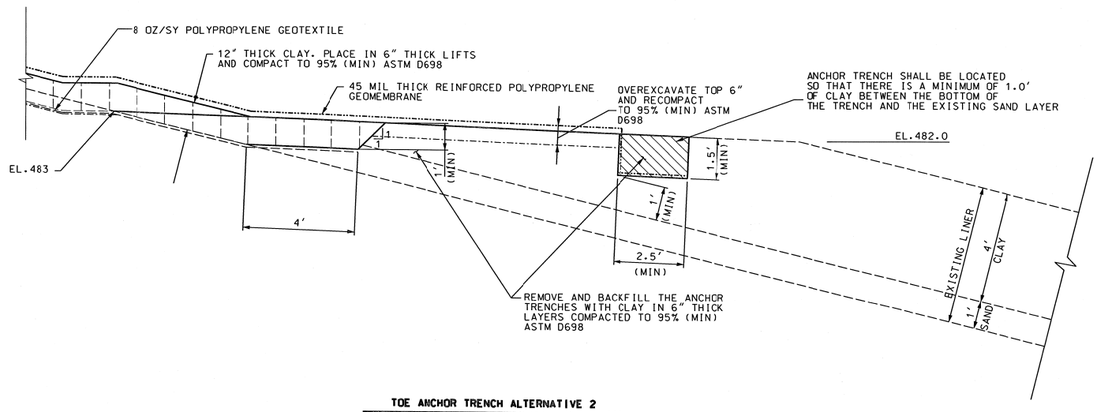
PROJECT NO.: 08820-331
CLIENT: DYNEGY MIDWEST GENERATION
DWG. NO.: C-55
REV.: 0.1

E-MOD1-E157-1.DGN VAY
07-10-2001

02-13-03 ALS



TOE ANCHOR TRENCH ALTERNATIVE 1



TOE ANCHOR TRENCH ALTERNATIVE 2

SECTION A
SEE DWG C-55

2 0 2 4
GRAPHIC SCALE
HOR 1/2"=1'-0"

2 0 2 4
GRAPHIC SCALE
VER 1/2"=1'-0"

NOTES:

1. CONTRACTOR SHALL BE RESPONSIBLE FOR CHECKING EXISTING ELEVATIONS AND DIMENSIONS PRIOR TO FABRICATION OF THE GEOMEMBRANE LINER.
2. CONTRACTOR MAY USE EITHER ALTENATIVE 1 OR ALTERNATIVE 2 AS APPROVED BY THE BUYER FOR ALL TOE ANCHOR TRENCH DETAILS.
3. DIMENSIONS WERE TAKEN FROM TYPICAL SECTION ON DRAWING CH-HEN1-C6.1 DATED 12-9-93.

CAD FILE:

RONALD H. COOK 062-040802 REGISTERED PROFESSIONAL ENGINEER OF ILLINOIS

DATE: 02-14-2003
EXPIRES: 11-30-2003
Sargent & Lundy LLC's Illinois Department of Professional Regulation registration number is 184-000106

Sargent & Lundy LLC

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NO.	DATE	REVISION	PREP'D	REV'D	APPR'D
0.1	02-14-2003	FOR PERMIT	MED	VP	

SCALE:
DWN. M.DOWNS DATE 02-12-02
CHK. V.PATEL DATE 02-14-03
APPV. DATE

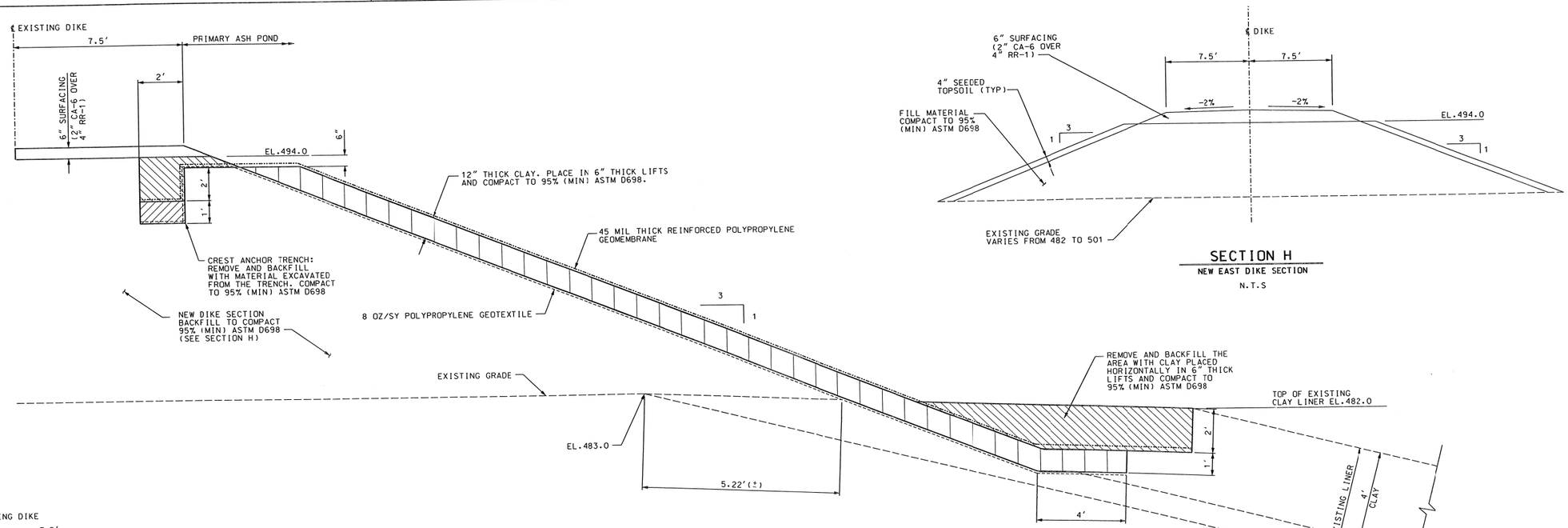
DYNEGY

SECTIONS AND DETAILS - SHEET 1
MODIFICATION TO PRIMARY ASH POND
HENNEPIN POWER STATION

PROJECT NO.: 08820-331
CLIENT: DYNEGY MIDWEST GENERATION
DWG. NO.: C-56 REV. 0.1

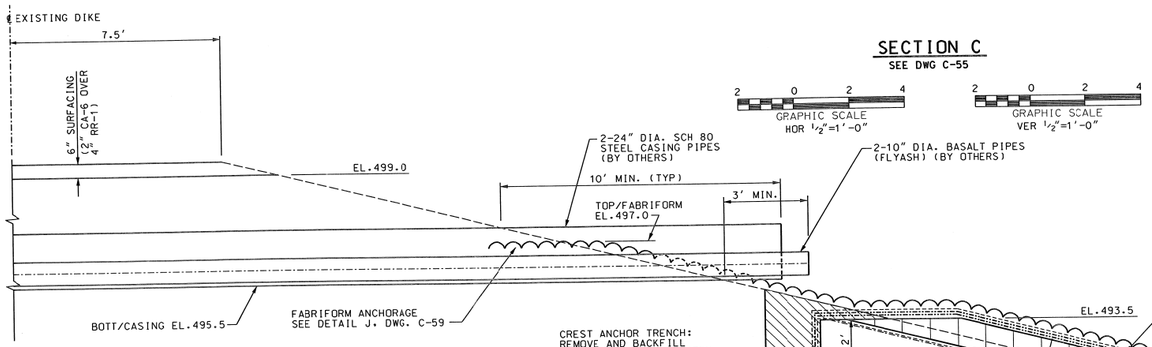
E-MOD1-E157-1.DGN VAX 07-10-2001

02-13-03 ALS



SECTION C
SEE DWG C-55

SECTION H
NEW EAST DIKE SECTION
N.T.S



SECTION D
SEE DWG C-55

DATE: 02-14-2003
EXPIRES: 11-30-2003
Sargent & Lundy LLC's Illinois Department of Professional Regulation registration number is 184-000106

Sargent & Lundy LLC

CAD FILE:

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REFERENCE DRAWINGS

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D
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SCALE: 1/2"=1'-0"
DWN. M.DOWNS DATE 02-12-02
CHK. V.PATEL DATE 02-14-03
APPV. DATE

DYNEGY

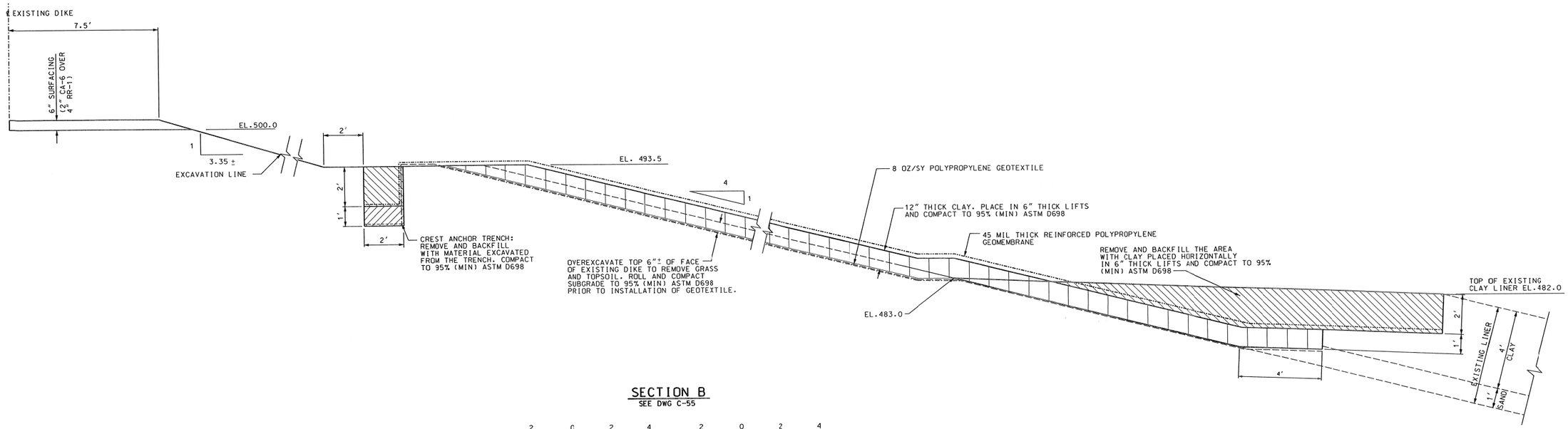
SECTIONS AND DETAILS - SHEET 2

MODIFICATION TO PRIMARY ASH POND
HENNEPIN POWER STATION

PROJECT NO.: 08820-331
CLIENT: DYNEGY MIDWEST GENERATION
DWG. NO.: C-57 REV.: 0.1

02-13-03 ALS

E-MDR-E157-1.DGN VAV 07-10-2001



SECTION B
SEE DWG C-55

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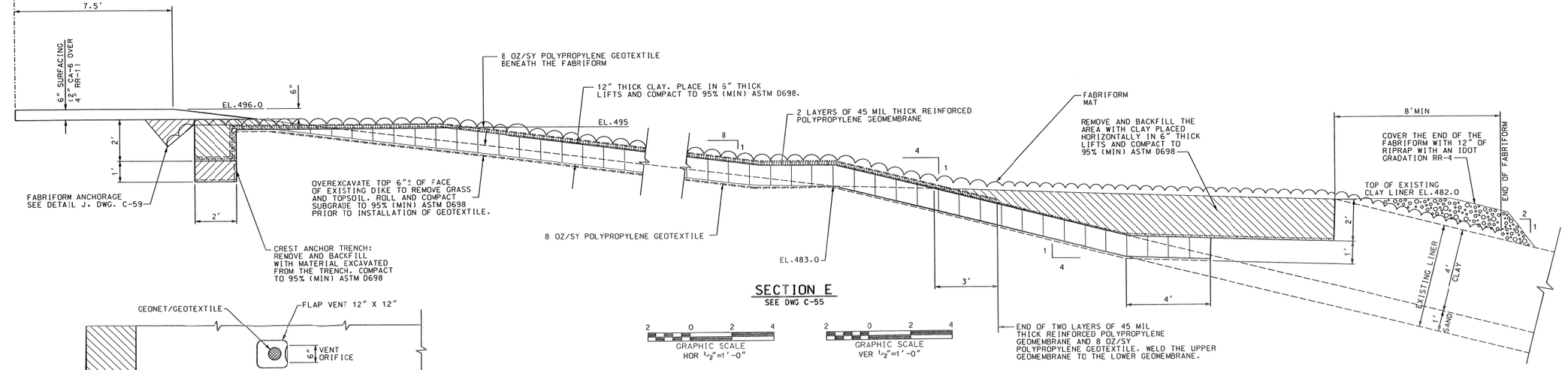
HCR 1/2"=1'-0"

2 0 2 4
GRAPHIC SCALE
VER 1/2"=1'-0"



SECTION E
SEE DWG C-55

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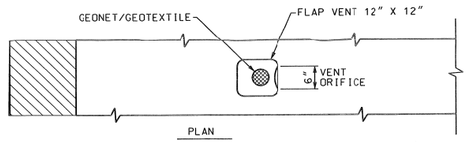
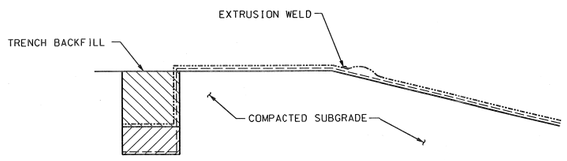
2 0 2 4
GRAPHIC SCALE
VER 1/2"=1'-0"



PLAN



SECTION

DETAIL C-58-1
MAXIMUM INTERVAL SHALL BE 100'

RONALD H. COX
062-048809
REGISTERED
PROFESSIONAL
ENGINEER
OF
ILLINOIS

DATE: 02-14-2003
EXPIRES: 11-30-2003
Sargent & Lundy LLC's Illinois Department of Professional Regulation registration number is 184-000106

Sargent & Lundy LLC

CAD FILE:

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REFERENCE DRAWINGS

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D
0.1	02-14-2003	FOR PERMIT	MED	VP	———

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D

SCALE 1/2"=1'-0"
DWN. M.DOWNS DATE 02-14-03
CHK. V.PATEL DATE 02-14-03
APPV. DATE

DYNEGY

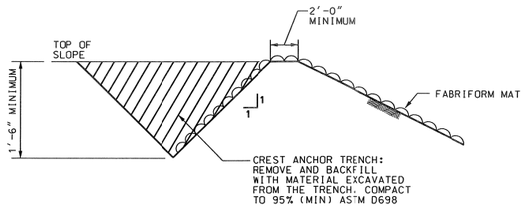
SECTIONS AND DETAILS - SHEET 3

MODIFICATION TO PRIMARY ASH POND
HENNEPIN POWER STATION

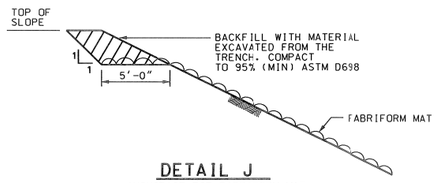
PROJECT NO.: 08820-331
CLIENT: DYNEGY MIDWEST GENERATION
DWG. NO.: C-58
REV. 0.1

02-12-03 ALS

E-MDR1-E157-1.DGN VAV
07-10-2001

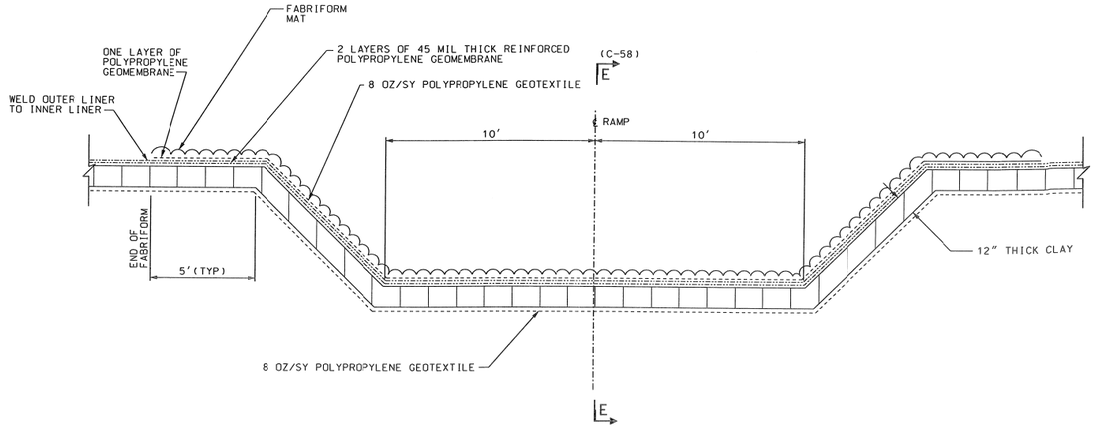


ANCHORAGE IF PROTECTION IS PROVIDED TO THE TOP OF THE SLOPE



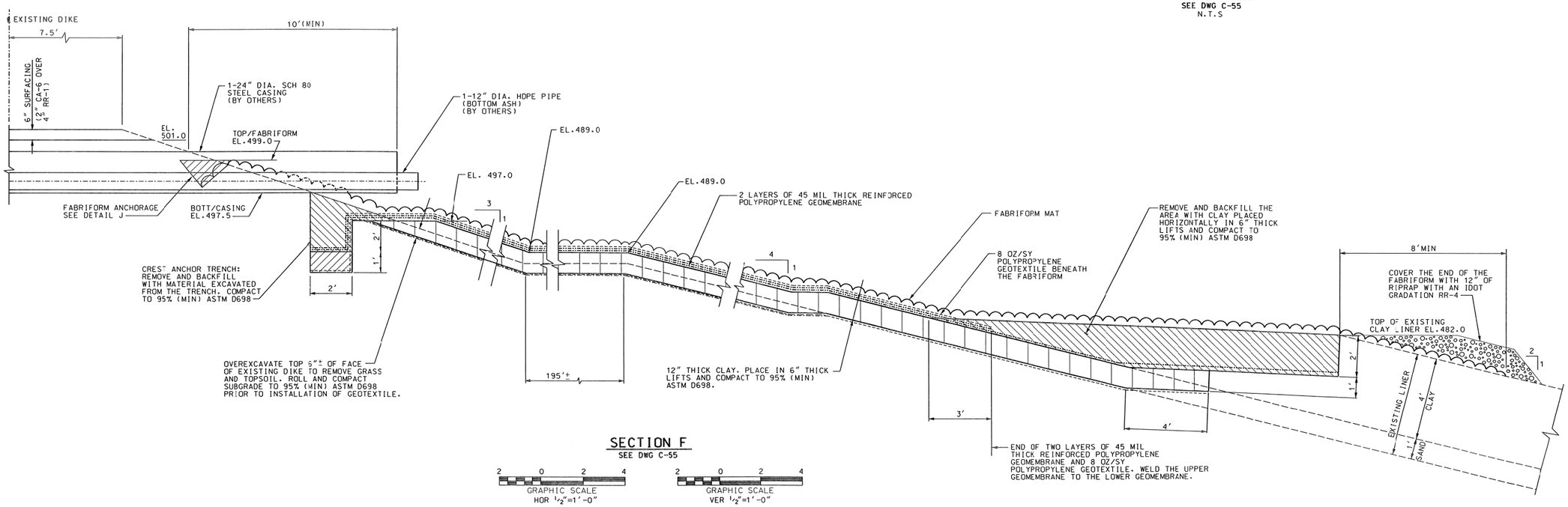
DETAIL J

ANCHORAGE FOR FABRIFORM MAT
N.T.S.



SECTION G

SEE DWG C-55
N.T.S



SECTION F

SEE DWG C-55

2 0 2 4
GRAPHIC SCALE
HOR 1/2"=1'-0"

2 0 2 4
GRAPHIC SCALE
VER 1/2"=1'-0"

RONALD H. COOK
062-048322
REGISTERED PROFESSIONAL ENGINEER OF ILLINOIS

DATE: 02-14-2003
EXPIRES: 11-30-2003
Sargent & Lundy LLC's Illinois Department of Professional Regulation registration number is 184-000106

Sargent & Lundy LLC

CAD FILE:

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REFERENCE DRAWINGS

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D
0.1	02-14-2003	FOR PERMIT	MED	VP	———

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D

SCALE: 1/4"=1'-0"
DWN. M.DOWNS DATE 02-12-02
CHK. V.PATEL DATE 02-14-03
APPV. DATE

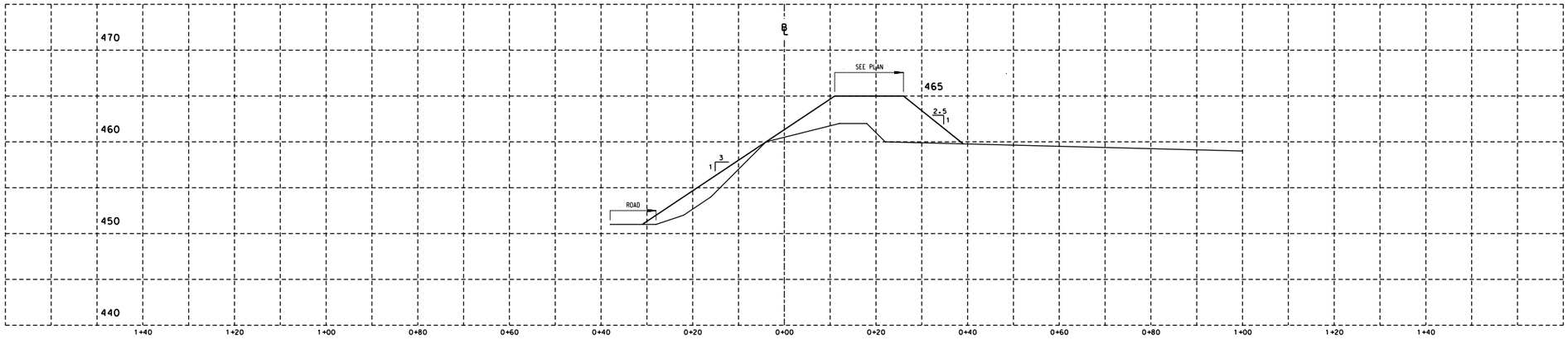
DYNEGY

SECTIONS AND DETAILS - SHEET 4

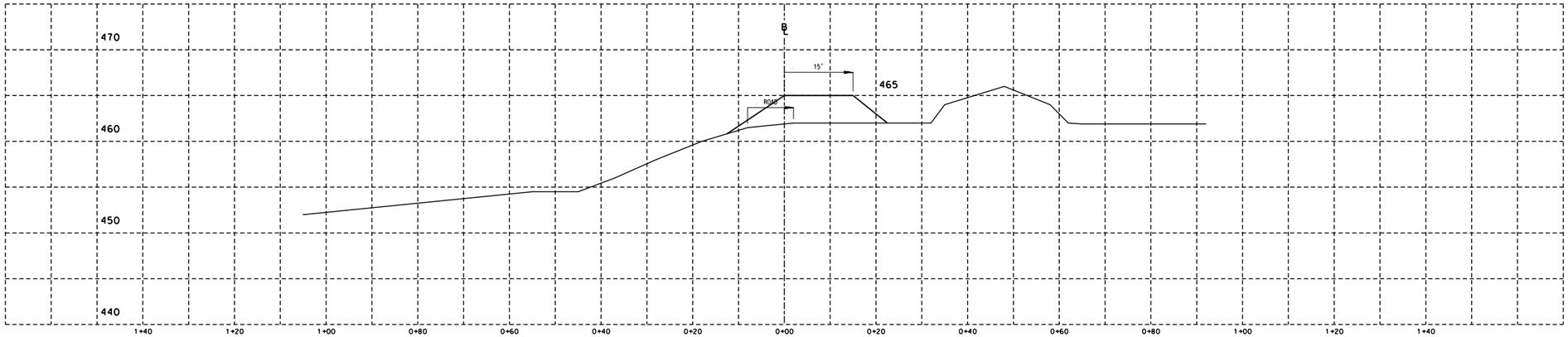
MODIFICATION TO PRIMARY ASH POND
HENNEPIN POWER STATION

PROJECT NO.: 08820-331
CLIENT: DYNEGY MIDWEST GENERATION
DWG. NO.: C-59 REV. 0.1

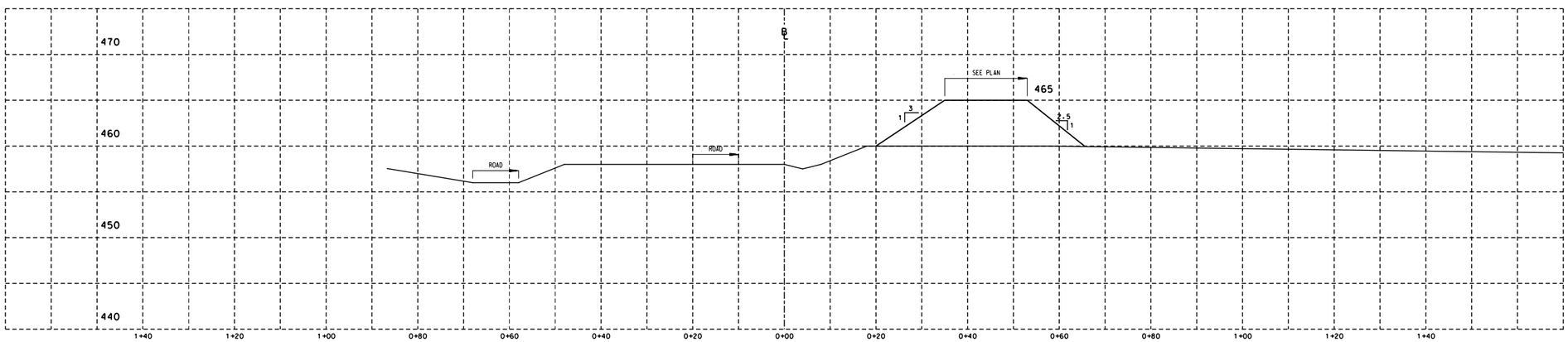
E-MOR1-S191-1.DGN VAX
01-10-2001
02-13-03 ALS



STATION 9+50



STATION 5+00



STATION 1+00

LEDGEND

- ℄ REFERENCE BASE LINE SHOWN ON PLAN
- OLD BERM
- NEW BERM
- ▽ WATER LINE
- ✳ ESTIMATED ELEVATION

NO	DATE	DRF	DESCRIPTION	E	C	A
0						

NOTES

REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
(0)

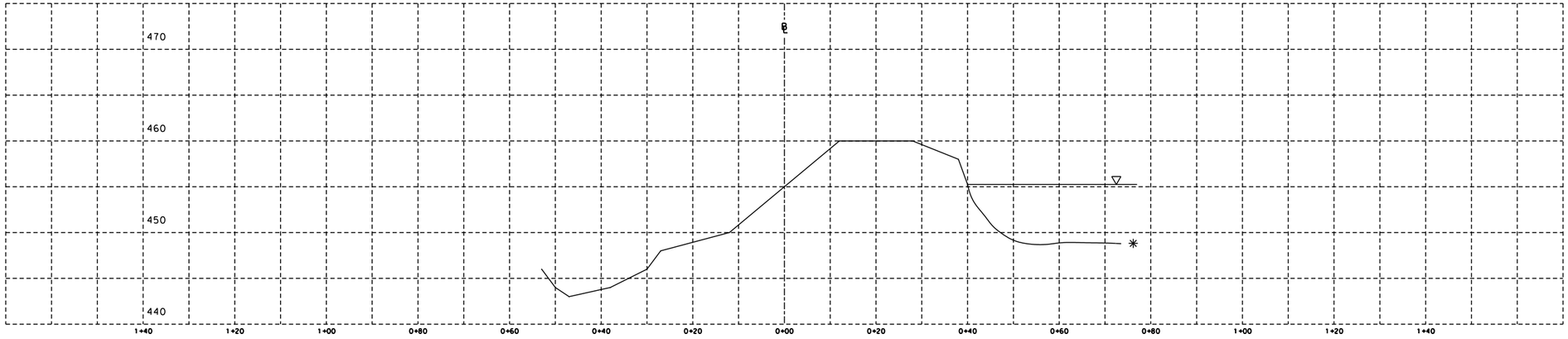
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 1+00, 5+00 & 9+50
HENNEPIN POWER STATION

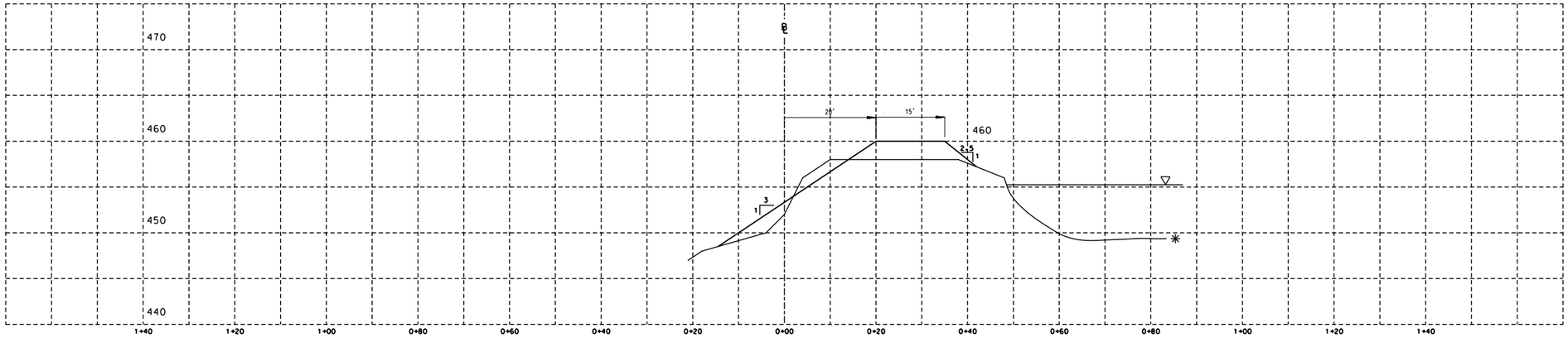
DR GRH	CAD EM	DATE 12-30-87
OK	CKD	SCALE 1"=10'H,1"=5'V
APP	PLOTTED 11-4-97	E-HEN1-B452
APP		

COMPUTER DNG. - DO NOT REVISE MANUALLY

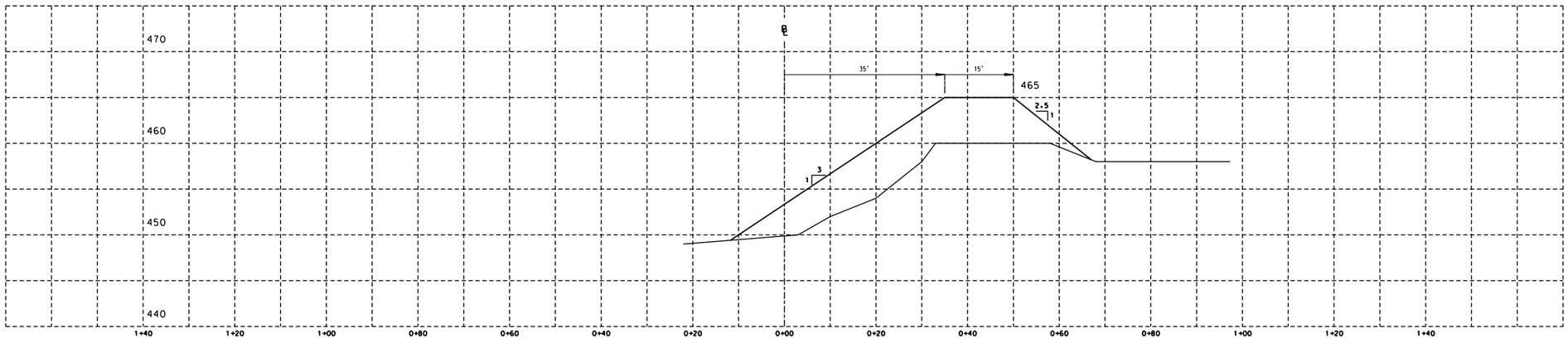
E-HEN1-B452



STATION 26+00



STATION 20+80



STATION 14+25

LEGEND

- ℄ REFERENCE BASE LINE SHOWN ON PLAN
- OLD BERM
- NEW BERM
- ▽ WATER LINE
- ✳ ESTIMATED ELEVATION

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
(0)													

NOTES

REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
(0)

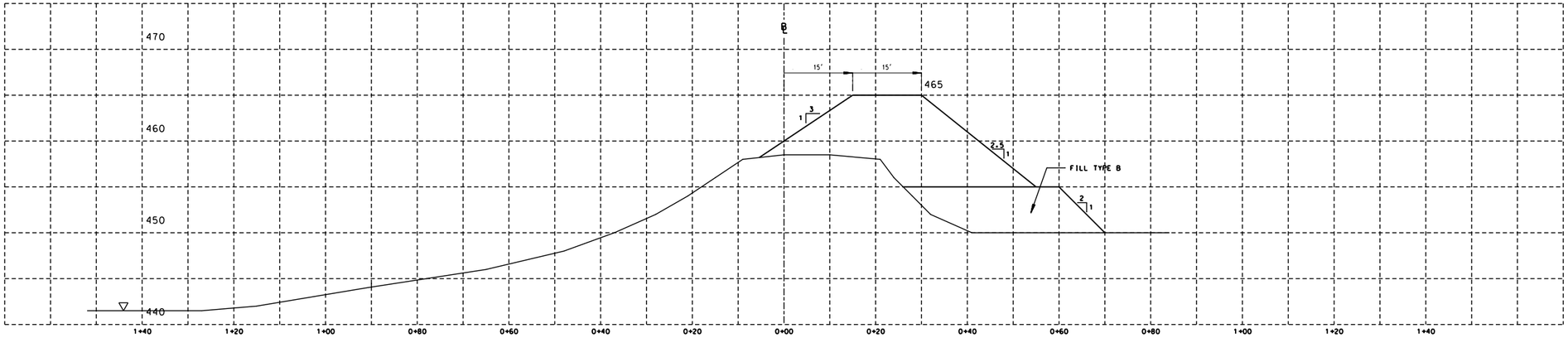
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 14+25, 20+80 & 26+00
HENNEPIN POWER STATION

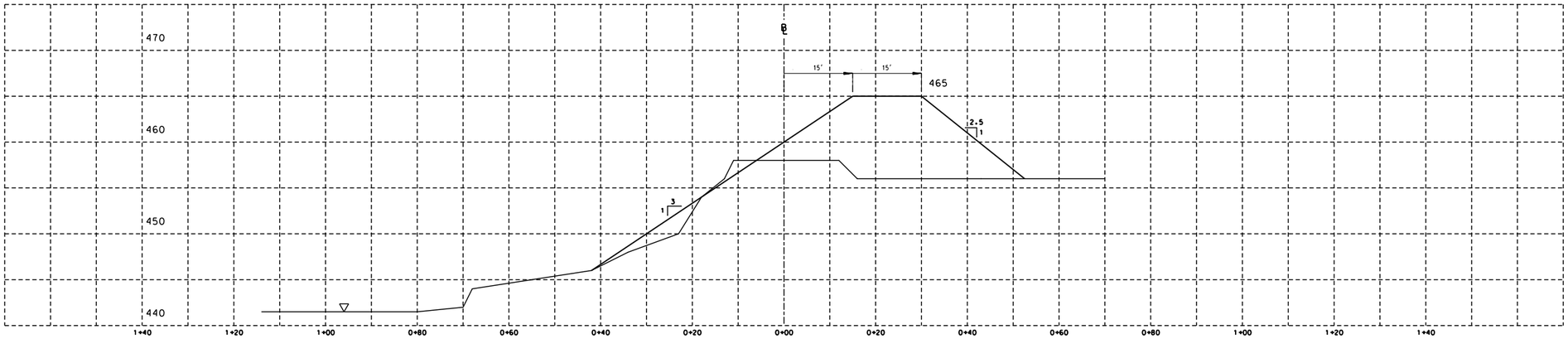
DR GRH	CAD EM	DATE 12-30-87
CK	CKD	SCALE 1"=10' H. 1"=5' V
APP	PLOTTED 11-4-97	E-HEN1-B453
APP		

COMPUTER DNG. - DO NOT REVISE MANUALLY

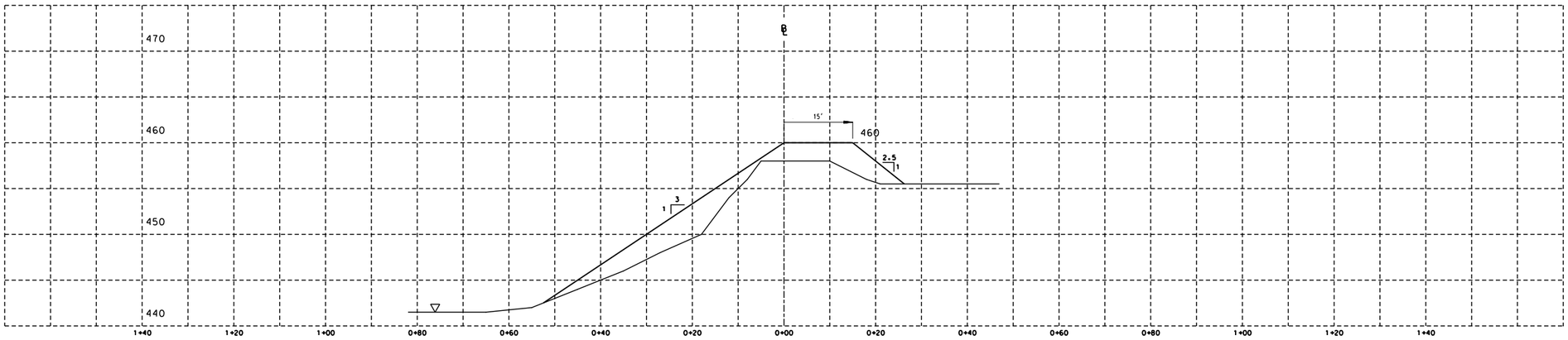
E-HEN1-B453



STATION 39+00



STATION 35+00



STATION 30+00

LEDGEND

- ℄ REFERENCE BASE LINE SHOWN ON PLAN
- OLD BERM
- NEW BERM
- ▽ WATER LINE
- ✳ ESTIMATED ELEVATION

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
⓪													

NOTES

REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
⓪

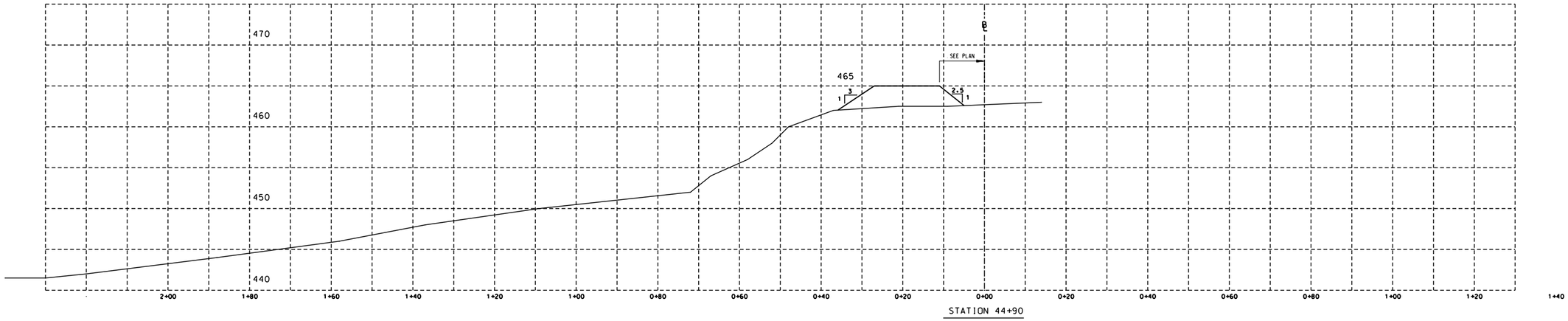
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 30+00, 35+00 & 39+00
HENNEPIN POWER STATION

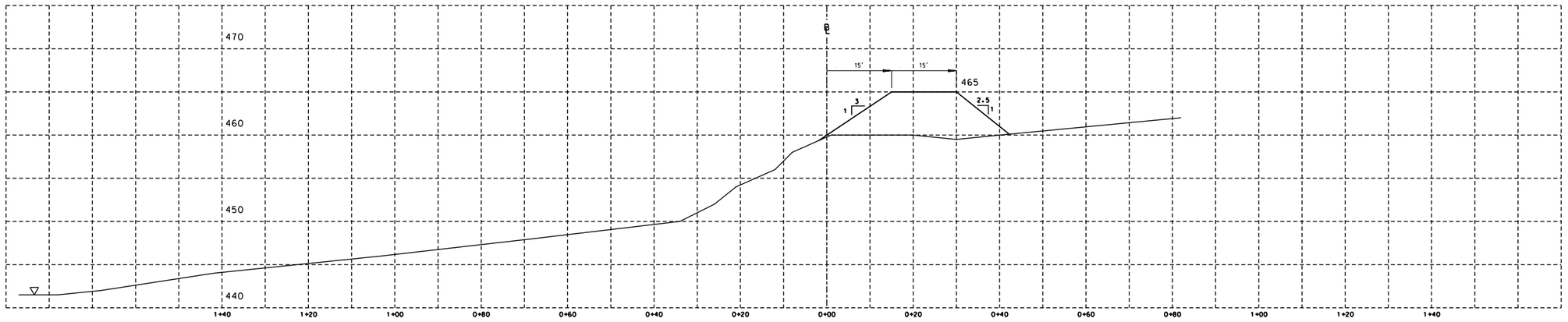
DR GRH	CAD EM	DATE 12-30-87
DK	CKD	SCALE 1"=10'H, 1"=5'V
APP	PLOTTED 11-4-97	E-HEN1-B454
APP		

E-HEN1-B454

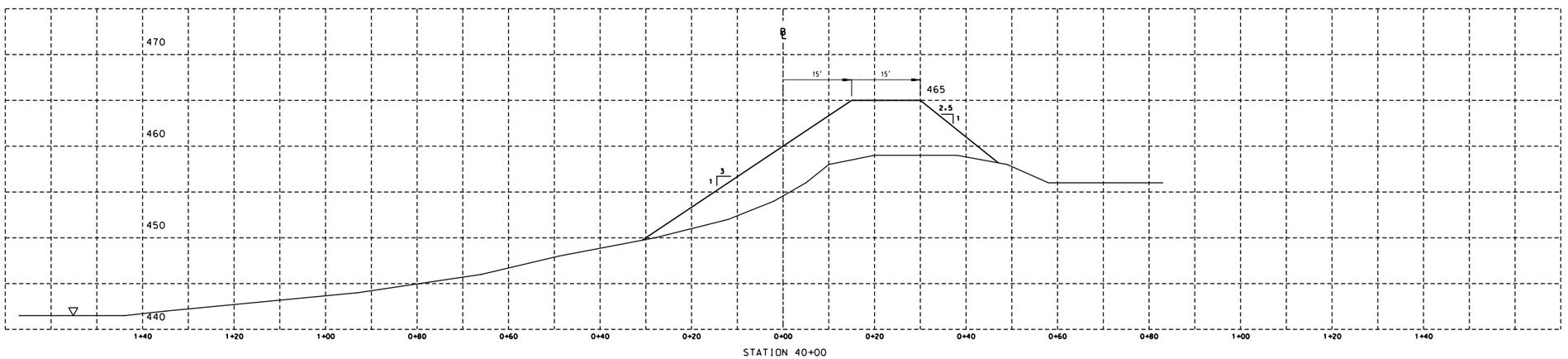
COMPUTER DWG. - DO NOT REVISE MANUALLY



STATION 44+90



STATION 42+00



STATION 40+00

LEDGEND

- ℄ REFERENCE BASE LINE SHOWN ON PLAN
- OLD BERM
- NEW BERM
- ▽ WATER LINE
- ✳ ESTIMATED ELEVATION

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
(0)													

NOTES

REFERENCES

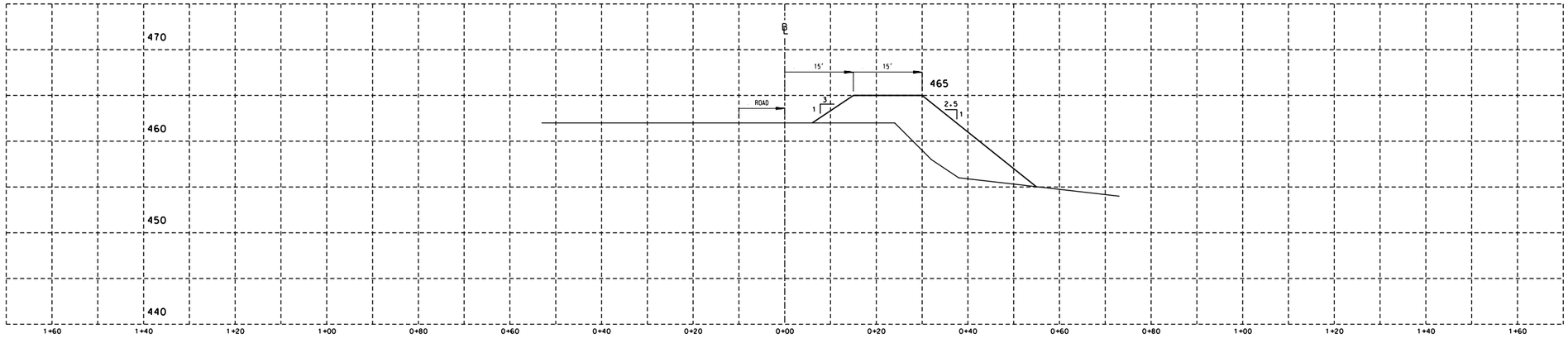
REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
(0)

ILLINOIS POWER COMPANY
DECATUR
CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 40+00, 42+00 & 44+90
HENNEPIN POWER STATION

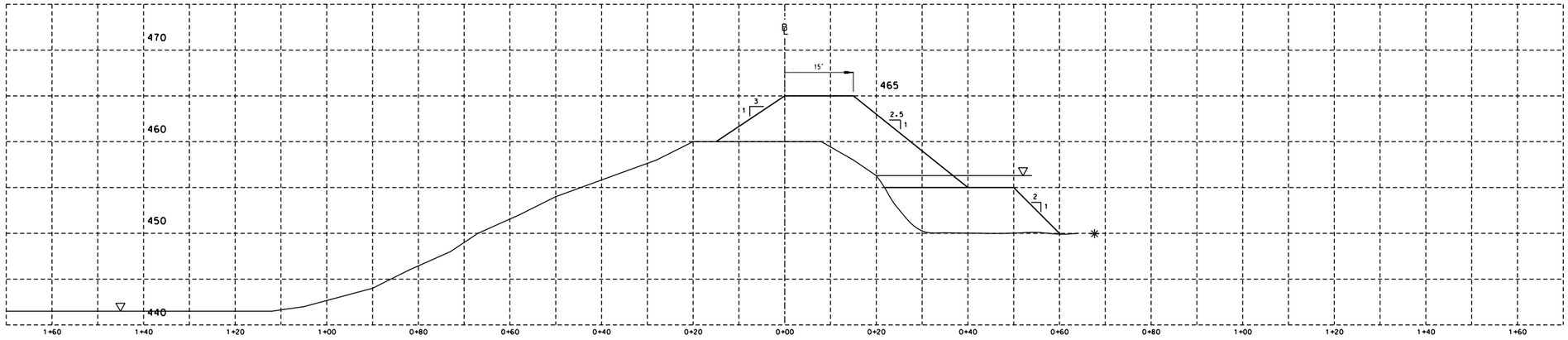
DR GRH	CAD EM	DATE 12-30-87
DK	CKD	SCALE 1"=10'H.1"=5'V
APP	PLOTTED 11-4-97	E-HEN1-B455
APP		

COMPUTER DWG. - DO NOT REVISE MANUALLY

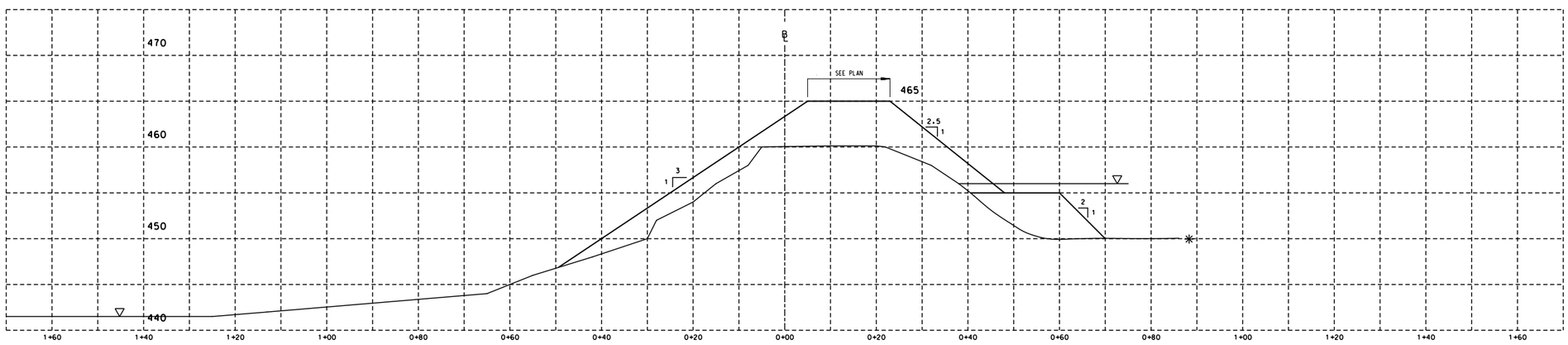
E-HEN1-B455



STATION 56+00



STATION 51+00



STATION 47+00

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
(0)

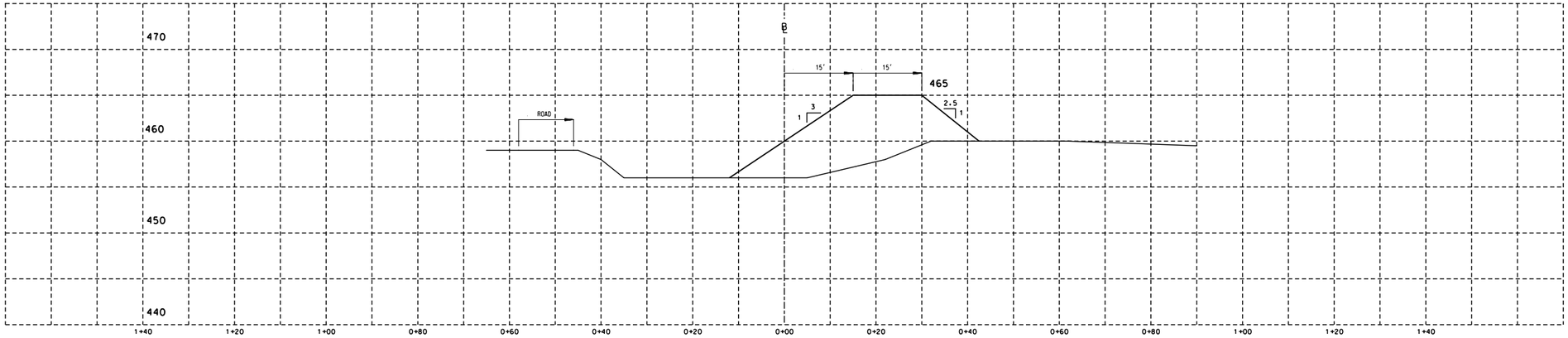
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 47+00, 51+00 & 56+00
HENNEPIN POWER STATION

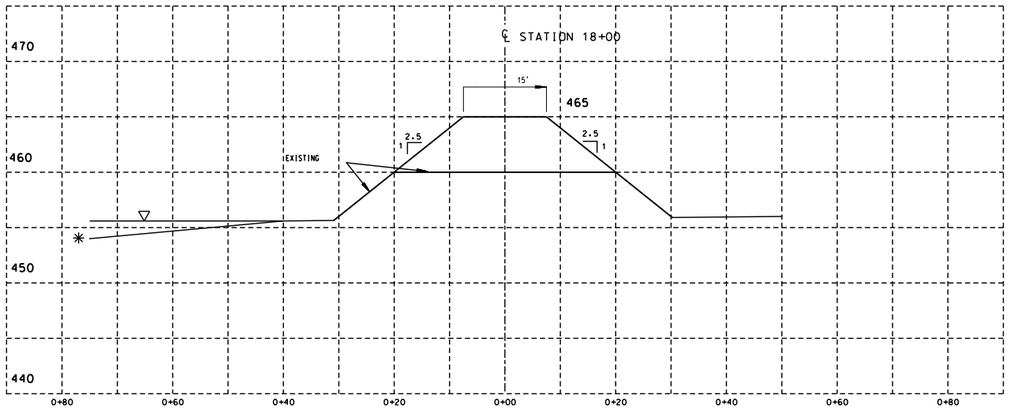
DR CRH	CAD EM	DATE 12-30-87
DR	CKD	SCALE 1"=10' H, 1"=5' V
APP	PLOTTED 11-4-97	E-HEN1-B456
APP		

E-HEN1-B456

COMPUTER DWG. - DO NOT REVISE MANUALLY



STATION 61+50



SECTION A-A

LEDGEND

- ℄ REFERENCE BASE LINE SHOWN ON PLAN
- OLD BERM
- NEW BERM
- ▽ WATER LINE
- ✳ ESTIMATED ELEVATION

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

REFERENCES

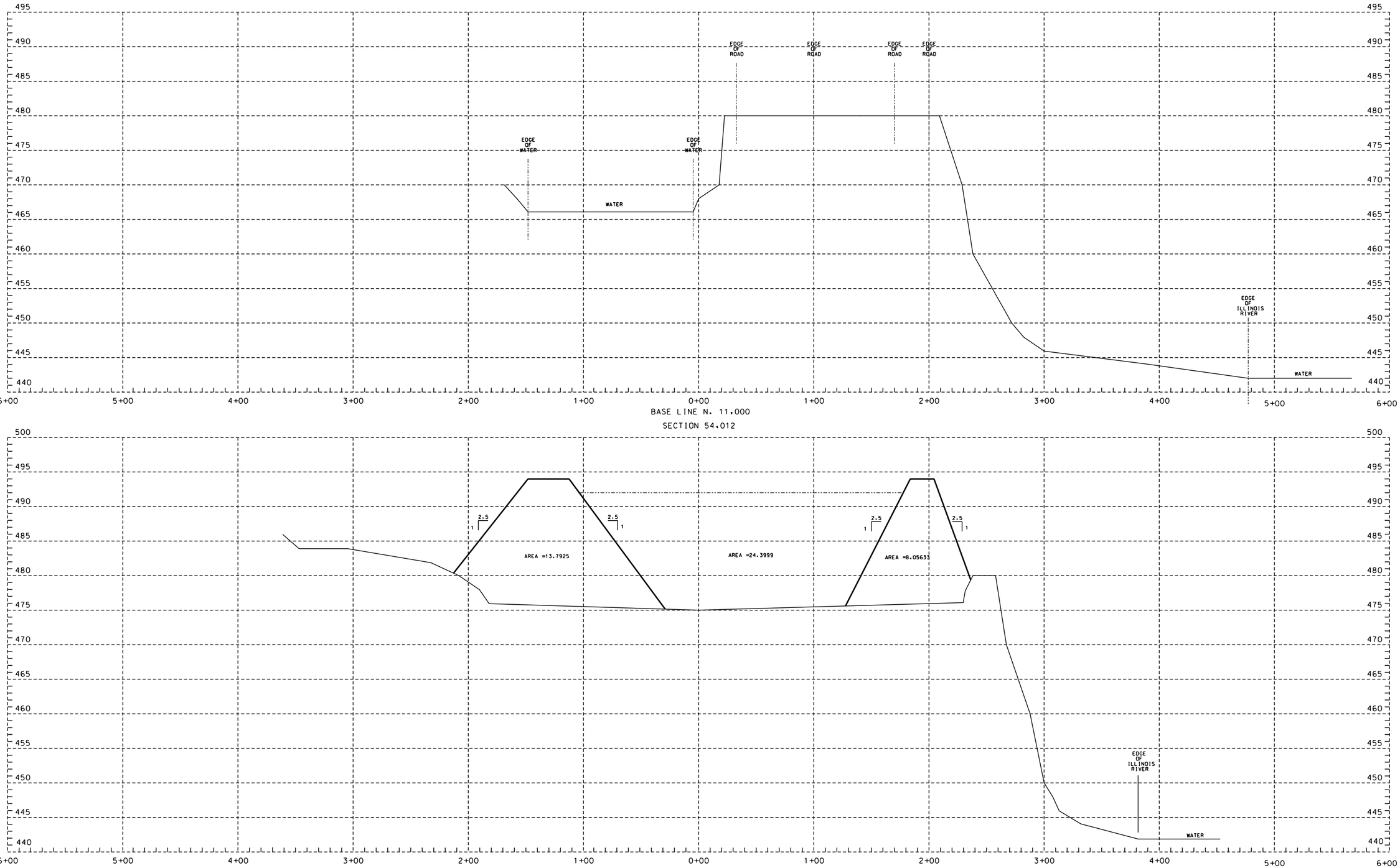
REVISION STATUS
D-CONSTRUCTION
R-RECORD
D: 0

ILLINOIS POWER COMPANY
DECATUR
CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 61+50
HENNEPIN POWER STATION

DR GRH	CAD EM	DATE 12-30-87
CK	CKD	SCALE 1"=10'H, 1"=5'V
APP	PLOTTED 11-4-97	E-HEN1-B457
APP		

E-HEN1-B457

COMPUTER DWG. - DO NOT REVISE MANUALLY



NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4, 1987, REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

REFERENCES

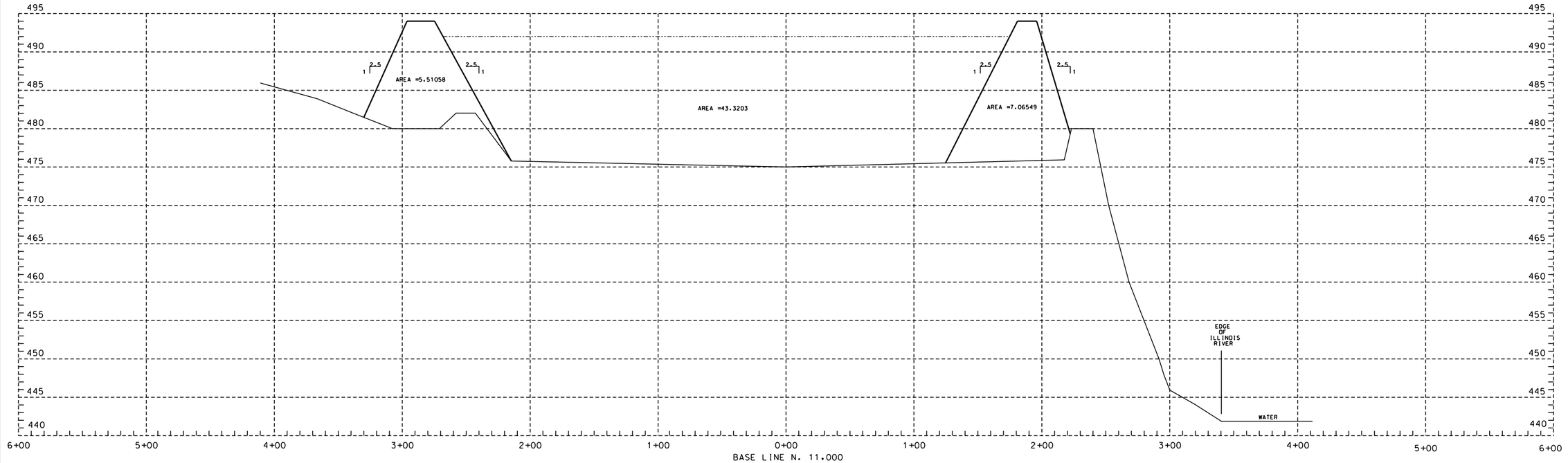
REVISION STATUS
O -CONSTRUCTION
O -RECORD

0

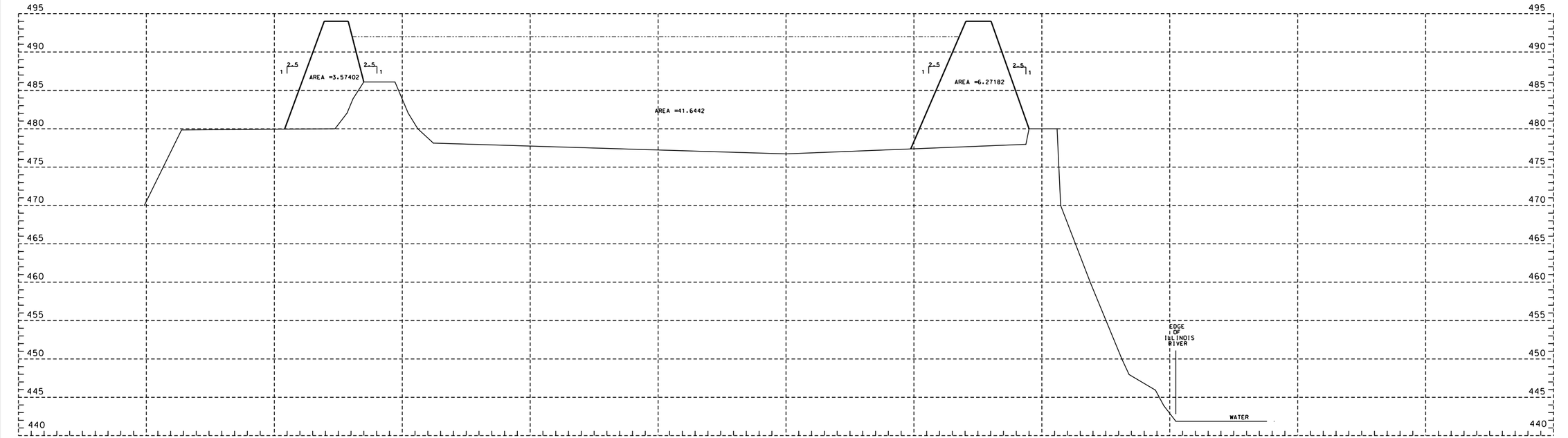
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR	WJM	CAD WJM	DATE 1-11-89
DK		CKD	SCALE 1"=5' V. 1"=30' H.
APP		PLOTTED 03-08-90	CE-HEN1-B458-1
APP			



BASE LINE N. 11.000
SECTION E. 53.692



BASE LINE N. 11.000
SECTION E. 53.492

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4, 1987, REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

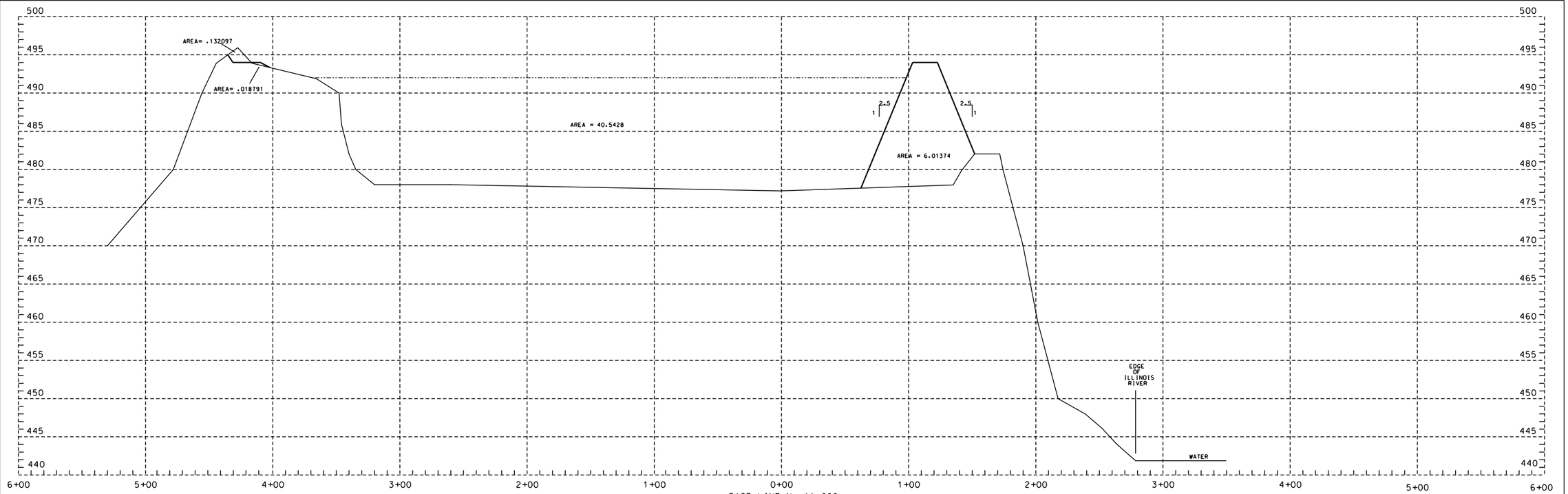
REFERENCES

REVISION STATUS
C -CONSTRUCTION
R -RECORD
0

ILLINOIS POWER COMPANY
DECATUR

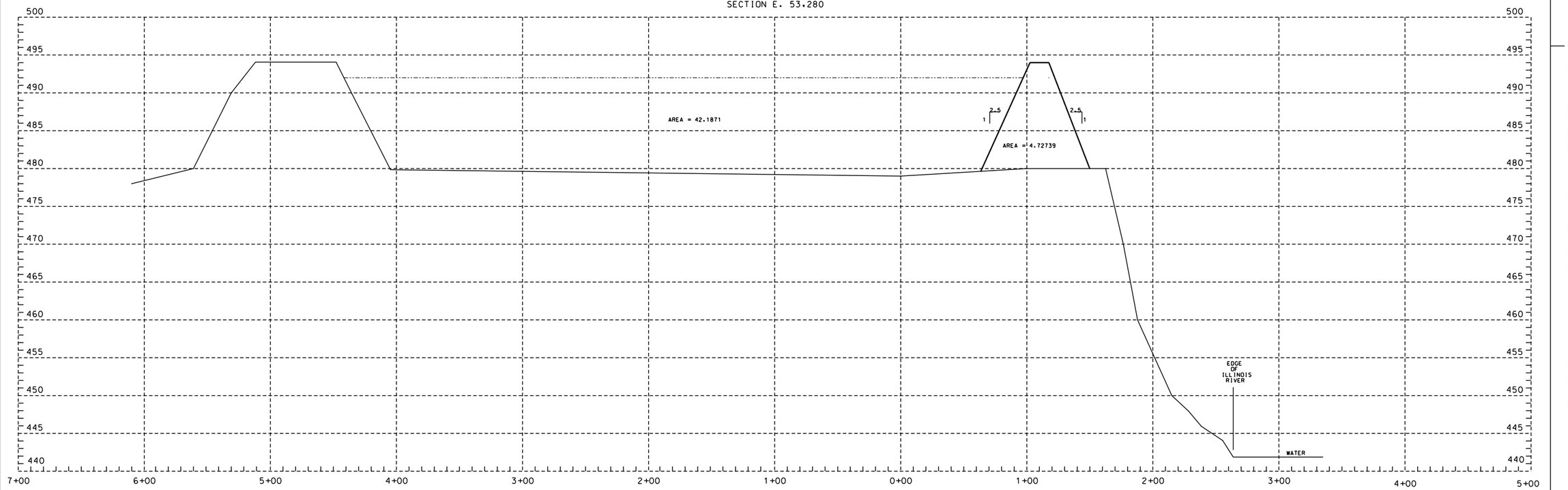
CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-12-89	
OK	CKD	SCALE 1"=5' V. 1"=30' H.	
APP	PLOTTED 03-08-90	CE-HEN1-B458-2	
APP			



BASE LINE N. 11.000

SECTION E. 53.280



BASE LINE N. 11.000

SECTION E. 53.080

NO	DATE	DRF	DESCRIPTION	E	C	A
0						

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4. 1987. REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

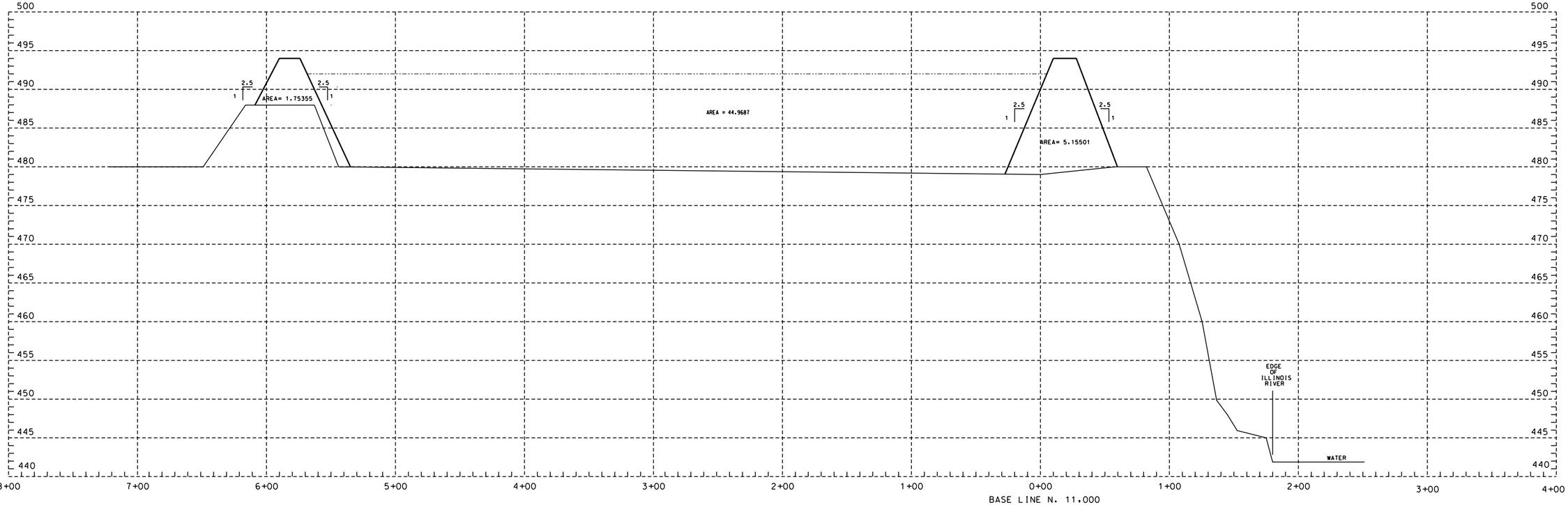
REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD

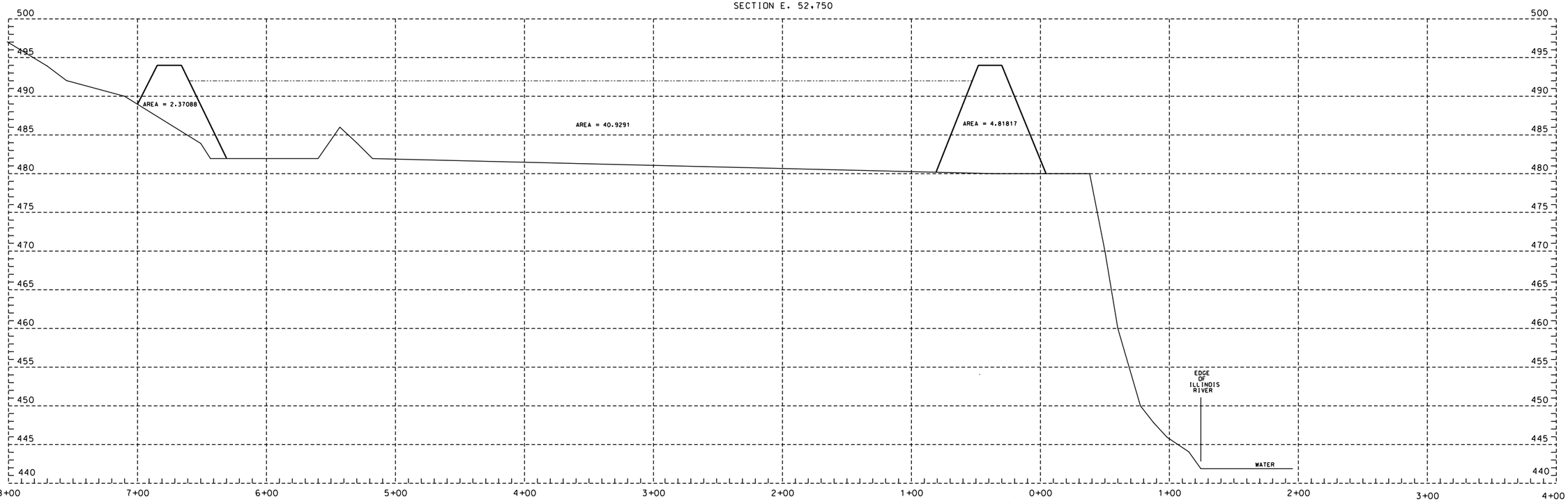
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-12-89	
DK	CKD	SCALE 1"=5' V. 1"=30' H.	
APP	PLOTTED 03-08-90	CE-HEN1-B458-3	
APP			



SECTION E. 52.750



SECTION E. 52.448

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4, 1987, REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

REFERENCES

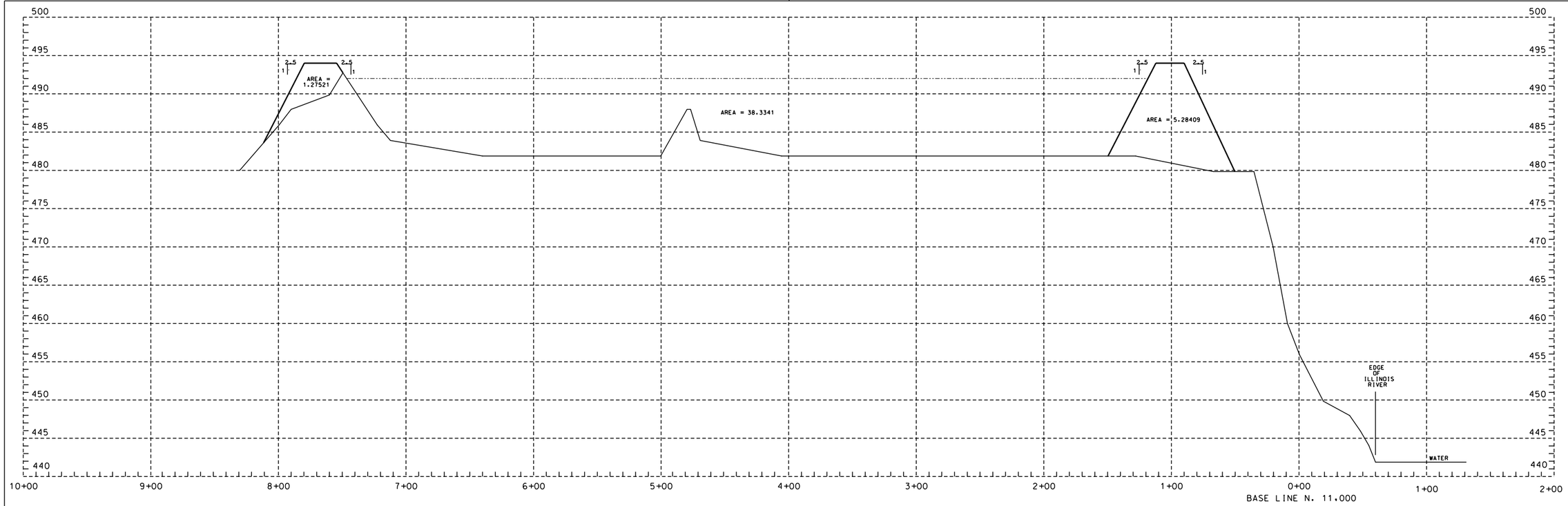
REVISION STATUS
□ -CONSTRUCTION
○ -RECORD

0

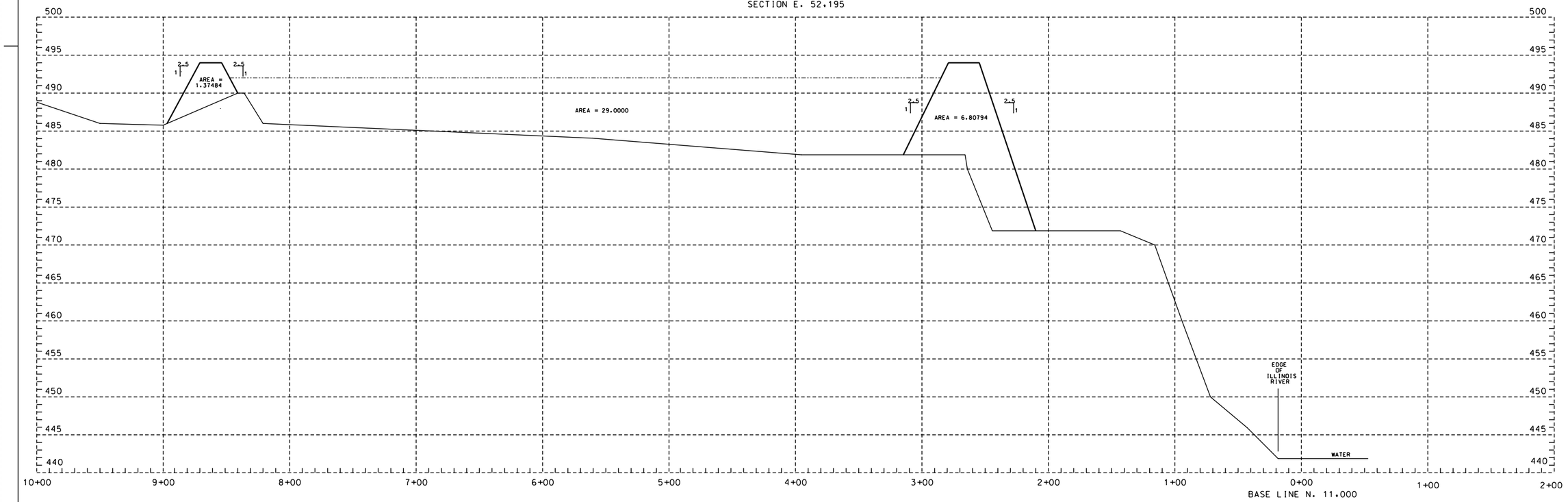
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS EAST ASH POND EXTENSION HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-12-89	
DK	CKD	SCALE 1"=5' V. 1"=30' H.	
APP	PLOTTED 03-08-90	CE-HEN1-B458-4	
APP			



SECTION E. 52.195



SECTION E. 51.920

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4. 1987. REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

REFERENCES

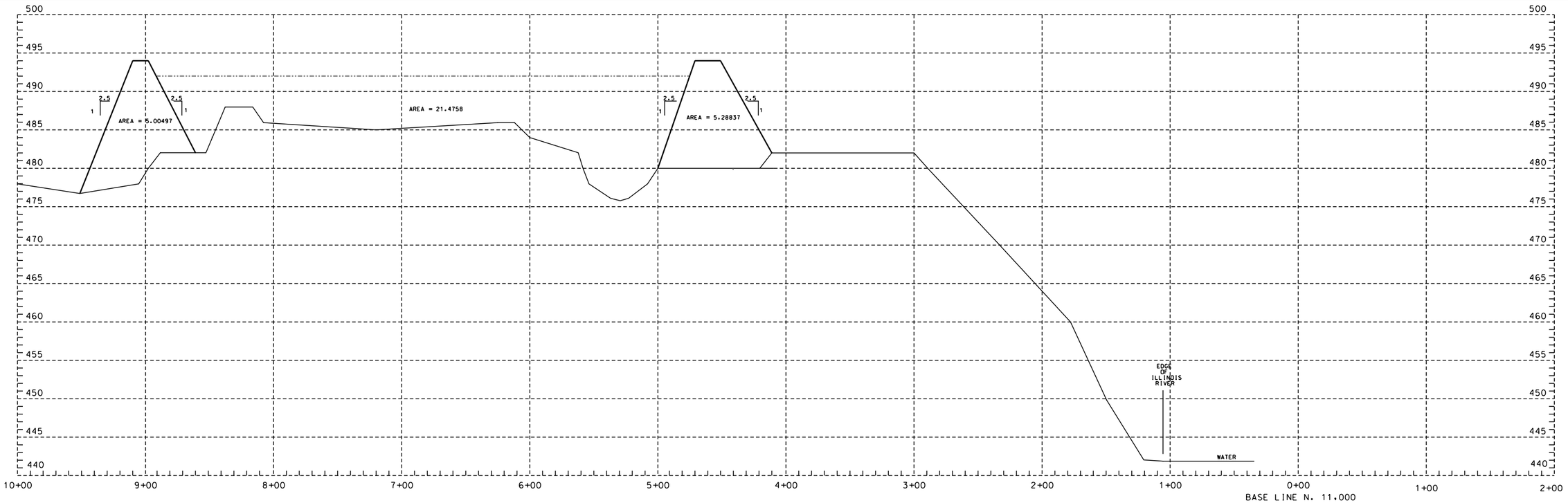
REVISION STATUS
O -CONSTRUCTION
O -RECORD

0

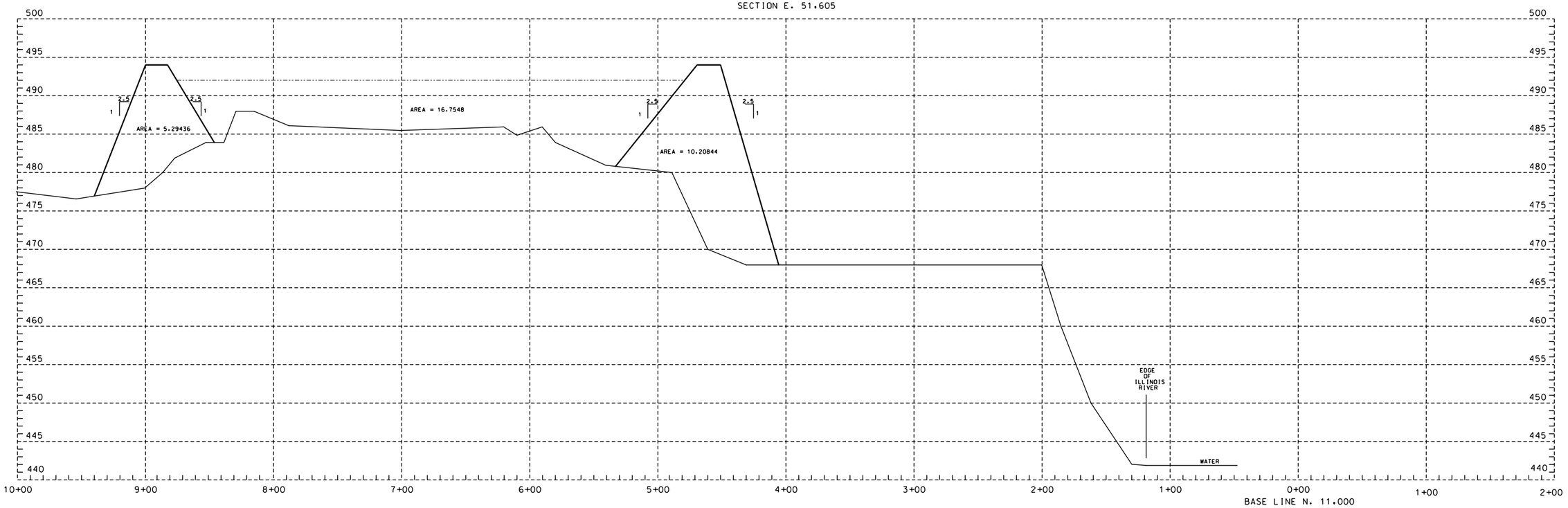
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR	WJM	CAD WJM	DATE 1-12-89
DK		CKD	SCALE 1"=5' V. 1"=30' H.
APP		PLOTTED 03-08-90	CE-HEN1-B458-5
APP			



SECTION E. 51.605



SECTION E. 51.552

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4, 1987, REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

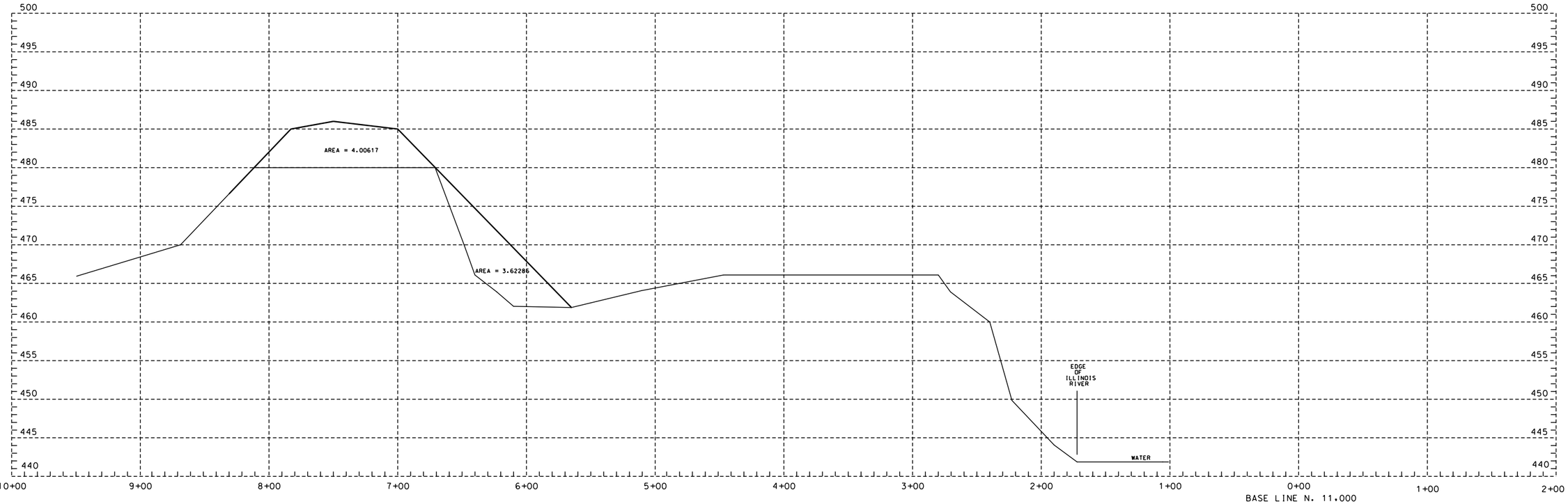
REFERENCES

REVISION STATUS
○ -CONSTRUCTION
○ -RECORD
0

ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR	WJM	CAD WJM	DATE 1-12-89
DK		CKD	SCALE 1"=5' V. 1"=30' H.
APP		PLOTTED 03-08-90	CE-HEN1-B458-6
APP			



SECTION E. 51.285

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4. 1987. REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD

0

ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR	WJM	CAD WJM	DATE 1-12-89
DK		CKD	SCALE 1"=5' V. 1"=30' H.
APP		PLOTTED 03-08-90	CE-HEN1-B458-7
APP			

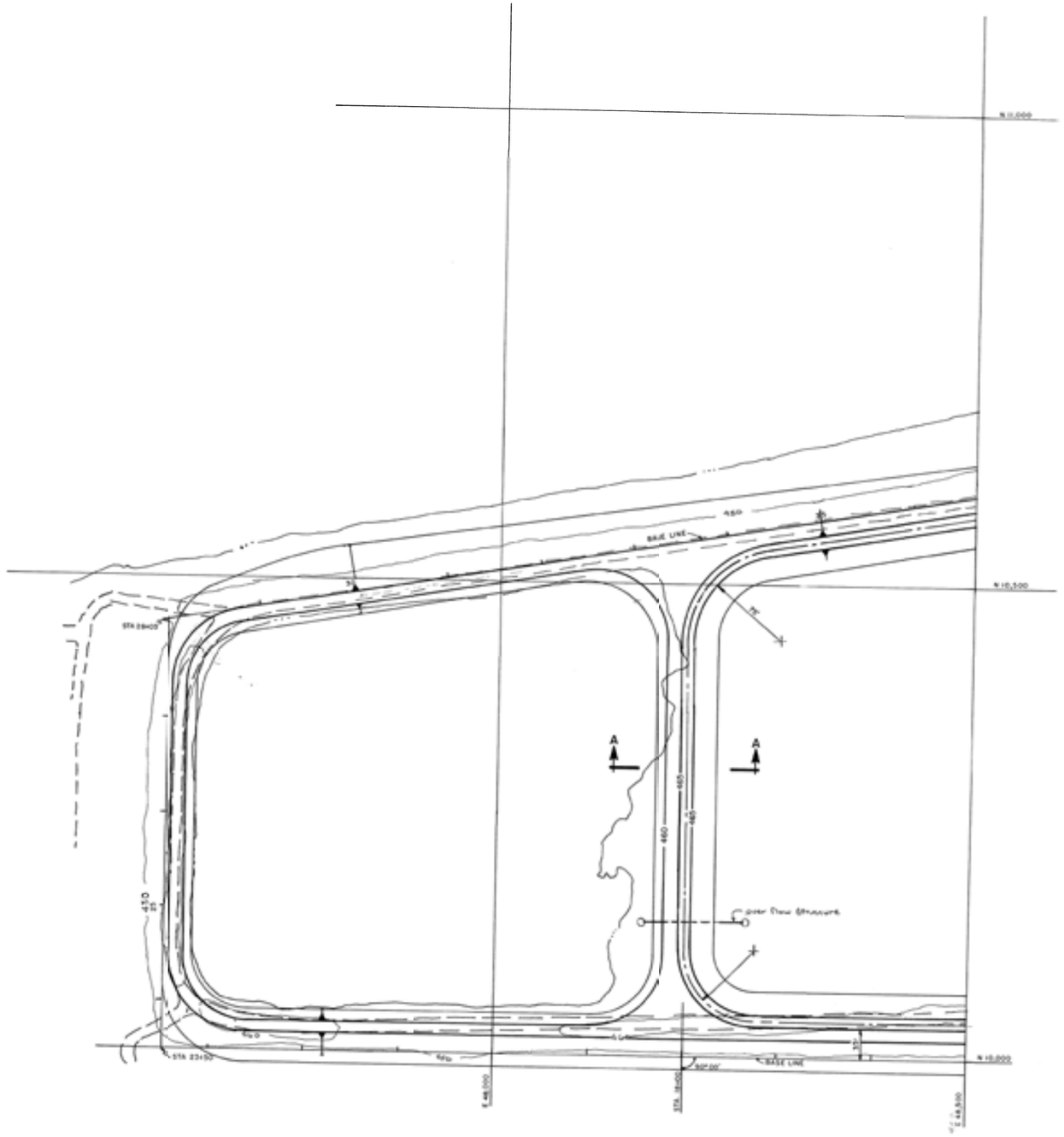
E-HEN1-B460-1

REVISION STATUS: C = CONSTRUCTION, R = RECORD	ILLINOIS POWER COMPANY, DECATUR	
	PLAN-UNITS ASH POND EXTENSION, HENNEPIN POWER STATION, SHEET 4 of 1	
DR. G.R.H.	TR.	CHK.
DES. JDO	DATE 2-2-88	SCALE 1"=50'
APP.	PROJECTED	E-HEN1-B460-1
APP.		

PLATE NO. 1

Scanned by Illinois Power Company

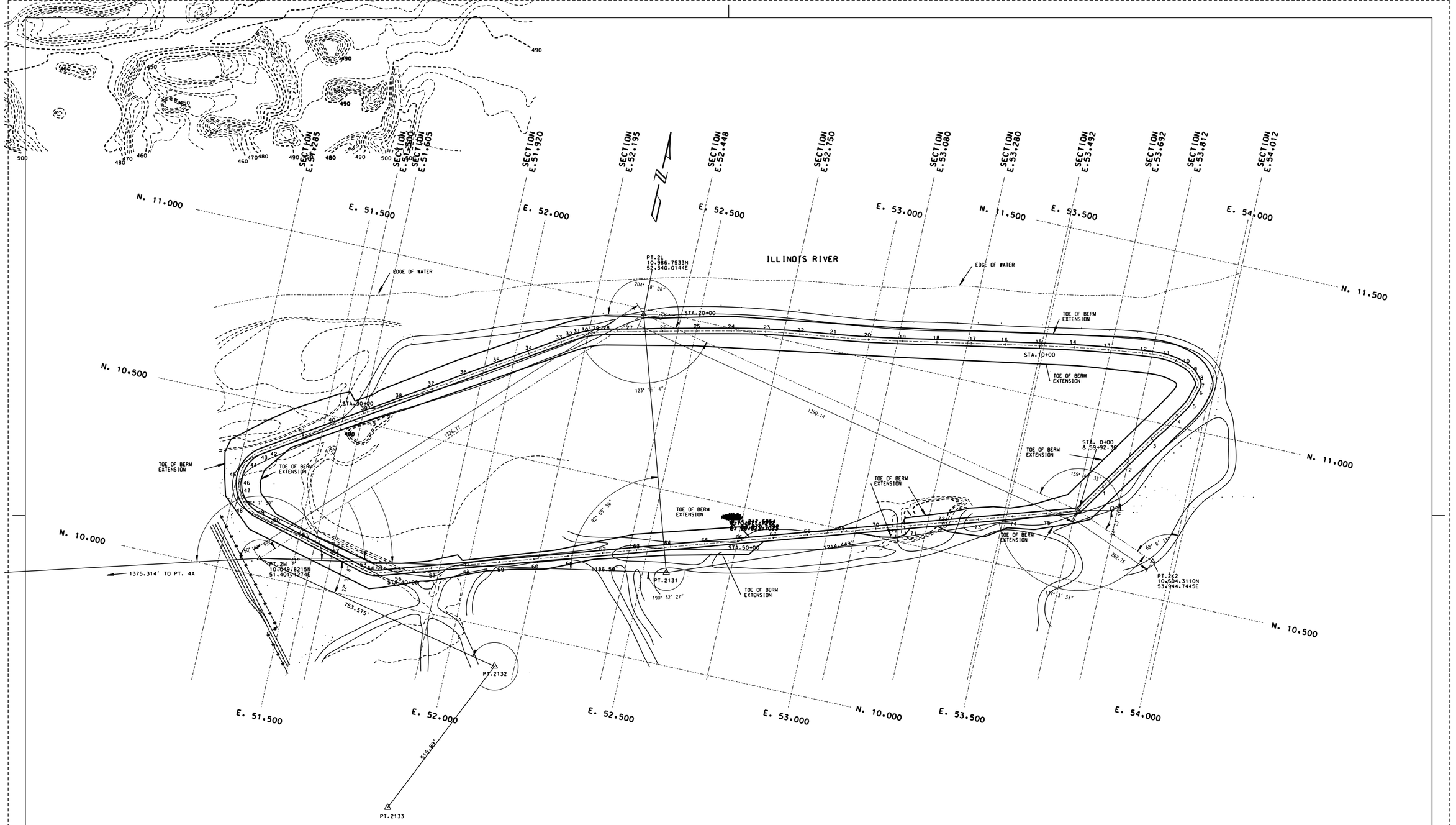
E-HEN1-B460-2



REVISION STATUS 1 CONSTRUCTION 2 RECORD	ILLINOIS POWER COMPANY DECATUR	
	PLAN - UNITH ASH POND EXTENSION HENNEPIN POWER STATION SHEET #2	
DR. G. H. H.	DES.	
DR. JWD	DATE 2-2-88	SCALE 1"=50'
TR.	PRINTED	E-HEN1-B460-2
APP.		

PLATE NO. 1

Scanned by Illinois Power Company



NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

REFERENCES

NOTE: TOPO WAS DIGITIZED FROM DWG. CE-HEN1-B-450 DATED 11-4-87

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD

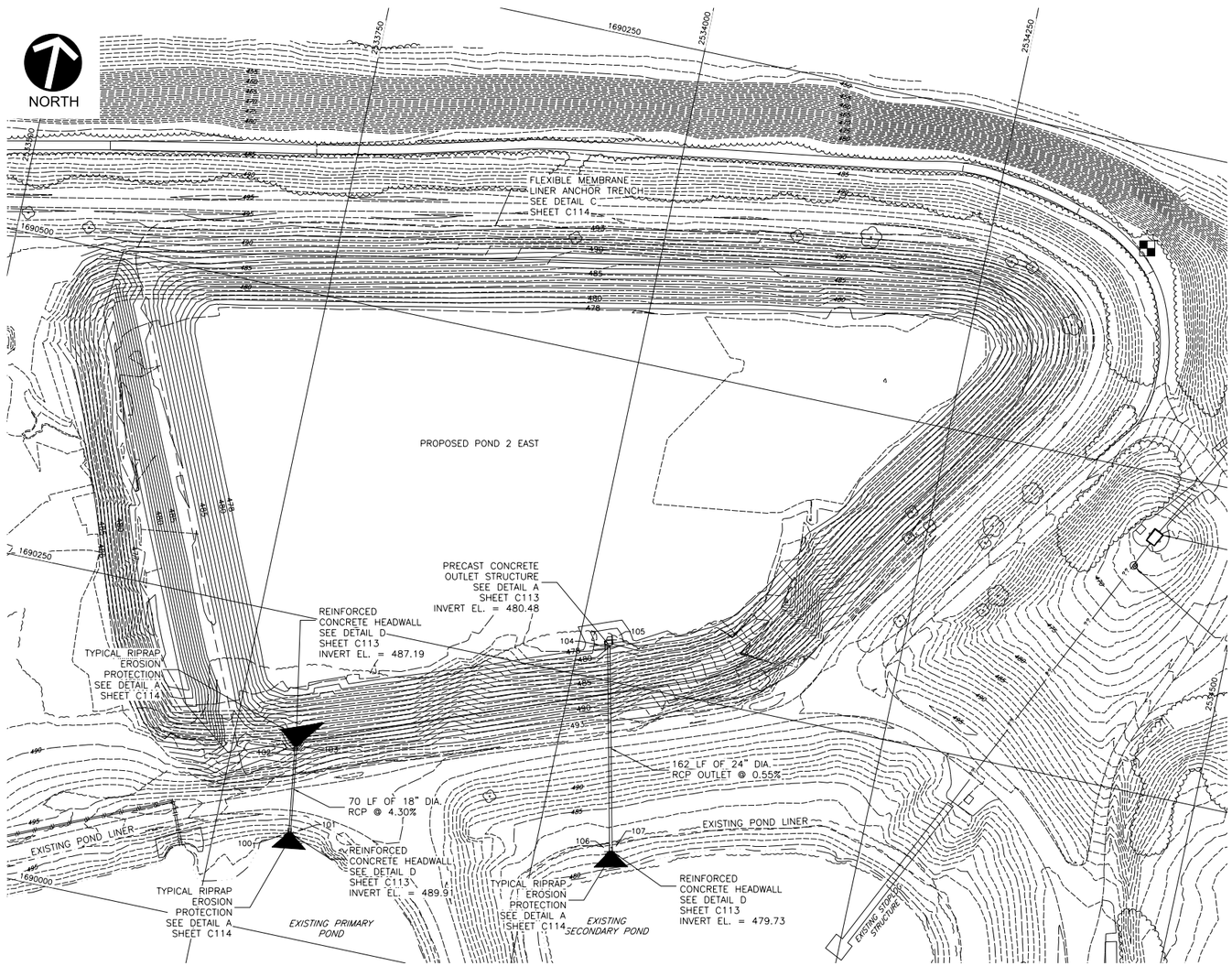
0

ILLINOIS POWER COMPANY
DECATUR

CONTOUR AND GRADING PLAN
UNIT #2 ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-11-89	
DR	CKD	SCALE 1"=100'	
APP	PLOTTED 03-08-90	CE-HEN1-B461	
APP			

DVO.1.2.3.4.5



SCALE IN FEET
0 40 80
DRAWING NOT TO SCALE IF SCALE BAR DOES NOT MEASURE 2 INCHES

REFERENCE

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON OCTOBER 26, 2008.

STRUCTURE TABLE		
Point #	Northing	Easting
100	1690080.864	2533807.450
101	1690081.207	2533809.928
102	1690149.246	2533797.977
103	1690149.589	2533800.456
104	1690276.331	2534020.790
105	1690282.205	2534024.973
106	1690118.909	2534057.560
107	1690119.451	2534060.003

NOTE

THE LOCATION OF THE ABOVE AND BELOW GRADE STRUCTURES SHOWN ON THESE DRAWINGS ARE APPROXIMATE. PRIOR TO PERFORMING EXCAVATIONS, THE CONTRACTOR SHALL FIELD LOCATE STRUCTURES THAT MAY BE WITHIN THE LIMITS OF WORK AND PROTECT THEM ACCORDINGLY.

LEGEND

- 495 PROPOSED INDEX CONTOURS
- 495 PROPOSED INTERMEDIATE CONTOURS
- 495 EXISTING INDEX CONTOURS
- 495 EXISTING INTERMEDIATE CONTOURS
- ?? EXISTING STORM WATER DRAINS
- EXISTING ACCESS ROAD

Civil & Environmental Consultants, Inc.
5910 Haper Road, Suite 106 • Solon, OH 44139
Ph: 330.310.6800 • 866.507.2324
www.cecinc.com

DYNEGY CONFIDENTIAL
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REFERENCE DRAWINGS

NO.	DATE	REVISION	BY	APPROVED

NO.	DATE	REVISION	BY	APPROVED
0	7/28/10	RECORD REVISION - 082-255	DFB	SFP

SCALE: AS_NOTED

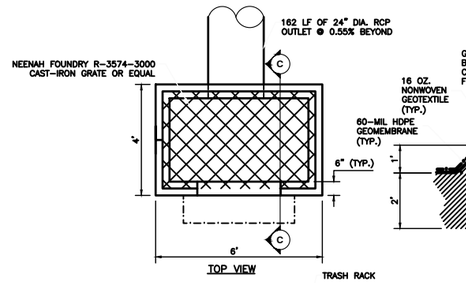
DWN DFB	DATE 07/05/2010
CHK RTM	DATE 07/12/2010
APPV SFP	DATE 07/12/2010

DYNEGY

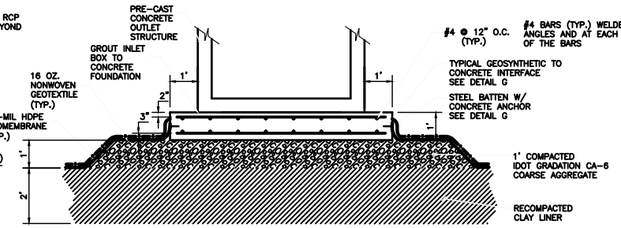
DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
POND 2 EAST
FLEXIBLE MEMBRANE LINER AND STRUCTURES

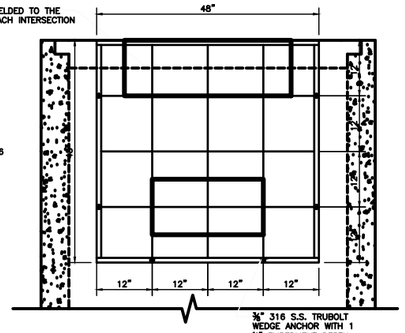
PROJECT NO: 082-255
CLIENT: DYNEGY
DWG NO: HEN1-C109
REV: 0

HEN1-C109 HENNEPIN DFB 07/05/2010

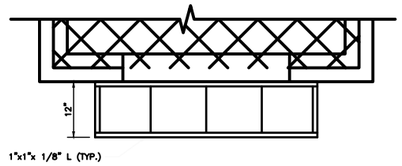


TOP VIEW

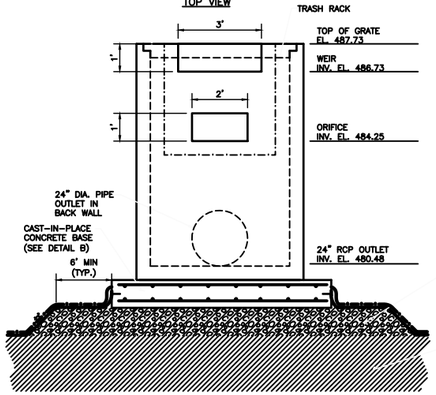




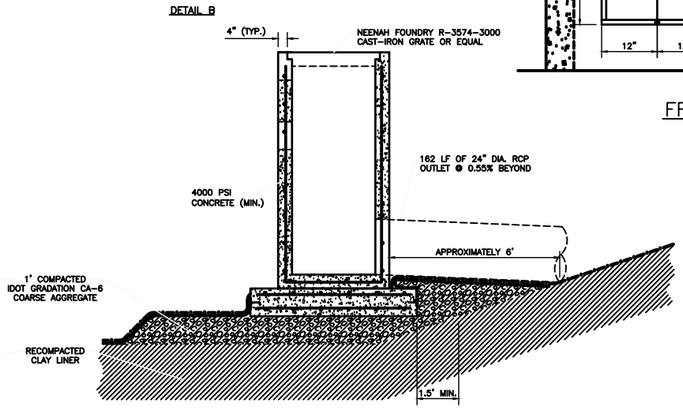
FRONT



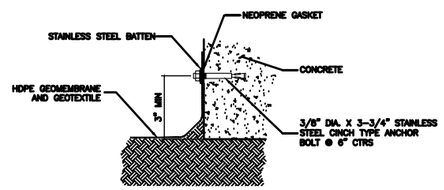
TOP



DETAIL B



DETAIL F
TRASH RAC□
N.T.S.

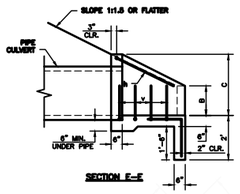


STEEL BATTEN W/ CONCRETE ANCHOR

DETAIL A
□RECAST CONCRETE OUTLET STRUCTURE
N.T.S.

NOTES
1. REFER TO ILLINOIS DEPARTMENT OF TRANSPORTATION (IDOT) STANDARD FOR OUTLET REINFORING.

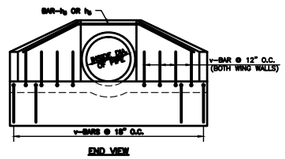
FRONT VIEW



SECTION E-E

BAR v

SECTION C-C

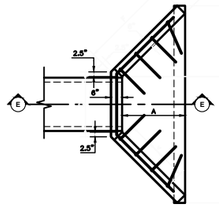


END VIEW

DETAIL D
REINFORCED CONCRETE HEAD□ ALL
N.T.S.

NOTES
1. REFER TO IDOT STANDARD 542101-02 REINFORCED CONCRETE HEADWALL DETAIL FOR FINAL DESIGN.

DIMENSIONS OF BARS-h_3 AND h_5		
BAR	a	b
h_3	2'-1"	3'-3.00"
h_5	2'-8"	4'-1.00"



PLAN

DIMENSIONS AND QUANTITIES													
DESIGN NO.	NOMINAL INSIDE DIA. OF PIPE	SLOPE OF WING WALLS	DIMENSIONS (A)	DIMENSIONS (B)	DIMENSIONS (C)	DIMENSIONS (D)	DIMENSIONS (E)	DIMENSIONS (F)	CONCRETE 2 END SECS. CU. YDS.	NO.4 REBAR h-BARS (BAR)	NO.4 REBAR h-BARS (LENGTH)	NO.4 REBAR v-BARS NO.	NO.4 REBAR TOTAL WT. 2 END SECS. LBS.
D18-2	1'-6"	1 TO 2	2'-2"	1'-1"	2'-2"	2'-3"	6'-10.20"	3'-3.25"	1.30	h_3	8'-6"	22	60
D24-2	2'-0"	1 TO 2	2'-10"	1'-4"	2'-8"	2'-11"	8'-10.20"	4'-2.00"	2.00	h_5	11'-0"	28	70

DETAIL G
T□□ICAL GEOS□NTHETIC TO CONCRETE INTERFACE
N.T.S.

NOTES
1. EARTH ADJACENT TO CONCRETE TO BE WELL COMPACTED TO PREVENT FUTURE DIFFERENTIAL SETTLEMENT.
2. ALL CONCRETE COLLARS TO BE CHAMFERED A MINIMUM OF 1" (TYP.) @ ALL CORNERS IN CONTACT WITH LINER

Civil & Environmental Consultants, Inc.
□□□□ H□□□r R□□d,S□□□ □□□ - S□□□□OH □□□□□
Ph: 330.310.6800 · 866.507.2324
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REFERENCE DRAWINGS

NO.	DATE	REVISION	BY	APPROVED
0	7/28/10	RECORD REVISION - 082-255	DFB	SFP

SCALE: AS_NOTED

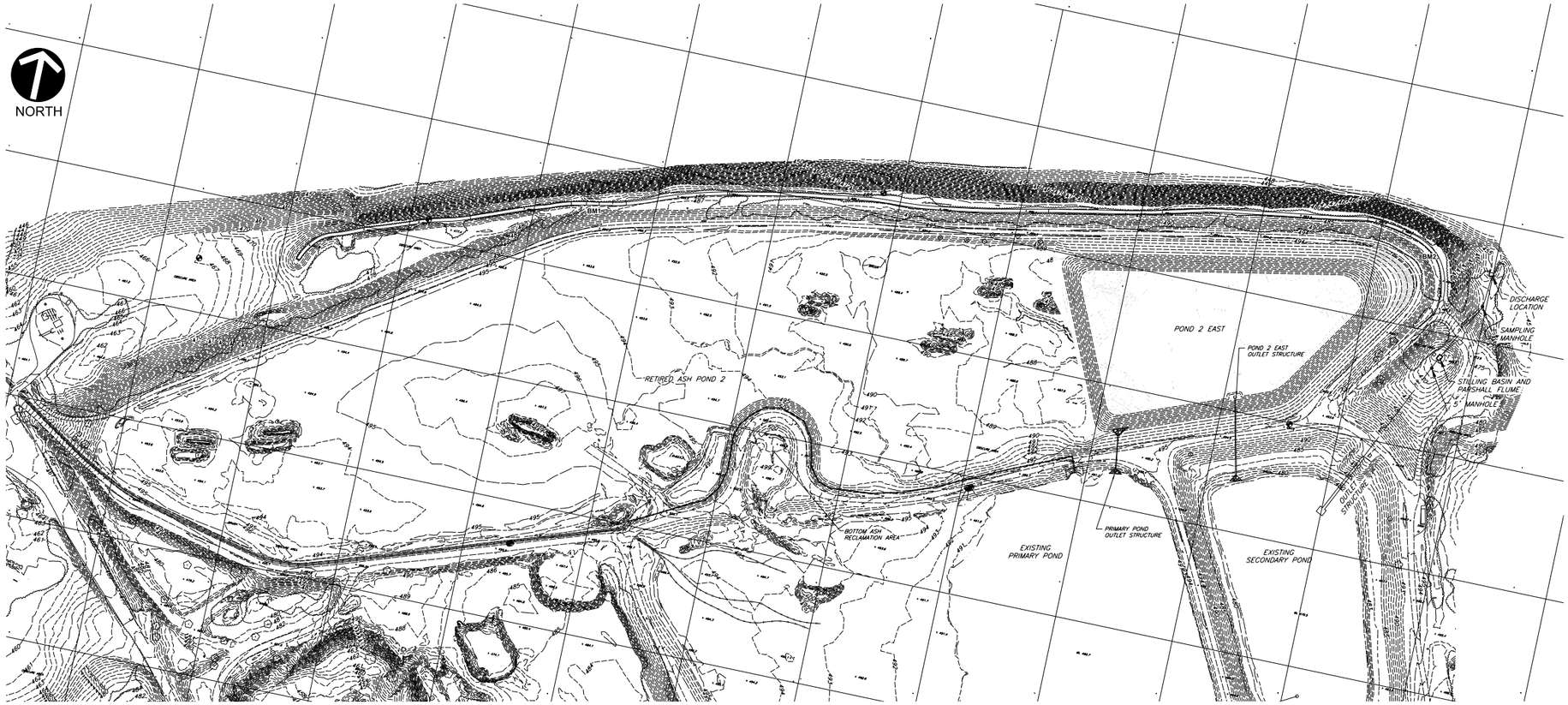
DWN. DFB	DATE 07/05/2010
CHK. RTH	DATE 07/12/2010
APPV. SFP	DATE 07/12/2010

DYNEGY

DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
POND 2 EAST
DETAILS

PROJECT NO: 082-255
CLIENT: DYNEGY
DWG. NO: HEN1-C113
REV: 0

07/05/2010 DFB HEN-C113 HENNEPIN



BENCHMARK LOCATIONS			
NUMBER	NORTHING	EASTING	ELEVATION
1	1690395.43	2532618.60	482.19
2	1690670.86	2534372.87	484.08
3*	1689478.87	2534643.99	506.80
4*	1688458.82	2533256.76	499.45
5*	1688781.84	2531352.15	468.27
6*	1689875.08	2531310.12	463.75

* BENCHMARKS BEYOND DRAWING BOUNDARY.

SCALE IN FEET
0 100 200
DRAWING NOT TO SCALE IF SCALE BAR DOES NOT MEASURE 2 INCHES

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.

   DUE TO CONSTRUCTION ACTIVITIES, ACTUAL FIELD TOPOGRAPHY MAY VARY.

2. POND 2 EAST CONTOURS FROM CONSTRUCTION DRAWINGS SUBMITTED AUGUST 2009.

LEGEND

- MISCELLANEOUS FLOW PIPING
- EXISTING STORMWATER DRAINS
- EXISTING TREELINE
- EXISTING PIPING
- EXISTING ACCESS ROAD
- EXISTING PONDS/STREAMS
- EXISTING FENCE
- EXISTING BENCHMARK
- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- EXISTING ROCK CHANNEL PROTECTION
- EXISTING MONITORING WELL

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REFERENCE DRAWINGS

NO.	DATE	REVISION	BY	APPROVED	
0	11/28/10	RECORD REVISION - 082-255	DFB	SFP	

SCALE: AS_NOTED

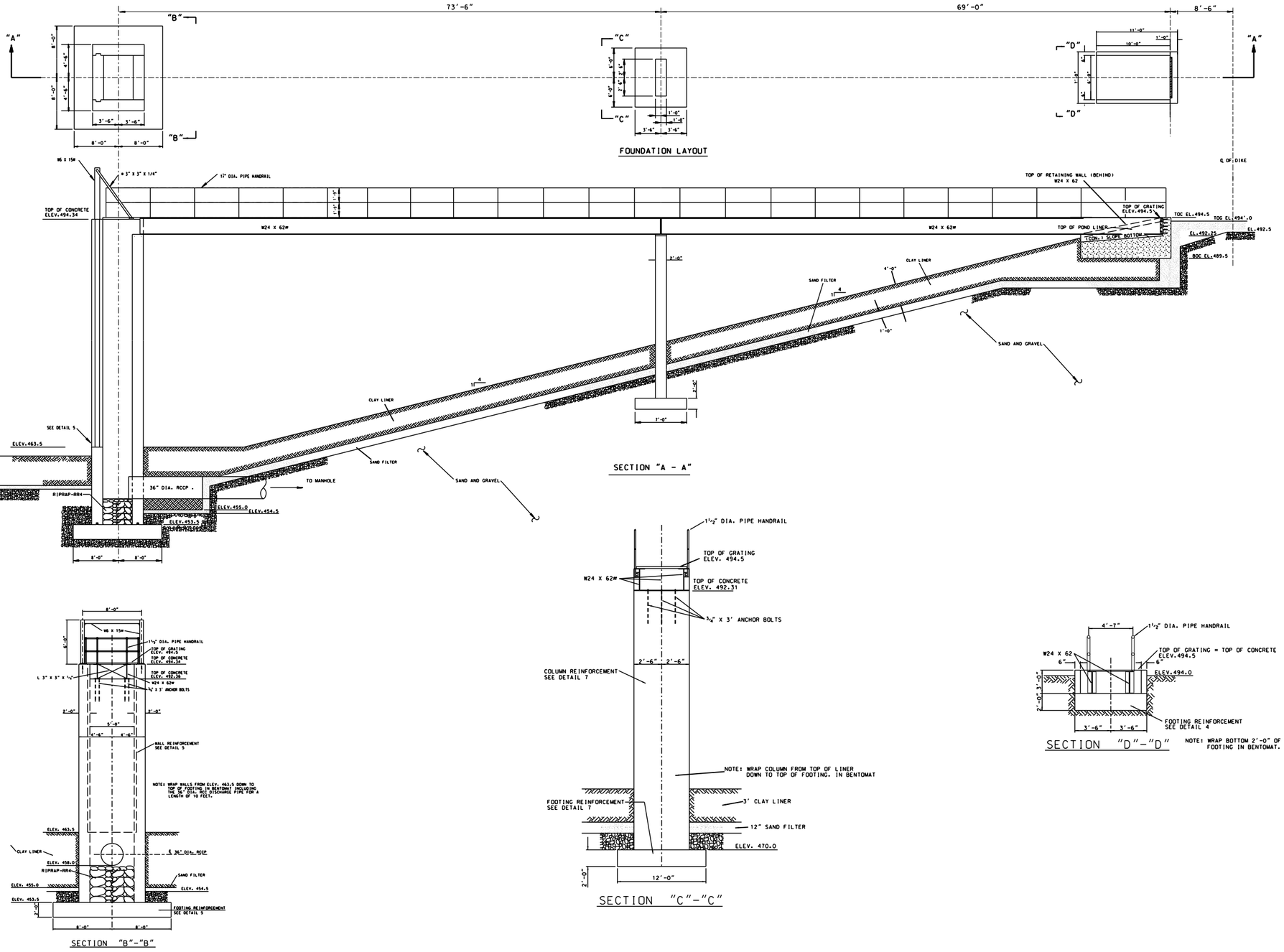
DWN. DFB	DATE 11/05/2010
CHK. RTM	DATE 11/12/2010
APPV. SFP	DATE 11/12/2010
EAPP_BY	EABD
FEAPP_BY	FEABD

DYNEGY

DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
LANDFILL PHASE 1 CONSTRUCTION
EXISTING CONDITIONS

PROJECT NO.: 082-255
CLIENT: DYNEGY
DWG. NO.: HEN1-C117
REV.: 0

HENNEPIN
HEN1-C117
DFB
07/05/2010



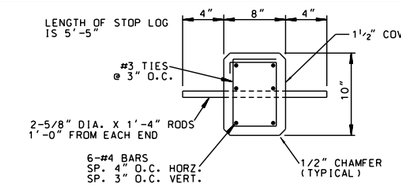
NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
0
p0019275.dgn

ILLINOIS POWER COMPANY
DECATUR

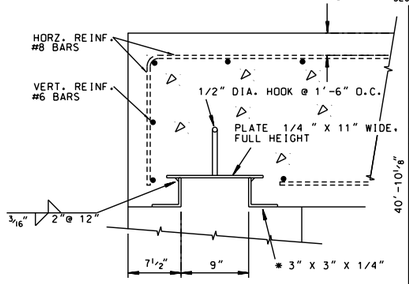
LAYOUT-POND DISCHARGE STRUCTURES
1995 ASH FACILITY
HENNEPIN POWER STATION

DR G.R.H.	CAD G.R.H.	DATE 1/5/94	
OK	CKD	SCALE NO SCALE	
APP	PLOTTED 9/17/96	CE-HEN1-C8	
APP			

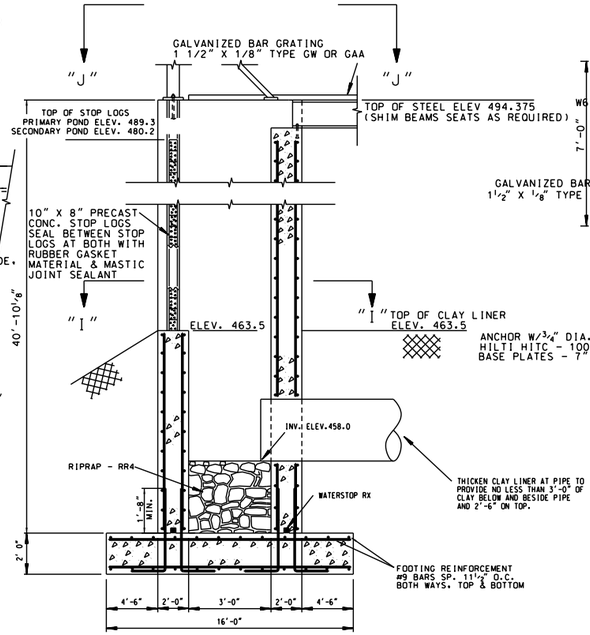


STOP LOG DETAIL

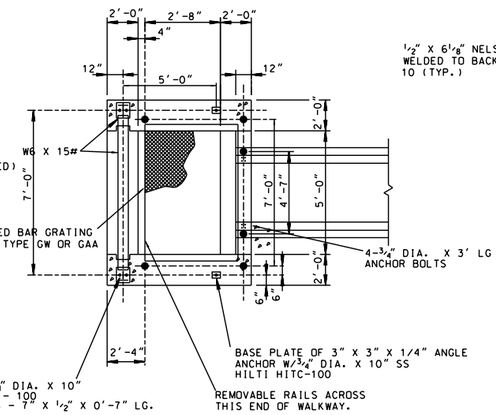
(51 REQUIRED INITIALLY, PROVIDE COMPANY WITH 10 EXTRA)
PRIMARY POND - 31
SECONDARY POND - 20



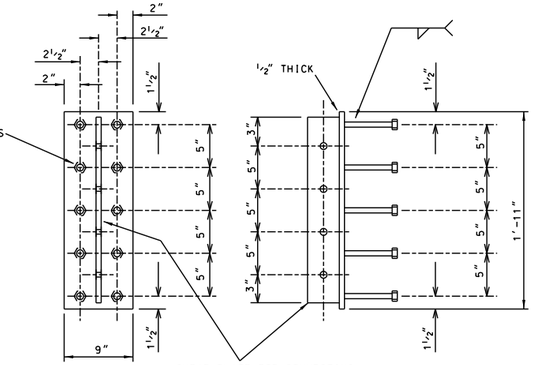
DETAIL 6



DETAIL 5

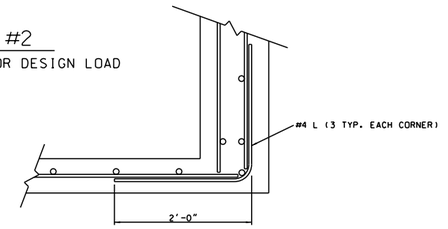


SECTION J-J

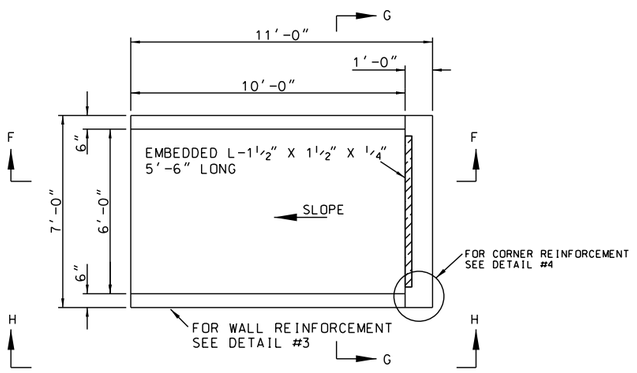


DETAIL #2

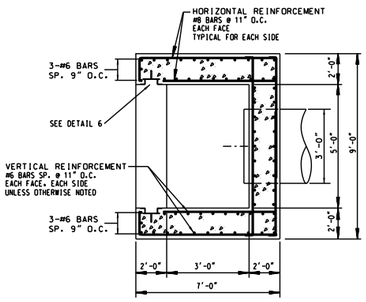
SEE CATWALK PLAN FOR DESIGN LOAD



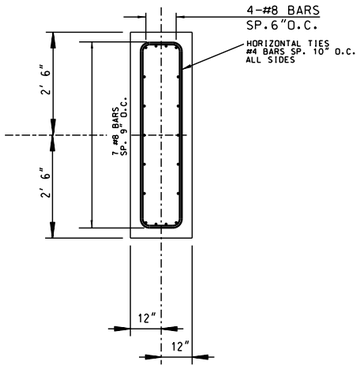
DETAIL #4



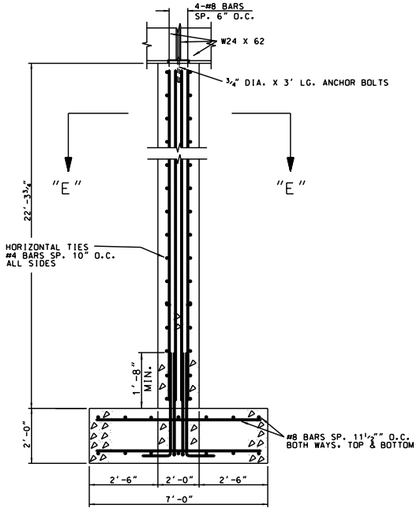
PLAN: CATWALK FOUNDATION



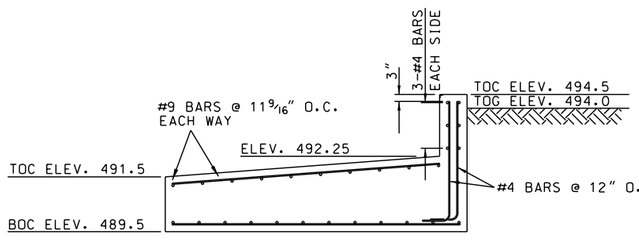
SECTION "I - I"



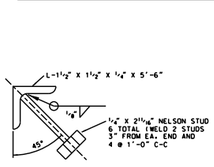
SECTION E-E



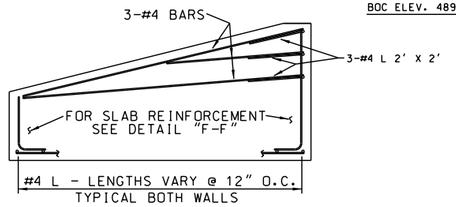
DETAIL 7



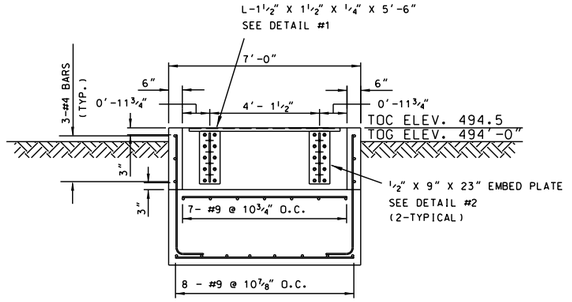
SECTION "F-F"



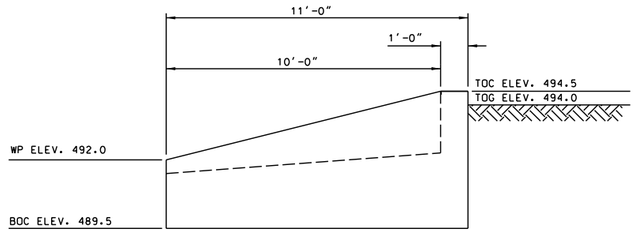
DETAIL #1



DETAIL #3



SECTION "G-G"



SECTION "H-H"

REVISION STATUS	ILLINOIS POWER COMPANY	
O -CONSTRUCTION O -RECORD	DECATUR	
0	DETAILS: POND DISCHARGE STRUCTURE 1995 ASH FACILITY HENNEPIN POWER STATION	
DR G.R.H.	CAD G.R.H.	DATE 1/5/94
OK	CKD	SCALE AS NOTED
APP	PLOTTED 9/17/96	CE-HEN1-C9
APP		
p0019276.dgn		

SUBMITTAL RECORD		
NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD		
NO	DATE	DESCRIPTION
△		
△		
△		
△		

NORTH

ILLINOIS RIVER FLOW

BASE GRADE ELEVATION 441.0'

2'ø DEADMAN

2'ø DEADMAN

2'ø DEADMAN

18D/18S

41S

5

05D

40S

19D/19S

3

6

4

EXISTING LOWER ACCESS ROAD

EXISTING UPPER ACCESS ROAD

PROPOSED BERM MODIFICATION AND VEGETATION REMOVAL AREA BOUNDARY

RETIRED ASH POND NO. 2

LANDFILL – PHASE 1

POND 2 EAST

EXISTING POND 2 EAST OUTLET STRUCTURE

DISCHARGE LOCATION

SAMPLING MANHOLE

STILLING BASIN AND PARSHALL FLUME

5' MANHOLE

EXISTING BOTTOM ASH RECLAMATION AREA

MISCELLANEOUS PLANT FLOWS

EXISTING PRIMARY POND OUTLET STRUCTURE

EXISTING OUTLET STRUCTURE

SECONDARY POND

PRIMARY POND

ABANDONED OUTLET STRUCTURE

LEGEND

- MISCELLANEOUS FLOW PIPING
- BASE GRADE ELEVATION
- EXISTING PIPING
- EXISTING TREELINE
- EXISTING PONDS/STREAMS
- EXISTING FENCE
- EXISTING ACCESS ROAD
- EXISTING STORM WATER PIPING
- EXISTING UNDERGROUND PLANT FLOW PIPING
- EXISTING PLANT FLOW PIPING
- EXISTING INDEX CONTOURS
- EXISTING INTERMEDIATE CONTOURS
- EXISTING MONITORING WELL LOCATIONS
- EXISTING ACCESS ROAD
- PROPOSED EAST BERM MODIFICATIONS AREA BOUNDARY

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
2. EMBANKMENT AREA SURVEY RECEIVED BY CEC FROM DLZ ON MARCH 4, 2013 AND JANUARY 10, 2014.
3. IL DNR PERMIT NO. DS2014017–DAM I.D. NO. 50663
4. AS–BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

AS-BUILT CONSTRUCTION PLANS

SCALE IN FEET
0 100 200

* HAND SIGNATURE ON FILE

Civil & Environmental Consultants, Inc.
555 Butterfield Road, Suite 300 - Lombard, IL 60148
Ph: 630.963.6026 · 877.963.6026 · Fax: 630.963.6027
www.cecinc.com

DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

EXISTING SITE CONDITIONS PLAN

DRAWING NO.: **3**

SHEET 3 OF 9

p:\2013\1_132-650\2000\~CADD\Dwg\Civil\132650-Civil-C100-Existing Conditions.dwg[EXISTING SITE CONDITIONS PLAN] LS:[2/11/2015 - lhostman] - LP: 2/11/2015 10:43 AM

SUBMITTAL RECORD		
NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	2/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD		
NO	DATE	DESCRIPTION

NORTH

TYPICAL BERM DETAIL 3/9

30" SILT FENCE DETAIL 1/4

TYPICAL BERM DETAIL 2/9

PROPOSED GRADING NOT SHOWN FOR CLARITY

ILLINOIS RIVER FLOW

4/9 TYPICAL BERM DETAIL WITH UNSUITABLE SOIL REMOVAL

BASE GRADE ELEVATION 441.0'

PROPOSED TEMPORARY SILT FENCE

2'ø DEADMAN

18D/18S

41S

5

05D

40S

19D/19S

ACCESS RAMP AND HAUL ROAD

ACCESS RAMP AND HAUL ROAD

6

3

2'ø DEADMAN

2'ø DEADMAN

4

DISCHARGE LOCATION

SAMPLING MANHOLE

TREE AND ROOT BALL REMOVAL AS WELL AS BERM RECONFIGURATION

POND 2 EAST

TREE AND ROOT BALL REMOVAL ONLY ON THIS SLOPE

UPPER ACCESS ROAD

LOWER ACCESS ROAD

LANDFILL – PHASE 1

EXISTING POND 2 EAST OUTLET STRUCTURE

RETIRED ASH POND NO. 2

STILLING BASIN AND PARSHALL FLUME

5' MANHOLE

TREE AND ROOT BALL REMOVAL ONLY ON THIS SLOPE

EXISTING BOTTOM ASH RECLAMATION AREA

MISCELLANEOUS PLANT FLOWS

EXISTING OUTLET STRUCTURE

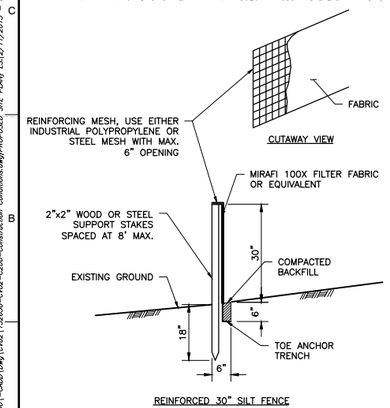
EXISTING PRIMARY POND OUTLET STRUCTURE

SECONDARY POND

PRIMARY POND

ABANDONED OUTLET STRUCTURE

SITE PLAN
SCALE: 1" = 100'



REINFORCED 30" SILT FENCE

DETAIL 1
30" SILT FENCE DETAIL
N.T.S.

SILT FENCE NOTES:

1. SILT FENCE SHALL BE PLACED ON LEVEL GRADE, WHERE POSSIBLE, AND BOTH ENDS OF THE SILT FENCE SHALL BE EXTENDED UP THE SLOPE.
2. SILT FENCE SHALL NOT BE PLACED IN ANY AREA OF CONCENTRATED FLOW NOR IN AREAS WHERE ROCK OR ROCKY SOILS PREVENT THE FULL AND UNIFORM ANCHORING OF THE FENCE TOE.
3. THE CONTRACTOR SHALL INSPECT THE SILT FENCE AFTER EVERY PRECIPITATION EVENT AND IMMEDIATELY REPAIR ANY DEFICIENCIES.
4. THE CONTRACTOR SHALL REMOVE ACCUMULATED SEDIMENTS AS REQUIRED TO KEEP THE FENCE FUNCTIONAL. IN ALL CASES, THE CONTRACTOR SHALL REMOVE DEPOSITS WHERE ACCUMULATIONS REACH ONE-HALF THE ABOVE GROUND HEIGHT OF THE FENCE.
5. THE CONTRACTOR SHALL IMMEDIATELY REPAIR ALL UNDERCUTTING OR EROSION OF THE ANCHOR TOE WITH A ROCK FILTER OUTLET.
6. THE CONTRACTOR SHALL CONFORM TO ANY RECOMMENDATIONS BY THE MANUFACTURER FOR REPLACING FILTER FABRIC FENCE DUE TO WEATHERING.

LEGEND

W	MISCELLANEOUS FLOW PIPING
	BASE GRADE ELEVATION
	EXISTING PIPING
	EXISTING TREELINE
	EXISTING PONDS/STREAMS
X X X	EXISTING FENCE
	EXISTING ACCESS ROAD
ST	EXISTING STORM WATER PIPING
P	EXISTING UNDERGROUND PLANT FLOW PIPING
	EXISTING PLANT FLOW PIPING
495	EXISTING INDEX CONTOURS
	EXISTING INTERMEDIATE CONTOURS
18D	EXISTING MONITORING WELL LOCATIONS
	PROPOSED CONSTRUCTION ACCESS ROAD
	PROPOSED EAST BERM MODIFICATIONS AREA BOUNDARY
SF	PROPOSED SILT FENCE
	PROPOSED GRADING LIMITS

AS-BUILT CONSTRUCTION PLANS

NOTE:
MONITORING WELLS EXIST WITHIN THE PROPOSED BERM MODIFICATION AREA. CONTRACTOR SHALL PROTECT EXISTING MONITORING WELLS WHILE PERFORMING BERM MODIFICATION ACTIVITIES.

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
2. EMBANKMENT AREA SURVEY RECEIVED BY CEC FROM DLZ ON MARCH 4, 2013 AND JANUARY 10, 2014.
3. IL DNR PERMIT NO. DS2014017-DAM I.D. NO. 50663
4. AS-BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

SCALE IN FEET
0 100 200

* HAND SIGNATURE ON FILE

Civil & Environmental Consultants, Inc.
555 Butterfield Road, Suite 300 · Lombard, IL 60148
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www.cecinc.com

DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

PROPOSED SITE PLAN

DRAWING NO.: **4**
SHEET 4 OF 9

A:\2015\132-650.02001-CAD\Dwg\CIVIL\132650-CV02-C200-Construction Conditions.dwg[PROPOSED SITE PLAN] LS(2/11/2015 - thoolman) - LP: 2/11/2015 10:43 AM

SUBMITTAL RECORD		
NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD		
NO	DATE	DESCRIPTION
△		
△		
△		
△		

NORTH

PROPOSED SECTIONS (TYP.)
SEE SHEETS 7 & 8

TYPICAL BERM DETAIL 3/9

TYPICAL BERM DETAIL 2/9

ILLINOIS RIVER FLOW

SAFETY BENCH

BASE GRADE ELEVATION
441.0'

WEST ACCESS RAMP

0+00 1+00 2+00 3+00 4+00 5+00 6+00 7+00 8+00 9+00 10+00 11+00

MATCHLINE – SEE SHEET 6

18D/18S

41S

LOWER ACCESS ROAD

2' ø DEADMAN

2'ø DEADMAN (REMOVED)

TREE AND ROOT BALL REMOVAL AS
WELL AS BERM RECONFIGURATION

UPPER ACCESS ROAD

TREE AND ROOT
BALL REMOVAL ONLY

RETIRED ASH POND

LEGEND

- MISCELLANEOUS FLOW PIPING
- BASE GRADE ELEVATION
- EXISTING TREELINE
- EXISTING PONDS/STREAMS
- EXISTING FENCE
- EXISTING ACCESS ROAD
- EXISTING STORM WATER PIPING
- EXISTING UNDERGROUND PLANT FLOW PIPING
- EXISTING PLANT FLOW PIPING
- EXISTING INDEX CONTOURS
- EXISTING INTERMEDIATE CONTOURS
- EXISTING MONITORING WELL LOCATIONS
- EXISTING ACCESS ROAD
- PROPOSED EAST BERM MODIFICATIONS AREA BOUNDARY
- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- PROPOSED SAFETY BENCH
- TREE/ROOT BALL REMOVAL ONLY
- TREE/ROOT BALL REMOVAL WITH BERM RECONFIGURATION

AS-BUILT CONSTRUCTION PLANS

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
2. EMBANKMENT AREA SURVEY RECEIVED BY CEC FROM DLZ ON MARCH 4, 2013 AND JANUARY 10, 2014.
3. IL DNR PERMIT NO. DS2014017–DAM I.D. NO. 50663
4. AS–BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

SCALE IN FEET
0 50 100

* HAND SIGNATURE ON FILE

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DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

PROPOSED GRADING PLAN
1 OF 2

DRAWING NO.: **5**
SHEET 5 OF 9

A:\2015\132-650.02001-CADD\Dwg\CV021\132650-CV02-C300-Proposed Grading Plan.dwg[PROPOSED GRADING PLAN - 1 OF 2] LS(2/17/2015 - dbvencik) - LP: 2/17/2015 10:43 AM

SUBMITTAL RECORD		
NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD		
NO	DATE	DESCRIPTION
△		
△		
△		
△		

NORTH

MATCHLINE – SEE SHEET 5

PROPOSED SECTIONS (TYP.)
SEE SHEETS 7 & 8

ILLINOIS RIVER FLOW

BASE GRADE ELEVATION
441.0'

SAFETY BENCH

LIMITS OF UNSUITABLE
SOIL REMOVAL

TYPICAL BERM SECTION WITH
UNSUITABLE SOIL REMOVAL 4/9

11+00 12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00 20+00 21+00 22+00 23+00 23+50

05D 5 40S 19D/19S 4

TREE AND ROOT BALL REMOVAL AS
WELL AS BERM RECONFIGURATION

TREE AND ROOT
BALL REMOVAL ONLY

DISCHARGE
LOCATION

SAMPLING MANHOLE

POND 2 EAST

LANDFILL - PHASE 1

EXISTING POND 2 EAST OUTLET STRUCTURE

STILLING BASIN AND
PARSHALL FLUME

5' MANHOLE

COAL PILE RUNOFF

MISCELLANEOUS PLANT FLOWS

LEGEND

- W — MISCELLANEOUS FLOW PIPING
- BASE GRADE ELEVATION
- EXISTING TREELINE
- EXISTING PONDS/STREAMS
- EXISTING FENCE
- EXISTING ACCESS ROAD
- ST — EXISTING STORM WATER PIPING
- P — EXISTING UNDERGROUND PLANT FLOW PIPING
- EXISTING PLANT FLOW PIPING
- 495 — EXISTING INDEX CONTOURS
- EXISTING INTERMEDIATE CONTOURS
- 18D — EXISTING MONITORING WELL LOCATIONS
- EXISTING ACCESS ROAD
- PROPOSED EAST BERM MODIFICATIONS AREA BOUNDARY
- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- PROPOSED SAFETY BENCH

- TREE/ROOT BALL REMOVAL ONLY
- TREE/ROOT BALL REMOVAL WITH BERM RECONFIGURATION

AS-BUILT CONSTRUCTION PLANS

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
2. EMBANKMENT AREA SURVEY RECEIVED BY CEC FROM DLZ ON MARCH 4, 2013 AND JANUARY 10, 2014.
3. IL DNR PERMIT NO. DS2014017–DAM I.D. NO. 50663
4. AS–BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

SCALE IN FEET
0 50 100

* HAND SIGNATURE ON FILE

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EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

PROPOSED GRADING PLAN
2 OF 2

DRAWING NO.: **6**
SHEET 6 OF 9

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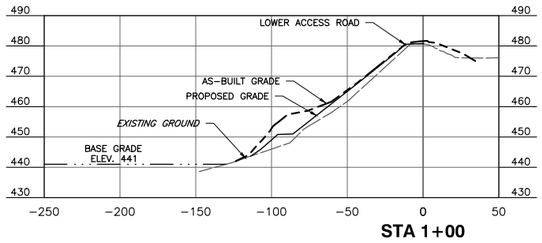

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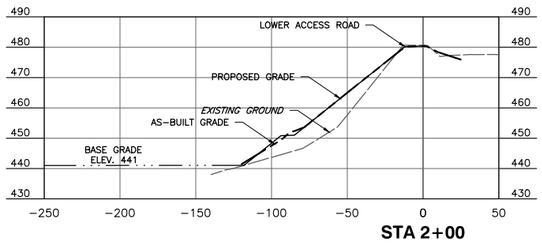

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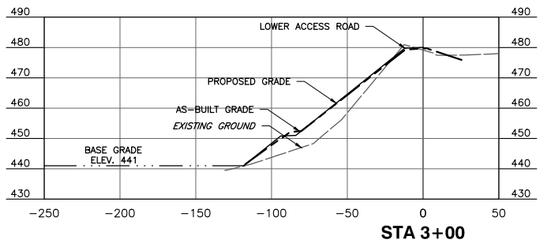

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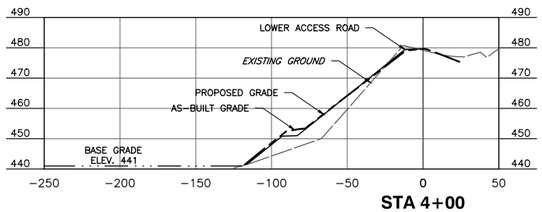

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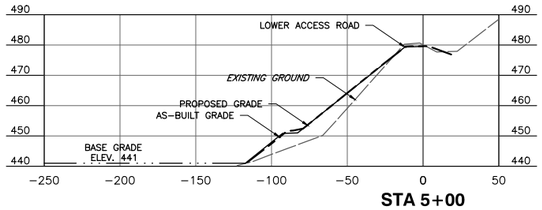

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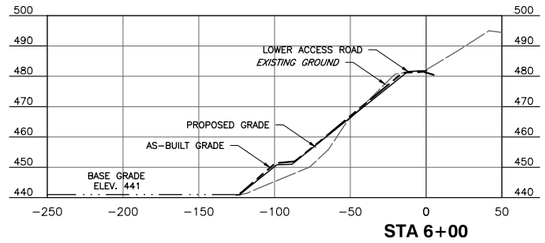

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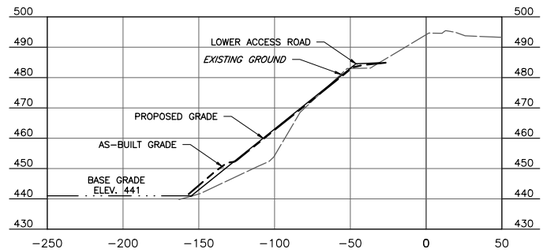

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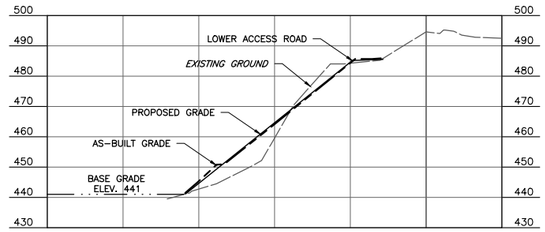

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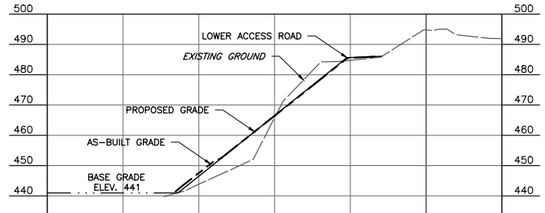

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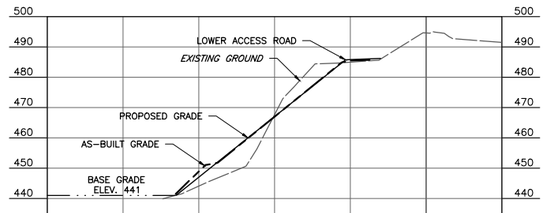

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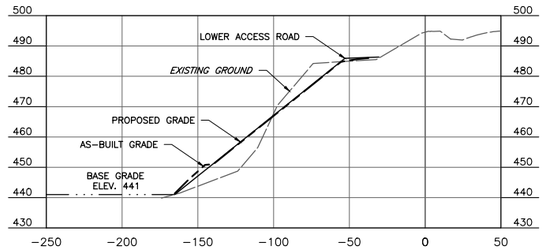

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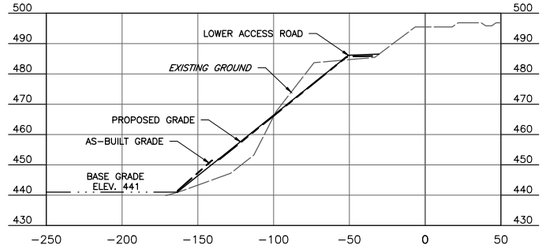

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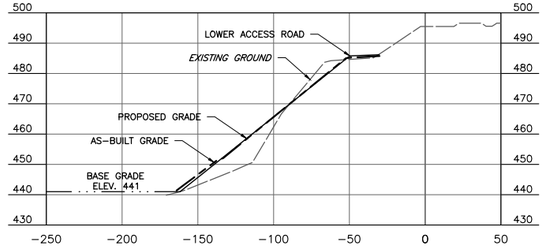

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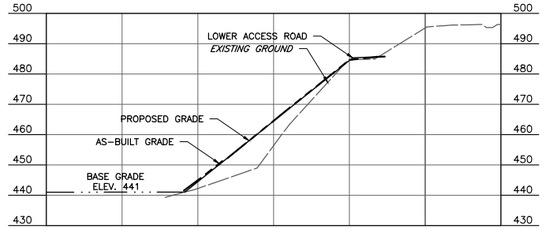

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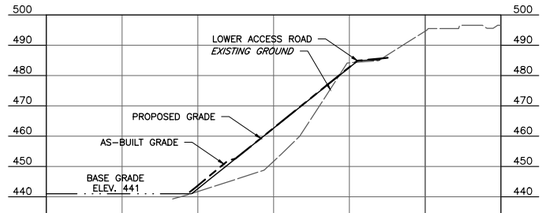

STA 15+00

SUBMITTAL RECORD		
NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD		
NO	DATE	DESCRIPTION
1		
2		
3		
4		

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
2. EMBANKMENT AREA SURVEY RECEIVED BY CEC FROM DLZ ON MARCH 4, 2013 AND JANUARY 10, 2014.
3. IL DNR PERMIT NO. DS2014017–DAM I.D. NO. 50663
4. AS–BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

AS-BUILT CONSTRUCTION PLANS

HORIZONTAL
SCALE IN FEET
0 50 100

VERTICAL
SCALE IN FEET
0 25 50

* HAND SIGNATURE ON FILE

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www.cecinc.com

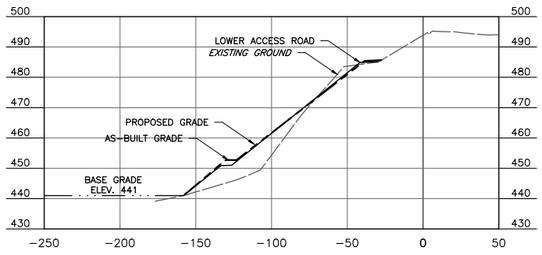
DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

PROPOSED SECTIONS
STA 1+00 TO 15+00

DRAWING NO.: **7**
SHEET 7 OF 9

P:\2013\132-650.0200\-CADD\Dwg\Civil\132650-Civil02-C350-Proposed Grading Plan.dwg(CROSS SECTIONS (1)) LS(2/17/2015 - dtvonulis) - LP: 2/17/2015 10:43 AM



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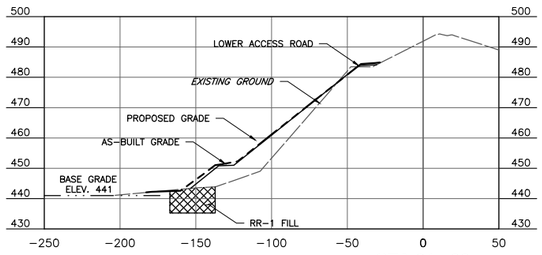

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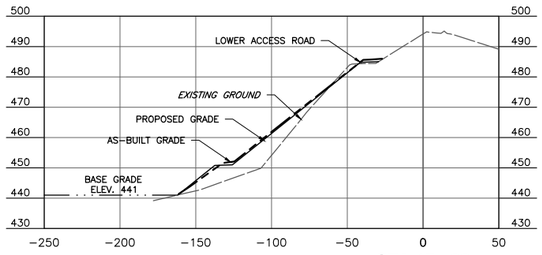

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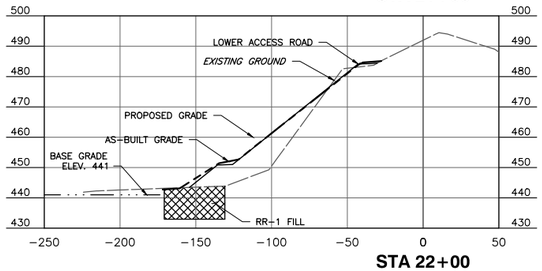

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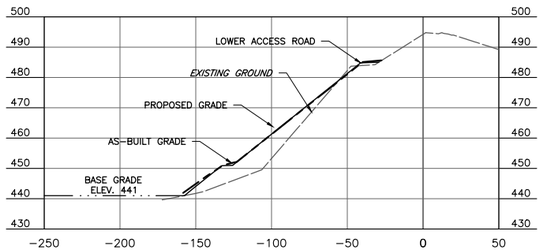

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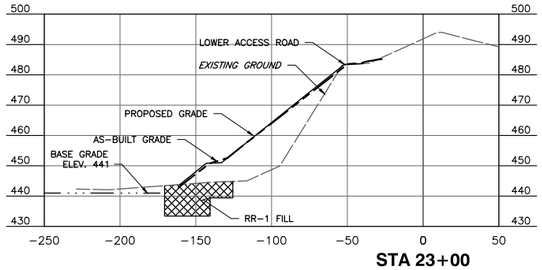

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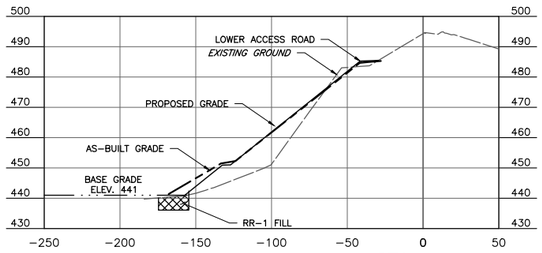

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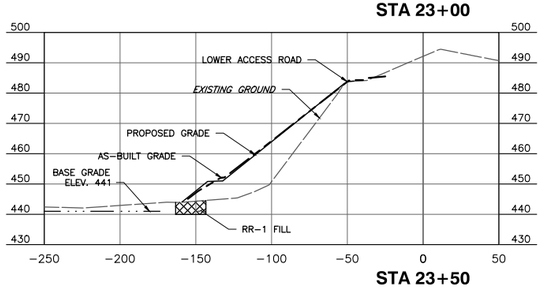

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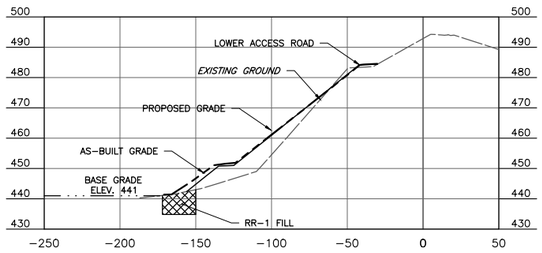

STA 20+00

SUBMITTAL RECORD		
NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD		
NO	DATE	DESCRIPTION
1		
2		
3		
4		

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
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AS-BUILT CONSTRUCTION PLANS

HORIZONTAL SCALE IN FEET
0 50 100

VERTICAL SCALE IN FEET
0 25 50

* HAND SIGNATURE ON FILE

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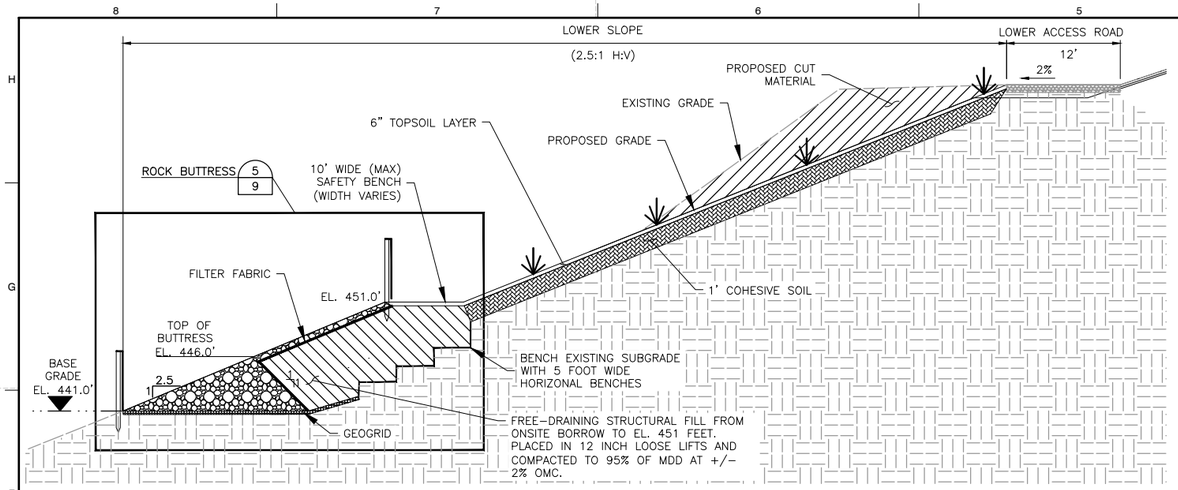
DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

PROPOSED SECTIONS
STA 16+00 TO 23+50

DRAWING NO.: **8**
SHEET **8** OF **9**

A:\2013\132-650\02001\-2400\Dwg\Civil\132650-Civil-C300-Proposed Grading Plan.dwg(08SS SECTIONS (2)) LS(2/17/2015 - dbrondyk) - LP: 2/17/2015 10:43 AM



DETAIL 2
TYPICAL BERM DETAIL
SCALE: NTS

LEGEND

- PROPOSED CUT MATERIAL
- PROPOSED STRUCTURAL FILL
- UNSUITABLES/RR1 FILL
- RIPRAP
- DRAINAGE LAYER
- PROPOSED GRADELINE
- EXISTING GRADELINE
- WATER SURFACE ELEVATION
- VEGETATION

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD

NO	DATE	DESCRIPTION
△		
△		
△		
△		

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
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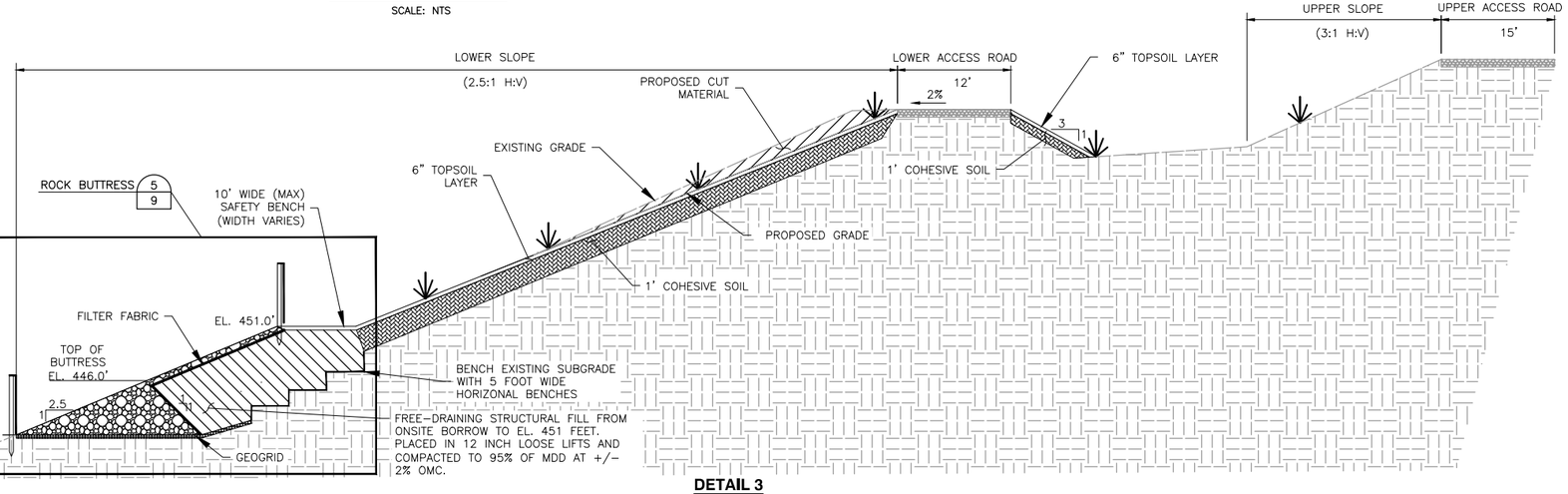
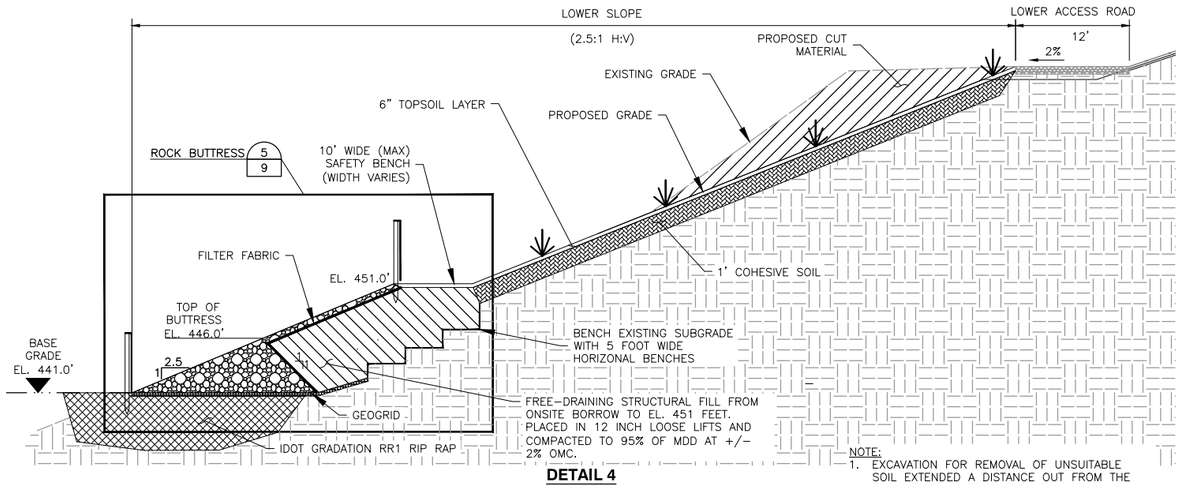
4. AS-BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.



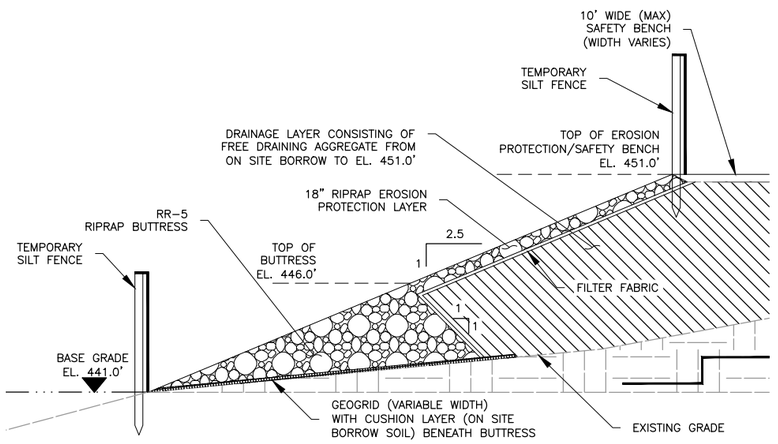
DETAIL 3
TYPICAL BERM DETAIL
SCALE: NTS

NOTE:
1. TEMPORARY SILT FENCE WAS INSTALLED PRIOR TO ROCK BUTTRESS INSTALLATION. UPON COMPLETION OF ROCK BUTTRESS. SILT FENCE WAS INSTALLED UP SLOPE OF ROCK BUTTRESS AND TEMPORARY SILT FENCE REMOVED.
2. AFTER PLACING TOPSOIL AND SEEDING, EROSION CONTROL BLANKETS WERE INSTALLED ON ALL SLOPES STEEPER THAN 3:1 FOR EROSION PROTECTION AND SEED ESTABLISHMENT. STRAW WATTLES WERE PLACED AT MID-HEIGHT OF BERM FOR ADDITIONAL EROSION PROTECTION.



DETAIL 4
TYPICAL BERM WITH UNSUTABLE SOIL REMOVAL DETAIL
SCALE: NTS

NOTE:
1. EXCAVATION FOR REMOVAL OF UNSUITABLE SOIL EXTENDED A DISTANCE OUT FROM THE TOE OF BERM EQUAL TO THE DEPTH OF EXCAVATION.



DETAIL 5
ROCK BUTRESS AND EROSION PROTECTION LAYER DETAIL
SCALE: NTS

AS-BUILT CONSTRUCTION PLANS

* HAND SIGNATURE ON FILE

Civil & Environmental Consultants, Inc.
555 Butterfield Road, Suite 300 - Lombard, IL 60148
Ph: 630.963.6026 · 877.963.6026 · Fax: 630.963.6027
www.cecinc.com

DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

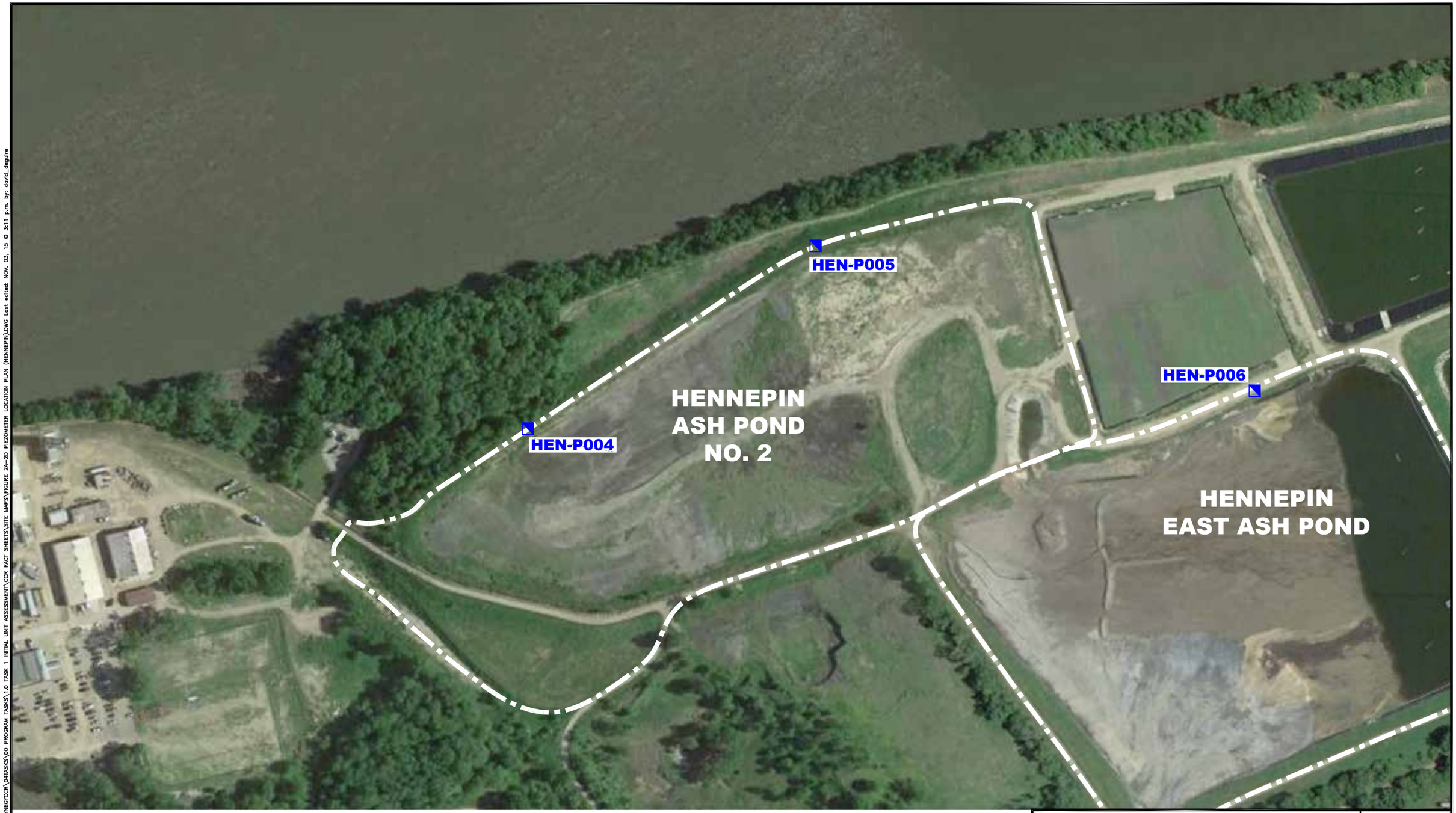
BERM AND EROSION CONTROL DETAILS

DRAWING NO.: 9

SHEET 9 OF 9

P:\2013\132-650.02001\-CADD\Dwg\CIVIL\132650-CIV02-CIV03-Erosion Control Details.dwg[DETAILS 2][4] LS(2/17/2015 - drenchik) - LP: 2/17/2015 10:43 AM

Appendix C: Hennepin Power Station Piezometer Locations



EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)

XXX-X###

ID NUMBER

STATION ABBREVIATION

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

LEGEND

PIEZOMETER LOCATION

CCR UNIT BERM ALIGNMENT

0 200

APPROXIMATE SCALE FEET

DYNEGY MIDWEST GENERATION, LLC	PROJECT NO. 60439752
AECOM	
DRN. BY: djd October 2015 DSGN. BY: eg CHKD. BY: eg	Hennepin Ash Pond No. 2 Piezometer Locations
	FIG. NO. 2A

File: P:\PROJECTS\GEOTECH\60428794_DYNEGYCCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 2A-2D PIEZOMETER LOCATION PLAN (HENNEPIN).DWG Last edited: NOV. 03, 15 @ 3:11 p.m. by: david_deguire

EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)

XXX-X###

ID NUMBER

STATION ABBREVIATION

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

LEGEND

PIEZOMETER LOCATION

CCR UNIT BERM ALIGNMENT

0 200

APPROXIMATE SCALE FEET

DYNEGY MIDWEST GENERATION, LLC

PROJECT NO. 60439752

AECOM

DRN. BY: djd October 2015
DSGN. BY: eg
CHKD. BY: eg

Hennepin East Ash Pond
Piezometer Locations

FIG. NO. 2B

File: P:\PROJECTS\GEOTECH\60428794_DYNEGY\CCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 2A-2D PIEZOMETER LOCATION PLAN (HENNEPIN).DWG Last edited: NOV. 03, 15 @ 3:11 p.m. by: david_deguire

EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)

XXX-X###

ID NUMBER

STATION ABBREVIATION

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

LEGEND

PIEZOMETER LOCATION

CCR UNIT BERM ALIGNMENT

0 200

APPROXIMATE SCALE FEET

DYNEGY MIDWEST GENERATION, LLC

PROJECT NO. 60439752

AECOM

DRN. BY: djd October 2015
DSGN. BY: eg
CHKD. BY: eg

Hennepin Old West Ash Pond (Pond No. 1 and Pond No. 3) Piezometer Locations

FIG. NO. 2C

File: P:\PROJECTS\GEOTECH\60428794_DYNEGYCCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 2A-2D PIEZOMETER LOCATION PLAN (HENNEPIN).DWG Last edited: NOV. 03, 15 @ 3:11 p.m. by: david_deguire

EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)

XXX-X###

ID NUMBER

STATION ABBREVIATION

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

LEGEND

PIEZOMETER LOCATION

CCR UNIT BERM ALIGNMENT

0 100

APPROXIMATE SCALE FEET

DYNEGY MIDWEST GENERATION, LLC		PROJECT NO. 60439752
AECOM		
DRN. BY: djd October 2015 DSGN. BY: eg CHKD. BY: eg	Hennepin Old West Polishing Pond Piezometer Locations	FIG. NO. 2D

File: E:\PROJECTS\GEOTECH\60428794_DYNEGYCCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 2A-2D PIEZOMETER LOCATION PLAN (HENNEPIN).DWG Last edited: NOV. 03, 15 @ 3:11 p.m. by: david_deguire

Appendix D: Specification J-2616, Rev. A, Primary Ash Pond Modifications

Sargent & Lundy

DYNEGY MIDWEST GENERATION
HENNEPIN POWER STATION

SPECIFICATION J-2616, REV. A
PERMIT APPLICATION

PRIMARY ASH POND MODIFICATIONS

Prepared By:
Sargent & Lundy, LLC
55 East Monroe Street
Chicago, Illinois 60603

PRIMARY ASH POND MODIFICATIONS

ISSUE SUMMARY

Rev.	Purpose of Issue	Date	Sections Affected
A	Spec No. J-2616 Released for Permit Application	02/14/03	All

CERTIFICATION OF SPECIFICATION

FOR

PRIMARY ASH POND MODIFICATION

I certify that this Specification was prepared by me or under my supervision and that I am a registered professional engineer under the laws of the State of Illinois.

Sargent & Lundy LLC's Illinois Department of Professional Regulation registration number is 184-000106.

Certified By: Ronald Cook Date: Feb 14, 2003

EXP. 11-30-03

Seal

Revision: _____ Certified By: _____ Date: _____

PRIMARY ASH POND MODIFICATIONS

TABLE OF CONTENTS

Notes:

(1) Where Division and/or Sections are not included, work under the unlisted headings is not part of the Work.

(2) This Table of Contents will indicate the date of issue for the latest complete issue or revision issue of each section and any subsequent revision issue thereto.

(3) The numbering and subsequent Revisions to the Specification are in sequence with the previously issued Revision mark number.

SECTION		DATE OF ISSUE	LATEST ISSUE/REVISION
PCTC 08003	Fabric Formed Concrete Mats	02/14/03	A
PCTC 12001	Temporary and Permanent Seeding (Illinois)	02/14/03	A
PCTC 36007	Crushed Stone Surfacing for Unpaved Roads, Parking Lots, and Laydown Areas (IDOT)	02/14/03	A
PCTC 54005	Earthwork and Clay Lining for a Clay/Geomembrane Lined Ash Pond	02/14/03	A
PCTC 56008	Polypropylene Geomembrane Liner for a Pond	02/14/03	A
PCTC 57001	Geotextile for Lined Ponds	02/14/03	A
PCTC 60008	Quality Assurance for Installation of Earthwork and Clay Lining for the Ash Pond	02/14/03	A

FABRIC FORMED CONCRETE MATS

ISSUE SUMMARY

Rev.	Purpose of Issue	Date	Sections Affected	Prepared By	Reviewed By	Approved By
A	Permit Application	02/14/03	ALL	Ronald Cook	Daniel C. Kunk	Ronald Cook

FABRIC FORMED CONCRETE MATS

TABLE OF CONTENTS

Notes:

(1) This Table of Contents will indicate the date of issue for the latest complete issue or revision issue of each section and any subsequent revision issue thereto.

(2) The numbering and subsequent Revisions to the Specification are in sequence with the previously issued Revision mark number.

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Fabric Formed Concrete Mats - Technical Specification and Optional Features/Accessories

1.0 Scope of Work

The intent of this specification is to define the material and installation requirements for fabric formed concrete mats installed in accordance with the Design Drawings, technical data and as specified herein.

1.1 Work Included

The work shall include, but not be limited to, the following items as indicated:

A. Preparation and grading of surfaces to receive fabric mats.

B. Placing fabric mats and filling them with a pumpable sand/cement slurry to form a stable erosion protection system.

C. Offsite disposal of excess or unsuitable materials and debris.

2.0 Codes and Standards

A. Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein. Methods, equipment and materials specified herein shall comply with the specified and applicable portions of the referenced documents, in addition to federal, state or local codes having jurisdiction.

B. References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of contract for the work.

C. Abbreviations listed indicate the form used to identify the reference documents in the specification text.

2.1 ASTM – American Society for Testing and Materials

A. ASTM C 31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.

B. ASTM C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

C. ASTM C 143 – Standard Test Method for Slump of Hydraulic Cement Concrete.

D. ASTM C 172 – Standard Practice for Sampling Freshly Mixed Concrete.

E. ASTM C 173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

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F. ASTM C 231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

G. ASTM C1064 – Standard Test Method for Temperature of Freshly Mixed Portland-Cement Concrete.

H. ASTM D 543 – Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.

I. ASTM D 751 – Standard Test Methods for Coated Fabrics.

J. ASTM D 792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

K. ASTM D1777 – Standard Test Method for Thickness of Textile Materials.

L. ASTM D2101 – Standard Test Method for Tensile Properties of Single Man-Made Textile Fibers Taken From Yarns and Tows.

M. ASTM D3776 – Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.

N. ASTM D3786 – Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics (Mullen Burst).

O. ASTM D3787 – Standard Test Method for Bursting Strength of Knitted Goods: Constant-Rate-of Traverse (CRT) Ball Burst Test.

P. ASTM D3885 – Standard Test Method for Abrasion Resistance of Textile Fabrics.

Q. ASTM D4355 – Standard Test Methods for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.

R. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

S. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

T. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

U. ASTM D5034 – Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

V. ASTM D5035 – Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Strip Method).

3.0
Supplier's Drawings and Data Submittals

A. Supplier shall submit drawings and data as specified. Supplier's drawings and data shall be submitted via electronic medium in a format compatible for importing into the Buyer's information systems specified by the Buyer.

3.1
Submittals Prior to Installation

The Supplier shall submit the following items at least 30 days prior to scheduled delivery of materials:

A. Manufacturer's literature providing specifications on the fabric mats that will be supplied.

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B. Manufacturer's certification that the fabric mats to be supplied comply with the requirements of this Technical Specification.

C. Manufacturer's Quality Control and Construction Quality Control Plans. The MQC Plan shall state the frequency that index tests are performed on the fabric mat during manufacturing.

D. If requested by the Buyer, four samples of each fabric mat suitable for testing.

E. Required concrete grout slurry mix design, including requirements for compressive strength, slump, air content and maximum temperature.

3.2
Submittals During and After Installation

The Supplier shall submit the following items on a daily basis during installation and a complete set of data within 30 days of the completion of the work:

A. Results of tests performed on the concrete grout fill.

4.0
Construction Quality Assurance

A. The Supplier shall examine the areas and conditions under which the work is to be installed and notify Buyer in writing of conditions detrimental to the proper and timely completion of the work that have changed from the time of the bidder's walkdown.

B. Material and installation procedures are subject to inspection and tests conducted by an Independent Testing Service employed by the Buyer. Such inspections and tests will not relieve the Supplier of responsibility for providing material and installation procedures in compliance with specified requirements. The Buyer reserves the right, at any time before final acceptance, to reject material not complying with the specified requirements.

C. The Supplier shall correct deficiencies in the work which inspections and laboratory test reports have indicated to be not in compliance with requirements. The Supplier shall perform additional tests, at his expense, as may be necessary to reconfirm any noncompliance of the original work, and as may be necessary to show compliance of corrected work.

D. The Supplier shall promptly correct errors or flaws in material or placement of the protection mats identified during construction. The Supplier shall make immediate substitution of non-complying component or make field changes to make the non-complying component acceptable. Whether the correction is made by substitution or field correction, it shall be performed without cost to the Buyer.

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4.1
Testing

4.1.1
Independent Testing Service

An Independent Testing Service shall perform the following:

A. Test material for the concrete slurry fill and prepare initial test cylinders in accordance with the requirements specified herein.

B. Prepare test cylinders and determine the compressive strength of job concrete fill test cylinders.

4.1.2
Concrete Grout Testing

A. Obtaining and testing concrete grout shall be by the Independent Testing Service in accordance with the following specifications:

- Sampling freshly mixed grout shall be done in accordance with ASTM C172.
- Making and curing concrete test specimens shall be in accordance with ASTM C31.
- Slump test shall be in accordance with ASTM C143.
- Air Content tests shall be in accordance with ASTM C173 or ASTM C231.
- Tests for the temperature of the freshly mixed grout shall be in accordance with ASTM C1064.
- Compressive strength test shall be in accordance with ASTM C39.

B. The frequency of testing shall be as directed by Buyer as follows:

- At least one test shall be made for each day's placement of grout, but not less than once for each 100 cubic yards or part thereof placed.
- A test shall consist of a minimum of four cylinders taken from the same truck. One 7-day and two 28-day tests shall be performed by the laboratory with results submitted to the Buyer as soon as possible. One spare cylinder shall be made and used as directed by the Buyer.
- A slump test and air content test shall be performed on every 100 cubic yards of concrete grout.
- The temperature of each 100 cubic yards shall be recorded in the field prior to placement. If the concrete grout temperature is in excess of 100°F, the concrete shall be rejected.

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5.0
Materials

5.1
Fabric Design

A. Fabric-forming material shall consist of double-layer, open-selvage fabric joined in a mat configuration. The fabric shall be woven of 100% continuous multi-filament nylon fiber of which 50% by weight shall be bulk textured fiber. The use of staple yarns will not be permitted.

B. The fabric shall be woven in such a manner as to provide interwoven points of attachment on spaced centers. These points of attachment shall serve to control the thickness of the finished product and to also act as a filter point to provide relief of hydrostatic uplift pressure beneath the completed revetment. The fabric shall be woven in a basket or other open pattern to provide permeability at the filter points and the main fabric field.

C. The spacing of the filter points is indicated on the Design Drawings. This spacing will result in an average revetment thickness that is consistent with the average thickness published by the manufacturer for the designated style specified.

5.2
Fiber and Fabric Material

A. The warp fiber shall be 1260 Denier Nylon, 18.5 ends/inch per single layer and the fill fiber shall be 1900 Denier Nylon, 14 picks/inch per single layer. The fiber and fabric material shall meet the minimum requirements listed in Table 1.

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TABLE 1
MATERIAL PROPERTIES

PROPERTY	ASTM TEST METHOD	MINIMUM TEST VALUE
Fiber count	-	0.164 g/m
Trapezoidal tear breaking force on the warp fiber at 70% elongation	D 4533	80 lbs/in
Trapezoidal tear breaking force on the fill fiber at 70% elongation	D 4533	40 lbs/in
Density	D 792	1.00 g/cm^3
Fiber dry breaking strength at 48% elongation	D 2101	20 lbs
Fiber wet breaking strength at 53% elongation (soaked in water for 2 hours)	D 2101	19 lbs
Tensile strength in the warp direction after exposure to 300 hours of Ca (OH) at a pH of 10	D 543	180 lbs/in
Tensile strength in the warp direction after exposure to 300 hours of H_2SO_4	D 543	170 lbs/in
Tensile breaking strength in the warp direction on a strip of the fabric at 39% elongation (1)	D 5034, D 5035	160 lbs/in
Tensile breaking strength in the fill direction on a strip of the fabric at 34% elongation (1)	D 5034, D 5035	190 lbs/in
Mass/unit area for a single layer of fabric	D 3776	7.8 oz/sq yd
Thickness of a single layer of fabric	D 1777	31 mils
Falling head permittivity of two layers of fabric woven together	D 4491	0.28 s^{-1} 0.04 cm/s (3)
Falling head permittivity of a single layer of fabric	D 4491	1.3 s^{-1} 0.12 cm/s
Seam strength (2)	D 751	35 lbs/in
Abrasion resistance in the warp direction	D 3885	160 lbs/in
Grab strength in the warp direction at 31% elongation	D 4632	350 lbs
Grab strength in the fill direction at 41% elongation	D 4632	275 lbs
Breaking strength in the warp direction after exposure to 500 hours of UV light	D 4355	190 lbs/in
Mullen burst test	D 3786	750 psi
Puncture test	D 3787	80 lbs

Notes for Table 1:

(1) 3" x 8" sample gripped along full width of the specimen with 3" of separation between grips. Strip test to be performed on single layer of fabric at cross-head speed of 5 inches per minute.

(2) Seam centered between grips 3" apart and gripped the full width of the specimen.

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(3) Applies to Filter Points only

5.3
Fabric Assembly

A. Adjacent fabric panels shall be connected by sewing or by means of zipper.

B. The two top layers of fabric and the two bottom layers of fabric shall be joined separately permitting full mat thickness between the two parallel seams. A single seam in which all four layers of the fabric are joined at one point will not be permitted.

C. If required, grout stops may be installed parallel to and in between individual mill widths at predetermined intervals to regulate the flow of the concrete fill. Grout stops shall be so designed as to produce full mat thickness along the full length of the grout stop.

5.4
Concrete Grout

A. The concrete grout shall consist of a mixture of Portland cement, fine aggregate and water so proportioned and mixed as to provide a readily pumpable slurry.

B. Admixtures and/or a pozzolan may be used with the approval of the Buyer. The use of superplasticizers and/or silica fume require special precautions and the approval of the Buyer.

C. The hardened concrete shall exhibit a minimum compressive strength of 2,500 psi at 28 days when specimens are made and tested in accordance with the provisions of ASTM C 31 and ASTM C 39.

5.5
Acceptable Materials

The following companies manufacture products that meet the requirements of the specification:

A. Fabriform Filter Point Fabric as manufactured by Construction Techniques, Inc., Cleveland, Ohio, 440-572-8300.

B. Other approved by Buyer.

6.0
Execution

6.1
Acceptance and Storage at the Project Site

6.1.1
Handling of Rolls

A. The method of off-loading the fabric at the project site shall not cause any damage to the fabric, its core, nor its protective covering.

B. Any protective covering that is accidentally damaged or stripped off of a pallet or roll shall be immediately repaired or the pallet or roll shall be moved to an enclosed facility until the repair can be made.

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6.1.2
Storage at the Field Site

A. The Buyer shall provide on-site storage space in a location near where the fabric will be placed such that on-site transportation and handling are minimized. The Supplier shall be responsible for protecting the stored material from theft and vandalism.

B. Rolls or pallets of fabric shall be stored in such a manner that cores are not crushed, the fabric damaged, and as required to provide protection from exposure to ultraviolet light, inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious condition.

C. Outdoor storage of rolls or pallets shall not exceed the manufacturer's recommendations or longer than six months, whichever is less.

6.2
Inspection upon Delivery

A. Upon delivery of the materials to the site, the Supplier shall conduct a visual inspection of all rolls of fabric for damage or defects. This inspection shall be done without unrolling any rolls unless damage to the inside of a roll is found or suspected.

B. Any damage or defects shall be noted and immediately reported to the Buyer, the manufacturer and the carrier that transported the material. Any roll, or portion thereof, which, in the judgement of the Buyer, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to the Buyer.

6.3
Fabric Placement

A. Prior to concrete injection, the fabric shall be positioned over a geotextile on the grade as indicated on the Design Drawings making appropriate allowances for contraction of the fabric mats as a result of injecting the concrete grout.

B. Anchoring of fabric shall be as shown on the Design Drawings.

C. Fabric panels may be factory assembled in predetermined sizes and joined together side-by-side at the project site by field sewing or by means of zipper closures attached to the upper and lower layers of the fabric. In no case will simple unattached butt joints between panels be allowed. Overlapping shall be allowed only if approved by the Buyer.

6.4
Concrete Injection

A. Following placement of the fabric mats the specified concrete grout shall be injected between the top and bottom layers of the fabric through small slits cut in the upper layer of the fabric. The injection pipe shall be wrapped tightly at the point of injection with a strip of burlap, or similar material, during pumping to seal the joint between the injection pipe and the slit. After pumping, the burlap shall be pushed into the slit as the injection pipe is withdrawn in order to minimize spillage of the concrete slurry onto the surface of the revetment.

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B. The sequence of concrete slurry injection shall be such as to insure complete filling of the revetment-forming fabric to average thickness indicated by the manufacturer for the designated style specified on the Design Drawings.

C. Foot traffic will not be permitted on the freshly pumped mat since such traffic will cause permanent indentations in the mat surface. Walk boards shall be used where necessary.

D. Excess concrete slurry which has been inadvertently spilled on the mat surface shall be cleaned up with a broom and shovel. The use of a water hose to remove spillage from the surface of a freshly pumped mat will not be permitted.

E. During concrete slurry injection, the mat thickness shall be measured by inserting a short piece of stiff wire through the crowns of the mats midway between the filter points at several locations from the crest to the toe of the slope. Any mat measurements less than 90% of the average of all thickness measurements shall be re-injected until the average thickness indicated for the style specified has been attained.

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TEMPORARY AND PERMANENT SEEDING (ILLINOIS)

ISSUE SUMMARY

Rev.	Purpose of Issue	Date	Sections Affected	Prepared By	Reviewed By	Approved By
A	Permit Application	02/14/03	ALL	Ronald Cook	Daniel C. Kunk	Ronald Cook

TEMPORARY AND PERMANENT SEEDING (ILLINOIS)

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(2) The numbering and subsequent Revisions to the Specification are in sequence with the previously issued Revision mark number.

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Temporary and Permanent Seeding (Illinois) – Technical Specification and Optional Features/Accessories

1.0 Scope of Work

The intent of this specification is to define the minimum requirements for material and work for establishing a vegetative cover by planting grass seed.

1.1 Purpose and Use

A. All graded areas, slopes, and ditches which will not be paved or otherwise surfaced shall be provided with permanent seeding.

B. Graded areas subject to erosion shall not remain unprotected for longer than 30 days. Temporary seeding shall be provided by the Supplier to protect graded areas from erosion where permanent protection is not scheduled to be installed for 2 to 12 months after grading is completed.

1.2 Method of Seed and Mulch Application

Seed may be spread by a conventional method of application such as broadcasting, grass drill, or cultipacker followed by an application of mulch or by a hydro seeding procedure consisting of spraying a slurry mixture of water, seed, mulch, fertilizer, and tackifier onto the prepared seedbed.

1.3 Work Included

A. Furnish all materials.

B. Subgrade preparation.

C. Seedbed preparation, including placing topsoil and the addition of lime and fertilizer.

D. Seeding using broadcast, grass drill, or the cultipacker method and mulching, or hydro seeding with a mixture that contains seed, mulch and a tackifier.

E. Installation of matting where specified for erosion control.

F. Protection.

G. Maintenance.

H. Repairing and reseeding.

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2.0
Codes and Standards

A. Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein. Methods, equipment and materials specified herein shall comply with the specified and applicable portions of the referenced documents, in addition to federal, state or local codes having jurisdiction.

B. References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

C. Abbreviations listed indicate the form used to identify the reference documents in the Specification text.

2.1
USDA - United States Department of Agriculture, Soil Conservation Service

A. USDA-SCS Soil Classification Supplement to Soil Classification System (7th Approximation), SCS, USDA, Second Printing, March 1967.

2.2
ASTM - American Society for Testing and Materials

A. C602 - Specification for Agricultural Liming Materials.

B. D977 - Specification for Emulsified Asphalt.

C. D2026 - Specification for Cutback Asphalt (Slow-Curing Type).

D. D2027 - Specification for Cutback Asphalt (Medium-Curing Type).

E. D2028 - Specification for Cutback Asphalt (Rapid-Curing Type).

F. D2397 - Specification for Cationic Emulsified Asphalt.

G. D5268 - Specification for Topsoil Used for Landscaping Purposes.

3.0
Supplier's Drawings and Data Submittals

Supplier shall submit drawings and data not less than 30 days before material is to be delivered. Supplier's drawings and data shall be submitted via electronic medium in a format compatible for importing into the Buyer's information systems specified by the Buyer.

3.1
Topsoil

A. Topsoil Material:

- A copy of laboratory reports on two representative samples of topsoil. Laboratory tests shall be performed for:
- Percent deleterious material.
- Total organic content.

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- Silt and clay contents.
- Sand content.
- pH.

B. If it is anticipated that topsoil stripped from either the present site or the borrow area will be used for permanent seeding, if requested by the Buyer, the Supplier shall provide two 50-pound samples to the Buyer's Testing Service for analyses.

3.2 Seed

A. A certified copy of a statement signed by the seed supplier that each lot of seed has been tested by a recognized seed-testing laboratory within six months before the date of delivery to the plant site.

B. A certified statement signed by the seed supplier that the maximum percentage of noxious weeds in the seed mixture complies with state law.

3.3 Data on Materials as Applied

As applied data on the following items:

A. Seed mixture and seed application rate.

B. Limestone application rate.

C. Fertilizer type, trademark name (if any), chemical composition, and application rate.

D. Mulch.

E. Tackifier.

3.4 Binder Spray

Data on the binder spray (tackifier) to be used on straw mulch or with hydro seeding. If a synthetic binder (tackifier) will be used, the Supplier shall provide a complete set of Manufacturer's specifications at least 30 days prior to anticipated use. Manufacturer's specifications shall contain a description of the binder material, the recommended method of application, and the recommended application rate.

3.5 Matting

Catalog data on the proposed erosion control matting and Manufacturer's literature on the recommended method of installation.

3.6 Samples

If requested by the Buyer, submit a sample of each material designated by the Buyer for laboratory testing.

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4.0 Products

4.1 Topsoil

A. Topsoil shall consist of sandy clay loam, sandy loam, loam, clay loam, silty clay loam or silt loam as defined by the SCS Soil Classification System.

B. Topsoil shall be relatively free from large roots, sticks, weeds, brush or stones larger than 1 inch in diameter or other litter and waste products. It shall have at least 90 percent passing the No. 10 sieve.

C. The topsoil shall meet requirements of ASTM D5268 as follows:

- It shall contain not less than 2 percent nor more than 20 percent total organic matter.
- It shall contain not less than 35 percent nor more than 70 percent silt and clay.
- It shall contain not less than 20 percent nor more than 60 percent sand.
- The pH of the sample shall not be lower than 5.0 nor higher than 7.5.
- The percent deleterious material (rock, gravel, slag, cinder, roots, sod) shall not exceed 5 percent.

4.2 Seed

4.2.1 General Requirements

A. Grasses, legumes, or cover crop seed of the type specified herein shall conform to the standards of the United States Department of Agriculture for seed certification.

B. Seed or seeding mixtures shall be furnished in sealed bags or containers in accordance with standard commercial practice.

C. Each bag or container shall be tagged or labeled in accordance with state law. As a minimum, the tag or label shall provide the following information:

- Name and address of the supplier.
- Common name of seed.
- Lot number.
- Net weight.
- Guaranteed percentage of germination.
- Percentage of weed seed and inert material content.

D. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.

E. All seed furnished shall be free of primary noxious weed seed such as Russian or Canadian Thistle, European Birdweed, Johnson Grass and Leafy Spurge. The maximum allowable percentage of noxious weed seed in the seed mixture shall comply with state law.

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4.2.2
Seed Storage

If it is necessary to store seeds after their arrival on the site, they shall be stored in an approved weatherproof building in such a manner as to protect the seeds from deterioration and to permit easy access for inspection. The Buyer's approval for the storage building and the method of storage shall not relieve the Supplier of responsibility for the quality and fitness of the seeds at the time of their use.

4.2.3
Seed Mixture

A. Seed species, rate per acre, and other data relevant to permanent seeding are given in Table 1.

B. Seed species, rate per acre, and other data relevant to temporary seeding are given in Table 2.

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TABLE 1
ACCEPTABLE MIXTURES FOR PERMANENT SEEDING

Mixture	Seed Species (1)	Seeding Rate, Pure Live Seed for Conventional Seed Application (2)		Suitable pH	Site Suitability			Acceptable Dates for Seeding
		Lbs. per acre	Lbs. per 1,000 sq. ft.		Sunny, Dry	Well Drained	Wet	
1	Smooth Bromegrass or Tall Fescue	30	0.75	6.0-7.5	X	X	X	4-1 to 6-1 8-1 to 9-1
	Alfalfa or Birdsfoot Trefoil	10	0.25					
2	Smooth Bromegrass or Tall Fescue	30	0.75	6.0-8.0	X	X		4-1 to 6-1 8-1 to 9-1
	Crown Vetch	20	0.50					
3	Tall Fescue	15	0.35	5.5-7.5		X	X	4-1 to 6-1 8-1 to 9-1
	Timothy or Redtop	3	0.07					
	Birdsfoot Trefoil	15	0.35					
4	Reed Canary Grass	15	0.35	5.5-7.5	X	X		4-1 to 6-1 8-1 to 9-1
	Smooth Bromegrass or Tall Fescue	15	0.35					
	Ladino (optional)	3	0.07					

Notes: (1) Mixtures as defined by SCS for Illinois.

(2) Triple the seeding rate shown in the table when hydro seeding.

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TABLE 2
ACCEPTABLE MIXTURES FOR TEMPORARY SEEDING

MIXTURE	SEED SPECIES	MAXIMUM WEED SEED (percentage)	SEEDING RATE PER ACRE	SUITABLE pH	PLANTING DEPTH	ACCEPTABLE DATES FOR SEEDING
1	Wheat	0.50	150 lbs	5.5 to 7.0	1" to 1 ½"	3-1 to 5-15 7-1 to 10-15
2	Cereal Rye	0.50	150 lbs	5.5 to7.0	1" to 1 ½"	3-1 to 5-15 7-1 to 10-15
3	Spring Oats	0.50	100 lbs	5.5 to 7.0	1"	3-1 to 7-1
4	Perennial Ryegrass	0.50	40 lbs	5.0 to 7.5	1/4"	4-1 to 6-1 8-1 to 9-15

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4.3
Lime (Agricultural Ground Limestone)

Agricultural lime shall be flour grade meeting the requirements of ASTM C602.

4.4
Fertilizer

A. Fertilizer shall be a standard brand commercial grade of inorganic fertilizer furnished in unopened containers. The material may be separate or in a mixture containing the percentage of total nitrogen, available phosphoric acid and water-soluble potash in the amounts specified. If materials are separate, the Buyer shall be present when the separate fertilizers are mixed in the field. The fertilizer shall be odor free.

B. Fertilizer shall be supplied in one of the following forms:

- A dry free-flowing granular fertilizer suitable for application by an agricultural fertilizer spreader.
- A soluble form that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.

C. The following information shall be shown on the fertilizer container or on a tag attached thereto:

- Name and address of manufacturer.
- Name, brand or trademark.
- Number of net pounds of ready-mixed material in the package.
- Chemical composition or analysis.
- Guarantee of analysis.

4.5
Mulch

4.5.1
Straw Mulch

A. Straw shall be stalks of small grain straw of wheat, rye, oats, barley or other approved grain. Straw shall be air dried and free of grain and noxious weed seed, other materials detrimental to plant life, and mold.

B. Straw shall be seasoned before bailing or loading. Straw mulch shall be suitable for spreading with mulch blower equipment.

C. Old dry straw which breaks up in the crimping process instead of bending, or straw in such advanced stages of decomposition that it will smother or retard the normal growth of grass, is not acceptable.

4.5.2
Wood Cellulose Fiber Mulch

A. Wood cellulose fiber shall be partly digested wood fibers.

B. The material shall be dyed green.

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C. The material shall not contain growth or organism inhibiting agents.

D. The material shall be air-dried with a minimum of 30 percent of the fibers 3.7 mm (0.145 inch) or longer.

4.5.3
Binder Sprays

A. Cutback Asphalt shall be in accordance with ASTM D2026 (Slow-Curing Type), ASTM D2027 (Medium-Curing Type) or ASTM D2028 (Rapid-Curing Type).

B. Emulsified Asphalt shall be in accordance with D977 (Emulsified Asphalt) or D2397 (Cationic Emulsified Asphalt).

4.6
Tackifier (Synthetic Binder)

A. Tackifier material shall be an acrylic copolymer or a polyvinyl acetate emulsion in a liquid form. The material may contain additives to enhance its ability to penetrate the soil.

B. The material shall be non-toxic, non-flammable, and biodegradable.

C. Approved Materials:

- Soil Seal Concentrate manufactured by Soil Seal Corp., 1111 W. Sixth St., Los Angeles, California 90017, telephone number 213-481-7185.
- Reinco Mulch Binder and Terra Tac manufactured by Rienco Mulch Binder Corp., 520 North Avenue, Plainfield, New Jersey 07060, telephone number 1-800-526-7687.
- Aerospray 70 Binder manufactured by American Cyanamid Company, Mobile, Alabama 36601, telephone number 205-476-5800.

4.7
Inoculant

A. The inoculant for treating legume seeds shall be a pure culture of nitrogen fixing bacteria prepared specifically for the species and shall not be used later than the date indicated on the container. A mixing medium, as recommended by the manufacturer, shall be used to bond the inoculant to the seed.

B. All legumes not pre-inoculated shall be inoculated within 12 hours of seeding. If the seed was pre-inoculated more than 60 days prior to seeding then it must be reinoculated.

4.8
Matting for Erosion Control

A. Matting for erosion control may be one of the following unless a specific matting is specified on the Design Drawings.

- Jute mat shall be cloth of a uniform plain weave of undyed and unbleached single jute yarn, 48 inches in width, plus or minus 1 inch and weighing an average of 1.2 pounds per linear yard of cloth with a tolerance of plus or minus 5 percent, with approximately 78 warp ends per width of cloth and 41 weft ends per linear yard of cloth. The yarn shall be

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of a loosely twisted construction having an average twist of not less than 1.6 turns per inch and shall not vary in thickness by more than one-half its nominal diameter.

- Excelsior mat shall be wood excelsior, 48 inches in width plus or minus 1 inch and weighing 0.8 pounds per square yard plus or minus 10 percent. The excelsior material shall be covered with a netting to facilitate handling and to increase strength.
- Glass fiber matting of bonded textile glass fibers with an average fiber diameter of 8 to 12 microns, 2 to 4 inch strands of fiber bonded with phenol formaldehyde resin. Mat shall be roll type, water permeable, minimum thickness 1/4 inch, maximum thickness 1/2 inch, density not less than 3 pounds per cubic foot.

B. Staples for anchoring soil stabilizing materials shall be No. 11 gauge wire or heavier. Their length shall be 6 to 10 inches. Ten inch long staples shall be used on loose, unstable soils.

5.0 Execution

5.1 Site Preparation

A. Prior to seeding, install all erosion control facilities specified on the Design Drawings. These include: diversions, berms, sediment control traps, silt fences and straw bale dikes.

B. Grade areas as specified on the Design Drawings. Gullied and uneven areas shall be smoothed before starting seedbed preparation.

5.2 Limestone for pH Adjustment

A. The Supplier shall apply limestone as required to raise the pH of the subsoil. Apply a minimum of 4 tons of limestone per acre for clayey soils, 3 tons of limestone per acre for sandy loam, and 2 tons of limestone per acre for loamy sand or silty soils.

B. Thoroughly work the limestone into the subsoil to a depth of 2 to 3 inches with a harrow or disk. The limestone may be applied prior to or concurrently with the fertilizer described.

5.3 Fertilizer

A. The Supplier shall apply a 12-12-12 fertilizer to the subsoil at a rate of 300 pounds per acre.

B. Work the fertilizer into the soil to a depth of 2 to 3 inches with a harrow, disk, or rake. On slopes, operate the disk or rake across the slope.

C. If hydro seeding is used, the fertilizer may be added to the hydroseed mixture.

5.4 Tilling of Subsoil

Prior to placing the topsoil, scarify the subsoil to a depth of 3 inches immediately prior to spreading topsoil to ensure bonding of the topsoil and the subsoil. Repeat scarification in areas where equipment used for hauling and spreading topsoil has compacted the subsoil.

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5.5
Placing Topsoil

Note: topsoil does not have to be placed for temporary seeding. Topsoil must be placed prior to permanent seeding.

A. Place topsoil during dry weather on a dry, unfrozen subgrade. Topsoil shall not be spread if it is frozen or muddy.

B. Remove large pieces of organic matter and foreign non-organic material from topsoil while spreading. There shall be no large roots, branches or trash of any kind in the topsoil.

C. Spread the topsoil to provide a compacted thickness of not less than 4 inches.

D. Compact the topsoil with a roller not exerting more than 100 pounds per square inch. The topsoil must be loose enough for water infiltration and root penetration. The soil surface on slopes shall be roughened to catch seeds if they are to be broadcast.

5.6
Seeding (Conventional Method)

A. Tables 1 and 2 list acceptable seed mixtures that may be used for seeding. The Supplier shall select a mixture from the appropriate table and plant within the dates shown in that table for that mixture.

B. Apply seed uniformly at the rate shown in the appropriate table with a rangeland grass drill or cultipacker type seeder, or broadcast seed uniformly. The seeding methods and equipment shall be submitted to the Buyer for approval prior to beginning work.

C. All seeders shall be calibrated and adjusted to sow seeds at the proper rate. Equipment shall be operated to ensure a complete and even coverage. Do not seed areas greater than that which can be mulched on the same day.

D. Do not sow immediately following a rain, where the ground is too dry, during windy periods, or otherwise when conditions are not proper for seeding.

E. No seeds shall be sown until the purity test has been completed for the seeds to be used and the tests show that the seed meets the noxious weed seed requirements.

F. Within 12 hours, all seeded areas shall be rolled at right angles to the runoff with a cultipacker or approved roller to compact the seedbed and place the seed in contact with the soil. The optimum depth for planting shall be 1/4 inch. Rolling is not required if the seeding equipment is equipped with a roller that achieves the desired compaction or a grass drill has been used. Note: For temporary seeding planted without topsoil, the optimum planting depth is shown in Table 2.

5.7
Mulching (Conventional Method)

5.7.1
Straw Mulching

A. All seeded areas shall be mulched with straw mulch within 24 hours after seeding. The mulch may be hand or machine applied. The mulch shall be uniformly applied in a loose enough condition to permit air to circulate, but compact enough to reduce erosion. About 25 percent of

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the solid surface should show through the mulch. If baled mulch material is used, care shall be taken that the material is in a loosened condition and contains no lumps or knots of compacted material.

B. Straw mulch shall be applied at the rate of 2 tons per acre, or 75 to 100 (two bales) pounds per 1,000 square feet.

C. Straw mulch shall be anchored immediately after placement to minimize loss by wind or water. Straw mulch shall be anchored using a mulch anchoring tool or by spraying with a liquid binder.

5.7.2
Anchoring Mulch Using a Mulch Anchoring Tool

A. The mulch anchoring tool shall be designed to punch and anchor the mulch into the top 2 to 3 inches of soil at 6 inch intervals. As an alternative, a smooth disk set in a straight position may be used.

B. On slopes flatter than 3 horizontal to 1 vertical, mulch anchoring shall cross the contour of the land (across slopes). On slopes steeper than 3 horizontal to 1 vertical, the mulch shall be anchored by tracking a bulldozer with 1-1/2 inch track cleats up and down slope making grooves running across the slope.

5.7.3
Anchoring Using a Sprayed Liquid Binder

A. A sprayed liquid binder may be used in lieu of crimping to anchor the mulch. The binder may be sprayed into the mulch as it leaves the blower pipe or it may be applied as an over spray. If over sprayed, the binder spray should be heavier at the edges where wind catches the mulch, in valleys and at crests of banks. Binder shall be applied uniformly over the remainder of the area. Caution shall be used when spraying binder near areas occupied by construction personnel.

B. Binder Spray shall be applied at the following rates:

- Cutback asphalt - Rapid curing (RC-70, RC-250, and RC-800) or medium curing (MC-250 or MC-800). Apply 5 gallons per 1,000 square feet or 218 gallons per acre.
- Emulsified asphalt - (SS-1, CSS-l, CMS-2, MS, RS-l, RS-2, CRS-l, and CRS-2). Apply 5 gallons per 1,000 square feet or 218 gallons per acre.
- Synthetic binders - Synthetic binders such as Acrylic Dir (Agri-Tac), DCA-70, Petroset or Terra Tack may be used at rates recommended by the manufacturer to anchor mulch material.

5.7.4
Repairing and Reseeding

A. Areas not mulched and anchored within 24 hours after seeding shall be reseeded and mulched.

B. Areas not properly mulched, or damaged due to construction activities, shall be repaired, reseeded, and remulched.

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5.8
Hydro Seeding

A. Hydro seeding consists of spraying a slurry mixture of water, seed, fertilizer, mulch, and a tackifier on a prepared seed bed.

B. The slurry mixture shall be mixed and applied using a hydraulic seeder. Hydraulic seeding equipment shall include a pump rated and operated at not less than 100 gallons per minute and 100 psi pressure. The tank shall have a mechanical agitator powerful enough to keep the slurry mixture in a uniform suspension in water.

C. Hydrated lime **shall not** be added to the slurry mixture.

D. The slurry mixture shall contain a maximum of 55 percent solids (125 pounds of solids per 100 gallons of water).

E. The seed mixture shall be as specified in Table 1 or Table 2 except that the weight of seed in the slurry mixture shall be a minimum of three times the weight of pure live seed per acre specified in the appropriate table for conventional seed application.

F. The slurry mixture shall contain a minimum of 1500 pounds of wood cellulose fiber mulch per acre or 2000 pounds of straw mulch per acre.

G. The amount of tackifier provided per acre shall be in accordance with Manufacturer's recommendations.

H. The slurry-mixture shall contain a minimum of 1000 pounds of grade 12-12-12 fertilizer per acre or the equivalent weight of chemicals if another grade is used.

I. The soil surface shall be moist when the slurry mixture is applied.

5.9
Laying and Securing Matting

5.9.1
Laying and Securing Jute Matting

A. Prepare the seed bed as specified and lime, fertilize, and seed, except that when using jute matting, apply approximately one-half of the seed after laying the mat.

B. Most drainage channels will require multiple widths of jute matting. The total width shall be as specified on the Design Drawings. Unroll matting starting at the upper end of the channel allowing a 4 inch overlap of mattings along center of channel.

C. Bury the top ends of jute matting in a narrow trench. Backfill the trench and tamp firmly to conform to channel cross-section. Secure the matting with a row of staples about 4 inches down slope from the trench. Spacing between staples shall be a maximum of 6 inches.

D. Staple the 4 inch overlap in the center of the channel using an 18 inch spacing between staples. Before stapling the outer edges of the matting, make sure the matting is smooth and in firm contact with the soil. Staples shall be placed 2 feet apart along the outer edge of matting.

E. Where one roll of jute matting ends and another begins, the end of the top strip shall overlap the upper end of the lower strip by 4 inches, shiplap fashion.

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F. Where matting crosses erosion stops, reinforce with a double row of staples placed six (6) inches apart in a staggered pattern on either side of erosion stop. Likewise, overlaps joining the length of matting together and the discharge end of the matting liner should be similarly secured with 2 double rows of staples.

5.9.2
Laying and Securing Excelsior Matting

A. Provide the same seedbed preparation as specified for jute matting with the exception that all seeding must be completed before laying excelsior matting.

B. Bury the top ends of excelsior matting in a trench as described for jute matting. As the blankets are unrolled down slope, the matting must be on top with the wood fibers in contact with the soils. Butt snugly at the ends and sides before stapling.

C. Using two (2) foot spacing between staples, excelsior matting shall be secured with four rows for each strip, with one row along each edge and alternating parallel rows down the center. The stapling over erosion stops, entrance and discharge ends of matting and butted end joints shall be the same as described for jute matting.

5.10
Construction Completed after Acceptable Seeding Dates

When construction is completed between October 15 and March 1 prepare the seedbed, fertilize and mulch as specified. Apply seed for permanent seed sometime between December 1 and March 1 increasing the seeding rates shown in Table 1 by 50 percent.

6.0
Protection

Planted areas shall be protected from damage and erosion. The Supplier shall provide and erect temporary barriers and signs as necessary to prevent vehicles, equipment and foot traffic from damaging seeded areas.

7.0
Maintenance

The Supplier shall perform the following maintenance tasks:

A. Keep seedbed continually moist with light, frequent sprinklings several times a day to prevent seedlings from drying out.

B. Inspect periodically after planting to see that vegetative stands are adequately established. Immediately reseed areas which show bare spots larger than 2 feet by 2 feet after germination.

C. Check for erosion damage after storm events and repair damage. Reseed and mulch, if necessary.

D. Fertilize newly permanent seeded areas one year after seeding with 300 pounds per acre of a complete (N-P-K) 10-10-10 or equivalent turf type slow release fertilizer.

- Application rate per acre shall be:

  Nitrogen (N) - 120 pounds of actual nitrogen.

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Phosphorus (P) - 120 pounds of P_2O_5.

Potassium (K) - 120 pounds of K_2O.

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Appendix E: Hennepin Power Station; West Ash Disposal Pond Maintenance Plan (2013)

DYNEGY MIDWEST GENERATION, LLC

Hennepin Power Station
Hennepin, Illinois

Putnam County

West Ash Disposal Pond

IDNR Permit No. (not permitted)

Dam ID No. (not permitted)

Maintenance Plan

September 2013

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1.0 GENERAL

The following operations and maintenance procedures are provided to maintain the structural integrity of the west ash storage surface impoundment at the Hennepin Power Station, which is unclassified and unpermitted, by the Illinois Department of Natural Resources, Office of Water Resources.

2.0 EMERGENCY OPERATIONS

2.1 Unusual Conditions

Any unusual condition discovered during major storm events or routine inspection, which may constitute an emergency, shall be handled as follows. Notice of any type of emergency involving the dikes or outfall shall be made to the Shift Leader on duty [(815) 339-9211]. The Shift Leader on duty shall notify the Station Manager, Ted Lindenbusch [home: (815) 875-2381], or, in his absence, the Environmental Coordinator, John P. Augspols [home: (815) 925-7488]. One of the above designated personnel shall notify the following city, county, state and federal regulatory authorities of the emergency condition.

- Division of Water Resources, Dam Safety Section, Dam Safety Engineers (217) 782-3862
- Illinois Emergency Management Agency, 24-hour service 1-(800) 782-7860
- Putnam County Sheriff/Hennepin Police Department (815) 925-7015
- Senior Director – Environmental Compliance, Dynegy Operating Company (618) 206-5912

2.2 Dewatering

The Station Manager or the Environmental Coordinator shall have the responsibility of determining how repairs shall be accomplished and whether dewatering of the disposal facility is necessary. Emergency dewatering shall be accomplished by portable pumps.

3.0 MAINTENANCE

3.1 Vegetation

Dikes shall be maintained to protect the structural integrity of the disposal facility. Damaged and barren areas shall be repaired as soon as appropriate after being discovered. Damaged areas shall be filled with topsoil. Limed, fertilized, and seeded with appropriate vegetation. Trees and shrubs observed during semiannual inspections shall be cut and removed from the dikes and discharge channel. This shall be done as frequently as is necessary to insure that no tree reaches a size where the root structure would require removal and filling. Woody vegetation, shrubs, and trees shall be removed during the early stages of growth before reaching a three-inch diameter.

Low growing vegetation, a prairie grass mixture that grows to a height of no more than six inches, shall be planted and maintained to facilitate inspections.

3.2 Discharge Structure

The discharge structure shall be inspected periodically for significant corrosion and deterioriation. Any defects discovered shall be promptly repaired.

3.3 Animal Damage and Repairs

Animal burrows discovered during inspections shall be promptly repaired by filling with grout.

3.4 Restriction of Unauthorized Vehicles

Facility approaches shall be posted with signs restricting unauthorized travel on the roadways and slopes.

3.5 Inspections/Remedial Measures

3.5.1 Weekly Inspections

Weekly inspections of the perimeter berms shall be conducted, looking for seepage and slumping, and unusual seepage at and/or blockage of the outfall structures in each cell. All findings shall be entered into the weekly inspection checklist, discussed in Section 4.0. Maintenance activities shall be initiated, if required. Refer to Section 4.0 for the recommended inspection checklist to be used for the weekly inspections.

3.5.2 Quarterly Inspections

Inspections shall be made quarterly by Station personnel to determine the general condition of the dam and embankments. During these inspections, embankment erosion, tree growth, and embankment seepage shall be monitored. Seepage shall be observed for change in quantity and coloration. Refer to Section 4.0, for the recommended inspection checklist to be used for documenting the quarterly inspections.

3.5.3 Annual Inspections

An annual inspection shall be made by a licensed professional engineer. This inspection shall follow the Illinois Department of natural Resources (IDNR) *Guidelines and Forms for Inspection of Illinois Dams*, and shall be followed by verbal and written reports by the consulting engineer. Based on the findings of the inspection, the Station Manager shall implement corrective action as required to promote dam safety. Procedures and methods for corrective action shall be performed in accordance with recommendations of the consulting engineer and as outlined above. Because the dam is not permitted by the IDNR, copies of the engineer's report, along with corrective action taken, will not be reported to the IDNR.

4.0 INSPECTION CHECKLISTS

The following Inspection checklists should be used during the weekly and quarterly inspections.

WEEKLY DAM INSPECTION FORM

Dam Location: Hennepin Power Station – West Ash Pond
Owner: Dynegy Midwest Generation, LLC, Havana Power Station
Permit No.:Not permitted **Class of Dam: Not classified**
Type of Dam: Homogeneous earth dam
Type of Spillway: Drop structure

Date Inspected: _____
Weather Conditions: _____
Pool Elevation: _____

Inspection Personnel:

_____ _____
Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest		
Unusual Movement or Cracking at or Beyond Toe		
Seepage		
Vegetative Cover		
Embankment Erosion		
Structural Cracking		
Outfall Structures		
Other		

QUARTERLY DAM INSPECTION FORM

Dam Location: Hennepin Power Station – West Ash Pond
Owner: Dynegy Midwest Generation, LLC, Hennepin Power Station
Permit No.: Not permitted **Class of Dam: Not classified**
Type of Dam: Homogeneous earth dam
Type of Spillway: Drop structure

Date Inspected: _____
Weather Conditions: _____
Pool Elevation: _____

Inspection Personnel:

_____
Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest	Good condition, with no significant issues	
Downstream Fill Slopes	Good condition, with no significant issues	
Upstream Fill Slopes	Good condition, with no significant issues	
Unusual Movement or Cracking at or Beyond Toe	Good condition, with no significant issues	
Seepage (Condition/Color)	Good condition, with no significant issues	
Vegetative Cover (Tree growth)	Good condition, with no significant issues	
Animal Damage	Good condition, with no significant issues	
Embankment Erosion	Good condition, with no significant issues	
Water Passages	Good condition, with no significant issues	
Structural Cracking	Good condition, with no significant issues	
Outfall Structures	Good condition	
Other		

Appendix F: Hennepin Power Station; Old East Ash Disposal Pond Maintenance Plan (2013)

DYNEGY MIDWEST GENERATION, LLC

Hennepin Power Station
Hennepin, Illinois

Putnam County

Old East Ash Disposal Pond

IDNR Permit No. (not permitted)

Dam ID No. (not permitted)

Maintenance Plan

September 2013

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1.0 GENERAL

The following operations and maintenance procedures are provided to maintain the structural integrity of the old east ash storage surface impoundment at the Hennepin Power Station, which is unclassified and unpermitted, by the Illinois Department of Natural Resources, Office of Water Resources.

This is primarily the @ 0.5 mile significant berm system that extends along the Illinois River. The old east ash pond system consists of the inactive cells # 2 and # 4. As a result of the May 2011 USEPA dam assessment, a dam safety permit was submitted to IDNR in May 2013, to address major modifications to this significant berm. These major modifications include extensive tree removal and resloping. Resloping is required to improve slope stability and allow safe access to slope, for long-term mowing and maintenance.

2.0 EMERGENCY OPERATIONS

2.1 Unusual Conditions

Any unusual condition discovered during major storm events or routine inspection, which may constitute an emergency, shall be handled as follows. Notice of any type of emergency involving the dikes or outfall shall be made to the Shift Leader on duty [(815) 339-9211]. The Shift Leader on duty shall notify the Station Manager, Ted Lindenbusch [home: (815) 875-2381], or, in his absence, the Environmental Coordinator, John P. Augspols [home: (815) 925-7488]. One of the above designated personnel shall notify the following city, county, state and federal regulatory authorities of the emergency condition.

- Division of Water Resources, Dam Safety Section, Dam Safety Engineers (217) 782-3862
- Illinois Emergency Management Agency, 24-hour service 1-(800) 782-7860
- Putnam County Sheriff/Hennepin Police Department (815) 925-7015
- Senior Director – Environmental Compliance, Dynegy Operating Company (618) 206-5912

2.2 Dewatering

Not applicable.

3.0 MAINTENANCE

3.1 Vegetation

Dikes shall be maintained to protect the structural integrity of the disposal facility. Damaged and barren areas shall be repaired as soon as appropriate after being discovered. Damaged areas shall be filled with topsoil. Limed, fertilized, and seeded with appropriate vegetation. Trees and shrubs observed during semiannual inspections shall be cut and removed from the dikes and discharge channel. This shall be done as frequently as is necessary to insure that no tree reaches a size where the root structure would require removal and filling. Woody vegetation, shrubs, and trees shall be removed during the early stages of growth before reaching a three-inch diameter.

Low growing vegetation, a prairie grass mixture that grows to a height of no more than six inches, shall be planted and maintained to facilitate inspections.

3.2 Discharge Structure

Not applicable.

3.3 Animal Damage and Repairs

Animal burrows discovered during inspections shall be promptly repaired by filling with grout.

3.4 Restriction of Unauthorized Vehicles

Facility approaches shall be posted with signs restricting unauthorized travel on the roadways and slopes.

3.5 Inspections/Remedial Measures

3.5.1 Weekly Inspections

Weekly inspections of the perimeter berms shall be conducted, looking for seepage and slumping. All findings shall be entered into the weekly inspection checklist, discussed in Section 4.0. Maintenance activities shall be initiated, if required. Refer to Section 4.0 for the recommended inspection checklist to be used for the weekly inspections.

3.5.2 Quarterly Inspections

Inspections shall be made quarterly by Station personnel to determine the general condition of the dam and embankments. During these inspections, embankment erosion, tree growth, and embankment seepage shall be monitored. Seepage shall be observed for change in quantity and coloration. Refer to Section 4.0, for the recommended inspection checklist to be used for documenting the quarterly inspections.

3.5.3 Annual Inspections

An annual inspection shall be made by a licensed professional engineer. This inspection shall follow the Illinois Department of natural Resources (IDNR) *Guidelines and Forms for Inspection of Illinois Dams*, and shall be followed by verbal and written reports by the consulting engineer. Based on the findings of the inspection, the Station Manager shall implement corrective action as required to promote dam safety. Procedures and methods for corrective action shall be performed in accordance with recommendations of the consulting engineer and as outlined above. Because the dam is not permitted by the IDNR, copies of the engineer's report, along with corrective action taken, will not be reported to the IDNR.

4.0 INSPECTION CHECKLISTS

The following Inspection checklists should be used during the weekly and quarterly inspections.

WEEKLY DAM INSPECTION FORM

Dam Location: Hennepin Power Station – Old East Ash Pond
Owner: Dynegy Midwest Generation, LLC, Havana Power Station
Permit No.:Not permitted **Class of Dam: Not classified**
Type of Dam: Homogeneous earth dam
Type of Spillway: N/A

Date Inspected: _____
Weather Conditions: _____
Pool Elevation: _____

Inspection Personnel:

_____ _____
Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest		
Unusual Movement or Cracking at or Beyond Toe		
Seepage		
Vegetative Cover		
Embankment Erosion		
Structural Cracking		
Outfall Structures		
Other		

QUARTERLY DAM INSPECTION FORM

Dam Location: Hennepin Power Station – Old East Ash Pond
Owner: Dynegy Midwest Generation, LLC, Hennepin Power Station
Permit No.: Not permitted **Class of Dam: Not classified**
Type of Dam: Homogeneous earth dam
Type of Spillway: Not applicable

Date Inspected: _____
Weather Conditions: _____
Pool Elevation: _____

Inspection Personnel:

_____
Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest	Good condition, with no significant issues	
Downstream Fill Slopes	Good condition, with no significant issues	
Upstream Fill Slopes	Good condition, with no significant issues	
Unusual Movement or Cracking at or Beyond Toe	Good condition, with no significant issues	
Seepage (Condition/Color)	Good condition, with no significant issues	
Vegetative Cover (Tree growth)	Good condition, with no significant issues	
Animal Damage	Good condition, with no significant issues	
Embankment Erosion	Good condition, with no significant issues	
Water Passages	Good condition, with no significant issues	
Structural Cracking	Good condition, with no significant issues	
Outfall Structures	Good condition	
Other		

Appendix G: Hennepin Power Station; East Ash Disposal Pond Maintenance Plan (2014)

DYNEGY MIDWEST GENERATION, LLC

Hennepin Power Station
Hennepin, Illinois

Putnam County

East Ash Disposal Pond

Small Class III Dam

IDNR Permit No. DS2011079

Dam ID No. IL50363

Maintenance Plan

Revised – August 2014

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1.0 GENERAL

The following operations and maintenance procedures are provided to maintain the structural integrity of the east ash storage surface impoundment at the Hennepin Power Station, which is classified as a small Class III dam by the Illinois Department of Natural Resources, Office of Water Resources. The primary pond's maximum normal poll elevation will be 489.5 msl with a dam crest at elevation 494.0 msl. The secondary pond's maximum normal pool elevation will be 480.5 with a dam crest at 494.0 msl.

2.0 EMERGENCY OPERATIONS

2.1 Unusual Conditions

Any unusual condition discovered during major storm events or routine inspection, which may constitute an emergency, shall be handled as follows. Notice of any type of emergency involving the dikes or outfall shall be made to the Shift Leader on duty [(815) 339-9211]. The Shift Leader on duty shall notify the Managing Director, Byron Veech [cell: (309) 543-8714], or, in his absence, the Environmental Coordinator, John P. Augspols [home: (815) 925-7488]. One of the above designated personnel shall notify the following city, county, state and federal regulatory authorities of the emergency condition.

- Division of Water Resources, Dam Safety Section, Dam Safety Engineers (217) 782-3862
- Illinois Emergency Management Agency, 24-hour service 1-(800) 782-7860
- Putnam County Sheriff/Hennepin Police Department (815) 925-7015
- Senior Director – Environmental Compliance, Dynegy Operating Company (618) 343-7761

2.2 Dewatering

The Station Manager or the Environmental Coordinator shall have the responsibility of determining how repairs shall be accomplished and whether dewatering of the disposal facility is necessary. Dewatering shall be accomplished by manually removing the concrete beams from the primary and/or secondary pond structures until the desired water level is reached.

3.0 MAINTENANCE

3.1 Vegetation

Dikes shall be maintained to protect the structural integrity of the disposal facility. Damaged and barren areas shall be repaired as soon as appropriate after being discovered. Damaged areas shall be filled with topsoil. Limed, fertilized, and seeded with appropriate vegetation. Trees and shrubs observed during periodic inspections shall be cut and removed from the dikes and discharge channel. This shall be done as frequently as is necessary to insure that no tree reaches a size where the root structure would require removal and filling. Woody vegetation, shrubs, and trees shall be removed during the early stages of growth before reaching a three-inch diameter.

Low growing vegetation shall be planted and maintained to facilitate inspections.

3.2 Discharge Structure

The discharge structure shall be inspected periodically for significant corrosion, spalling, and cracking. Any defects discovered shall be promptly repaired.

3.3 Animal Damage and Repairs

Animal burrows discovered during inspections shall be promptly repaired by filling with grout.

3.4 Restriction of Unauthorized Vehicles

Facility approaches shall be posted with signs restricting unauthorized travel on the roadways and slopes.

3.5 Inspections/Remedial Measures

3.5.1 Weekly Inspections

Weekly inspections of the perimeter berms shall be conducted, looking for seepage and slumping, and unusual seepage at and/or blockage of the outfall structures in each cell. All findings shall be entered into the weekly inspection checklist, discussed in Section 4.0. Maintenance activities shall be initiated, if required. Refer to Section 4.0 for the recommended inspection checklist to be used for the weekly inspections.

3.5.2 Quarterly Inspections

Inspections shall be made quarterly by Station personnel to determine the general condition of the dam and embankments. During these inspections, embankment erosion, tree growth, and embankment seepage shall be monitored. Seepage shall be observed for change in quantity and coloration. Refer to Section 4.0, for the recommended inspection checklist to be used for documenting the quarterly inspections.

3.5.3 Five-Year Inspections

Every five years, an inspection shall be made by a licensed professional engineer. This inspection shall follow the Illinois Department of natural Resources (IDNR) *Guidelines and Forms for Inspection of Illinois Dams*, and shall be followed by verbal and written reports by the consulting engineer. Based on the findings of the inspection, the Station Manager shall implement corrective action as required to promote dam safety. Procedures and methods for corrective action shall be performed in accordance with recommendations of the consulting engineer and as outlined above. Copies of the engineer's report, along with corrective actin taken, shall be reported to the IDNR.

3.6 Annual Statement

An annual statement on forms furnished by IDNR, certifying compliance with this maintenance plan, shall be submitted to IDNR.

4.0 INSPECTION CHECKLISTS

The following Inspection checklists should be used during the weekly and quarterly inspections.

WEEKLY DAM INSPECTION FORM

Dam Location: Hennepin Power Station – East Ash Pond
Owner: Dynegy Midwest Generation, LLC, Havana Power Station
Permit No.:DS2011079 **Class of Dam: III**
Type of Dam: Homogeneous earth dam, with clay and geosynthetic / clay liner
Type of Spillway: Drop structure and stop logs

Date Inspected: _____
Weather Conditions: _____
Pool Elevation: _____

Inspection Personnel:

_____ _____
Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest		
Unusual Movement or Cracking at or Beyond Toe		
Seepage		
Vegetative Cover		
Embankment Erosion		
Structural Cracking		
Outfall Structures		
Other		

QUARTERLY DAM INSPECTION FORM

Dam Location: Hennepin Power Station – East Ash Pond
Owner: Dynegy Midwest Generation, LLC, Hennepin Power Station
Permit No.:DS2011079 **Class of Dam: III**
Type of Dam: Homogeneous earth dam, with clay and geosynthetic / clay liner
Type of Spillway: Drop structure and stop logs

Date Inspected: _____
Weather Conditions: _____
Pool Elevation: _____

Inspection Personnel:

_____
Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest	Good condition, with no significant issues	
Downstream Fill Slopes	Good condition, with no significant issues	
Upstream Fill Slopes	Good condition, with no significant issues	
Unusual Movement or Cracking at or Beyond Toe	Good condition, with no significant issues	
Seepage (Condition/Color)	Good condition, with no significant issues	
Vegetative Cover (Tree growth)	Good condition, with no significant issues	
Animal Damage	Good condition, with no significant issues	
Embankment Erosion	Good condition, with no significant issues	
Water Passages	Good condition, with no significant issues	
Structural Cracking	Good condition, with no significant issues	
Outfall Structures	Good condition	
Other		

APPENDIX D
TYPES OF CCR AND CHEMICAL CONSTITUENTS (845.220(a)(2)(A))

Hennepin Power Plant - West Ash Pond System's Chemical Constituents

In accordance with 35 I.A.C. 845.220(a)(2)(A), DMG is submitting an available/existing description of "the types of CCR expected in the CCR surface impoundment, including a chemical analysis of each type of expected CCR" in the closed CCR impoundment, West Ash Pond System.

A list of the chemical constituents' analyses contained in the DMG surface impoundment can be found in Appendix A. Appendix A contains chemical constituents found in the surface free liquid and the subsurface free liquids as determined through antidegradation studies. DMG is also including Safety Data Sheets for materials contains in the West Ash Pond System in Appendix B.

Appendix A: Chemical Constituents Contained in the West Ash Pond System

Parameter	Units	Surface Free Liquids Average Concentration	Subsurface Free Liquids Average Concentration
Ammonia (as N)	mg/L	<0.20	4
Arsenic, Dissolved (1)	mg/L	0.0061	0.059
Arsenic, Total	mg/L	0.0062	0.062
Barium, Total	mg/L	0.12	0.066
Boron, Total	mg/L	5.6	22
Cadmium, Dissolved	mg/L	<0.00050	0.0005
Cadmium, Total	mg/L	<0.00050	0.0008
Calcium, Total	mg/L	56	225
Chloride, Total	mg/L	22.5	4.35
Chromium, Dissolved	mg/L	<0.0050	0.016
Chromium, Hexavalent	mg/L	<0.010	0.02
Chromium, Hexavalent, Dissolved	mg/L	<0.010	0.020
Chromium, Total	mg/L	0.0029	0.018
Chromium, Trivalent, Dissolved	mg/L	<0.010	<0.01
Copper, Dissolved	mg/L	0.0016	0.0052
Copper, Total	mg/L	0.0023	0.0056
Cyanide, Amenable	mg/L	<0.0036	0.0043
Fluoride, Dissolved	mg/L	0.23	0.14
Fluoride, Total	mg/L	0.17	<0.20
Hardness (as calcium carbonate)	mg/L	170	570
Iron, Dissolved	mg/L	0.089	0.22
Iron, Total	mg/L	0.25	0.65
Lead, Dissolved	mg/L	0.00072	0.0024
Lead, Total	mg/L	0.0017	0.0061
Magnesium, Total	mg/L	15.0	9.2
Manganese, Total	mg/L	0.04	0.44
Mercury (low level)	ng/L	3.85	6.30
Mercury, Dissolved Total	ug/L	0.12	<0.2
Nickel, Dissolved	mg/L	0.0016	0.0040
Nickel, Total	mg/L	0.0022	0.0049
Nitrogen, Kjeldahl	mg/L	1.45	2.04
Nitrogen, Nitrate Nitrite	mg/L	<0.10	0.40
Nitrogen, Total	mg/L	1.45	2.45
Oil & Grease (HEM)	mg/L	2.95	4.3
pH	S.U.	8.54	10.05
Phenolics, Total Recoverable	mg/L	<0.0050	<0.0050
Selenium, Total	mg/L	0.00165	0.075
Silver, Total	mg/L	<0.00050	<0.0005
Sulfate	mg/L	32.0	580
Total Dissolved Solids, Dissolved	mg/L	290	1150
Total Suspended Solids	mg/L	11.5	45.5
Zinc, Dissolved	mg/L	0.013	0.024
Zinc, Total	mg/L	0.0089	0.036

DYNEGY

Safety Data Sheet

Section 1
Identification of the Substance and of the Supplier

1.1 Product Identifier

Product Name/Identification:	ASTM Class C Fly Ash
Synonyms:	Coal Fly Ash, Pozzolan
Formula:	UVCB Substance

1.2 Relevant Identified Uses of the Substance or Mixture and Uses Advices Against

Relevant Identified Uses:	Component of wallboard, concrete, roofing material, bricks, cement kiln feed.
Uses Advised Against:	None known.

1.3 Details of the Supplier of the SDS

Manufacturer/Supplier:	Dynegy, Inc.
Street Address:	601 Travis Street, Suite 1400
City, State and Zip Code:	Houston, TX 77002
Customer Service Telephone:	800-633-4704

Section 2
Hazards Identification

2.1 Classification of the Substance

GHS Classification(s) according to OSHA Hazard Communication Standard (29 CFR 1910.1200):

- Eye Irritant, Category 2A
- STOT-SE, Category 3 (Respiratory Irritation)
- Carcinogen, Category 1A
- STOT-RE, Category 1 (Lungs)
- Toxic to Reproduction, Category 2

2.2 Label Elements

Labelling according to 29 CFR 1910.1200 Appendices A, B and C*	
Hazard Pictogram(s):	
Signal word:	**DANGER**
Hazard Statement(s):	*Causes serious eye irritation.* *May cause damage to lungs after repeated/prolonged exposure via inhalation.* *May cause respiratory irritation.* *May cause cancer of the lung.* *Suspected of damaging fertility or the unborn child.*
Precautionary Statement(s):	*Obtain special instructions before use.* *Do not handle until all safety precautions have been read and understood.* *Avoid breathing dust.* *Wear protective gloves/protective clothing/eye protection/face protection.* *Wash thoroughly after handling.* *Do not eat drink or smoke when using this product.* *Use outdoors or in a well-ventilated area.* *If exposed or concerned: Get medical advice/attention.* *Store in a secure area.* *Dispose of product in accordance with local/national regulations.*

** Fly ash and other coal combustion products (CCPs) are UVCB substances (unknown or variable composition or biological). Various CCPs, noted as ashes/ash residuals; Ashes, residues, bottom; Bottom ash; Bottom ash residues; Waste solids, ashes under TSCA are defined as: "The residuum from the burning of a combination of carbonaceous materials. The following elements may be present as oxides: aluminum, calcium, iron, magnesium, nickel, phosphorus, potassium, silicon, sulfur, titanium, and vanadium." Ashes including fly ash and fluidized bed combustion ash are identified by CAS number 68131-74-8. The exact composition of the ash is dependent on the fuel source and flue additives composed of many constituents. The*

classification of the final substance is dependent on the presence of specific identified oxides as well as other trace elements.

2.3 Other Hazards

Listed Carcinogens:

-Respirable Crystalline Silica

IARC: [Yes] **NTP:** [Yes] **OSHA:** [Yes] **Other:** **(ACGIH)** [Yes]

Section 3
Composition/Information on Ingredients

Substance	***CAS No.***	***Percentage (%)***	***GHS Classification***
Crystalline Silica	*14808-60-7*	*30 - 60%*	*Repeat Dose STOT, Category 1* *Carcinogen, Category 1A*
Silica, crystalline respirable (RCS)	*14808-60-7*	***See Footnote 1***	*Repeat Dose STOT, Category 1* *Carcinogen, Category 1A*
Aluminosilicates	*71243-67-9* *1327-36-2*	*30 - 60%*	*Single Exposure STOT, Category 3*
Iron oxide	*1309-37-1*	*1 - 10%*	*Not Classified*
Calcium oxide (CaO)	*1305-78-8*	*20 - 30%*	*Skin Irritant, Category 2* *Eye Irritant, Category 1* *Single Exposure STOT, Category 3*
Magnesium oxide	*1309-48-4*	*2 - 10%*	*Not Classified*
Phosphorus pentoxide (P_2O_5)	*1314-56-3*	*≤2%*	*Skin Irritant, Category 2* *Eye Irritant, Category 2B*
Sodium oxide	*1313-59-3*	*1-8%*	*Not Classified*
Potassium oxide (K_2O)	*12136-45-7*	*≤1%*	*Skin Irritant, Category 2* *Eye Irritant, Category 2B*
Titanium dioxide (TiO_2)	*13463-67-7*	*<3%*	*Not Classified*
Bromide salt (calcium)	*7789-41-5*	*See Footnote 2*	*Toxic to Reproduction, Category 2*

Footnote 1: *The percentage of respirable crystalline silica has not been determined. Therefore, a GHS classification of Carcinogen, Category 1A has been assigned.*

Footnote 2: *Analytical data are not available to demonstrate that the concentration of bromide salt is <0.1%; therefore, a GHS classification of Toxic to Reproduction, Category 2 has been assigned.*

Section 4
First Aid Measures

4.1 Description of First Aid Measures

Inhalation:	If product is inhaled and irritation of the nose or coughing occurs, remove person to fresh air. Get medical advice/attention if respiratory symptoms persist.
Skin Contact:	If skin exposure occurs, wash with soap and water.
Eye Contact:	If product gets into the eye, rinse copiously with water for several minutes. Remove contact lenses, if present and easy to do. Seek medical attention/advice if irritation occurs or persists.
Ingestion:	No specific first aid measures are required.

4.2 Most Important Health Effects, Both Acute and Delayed

Acute Effects: Direct exposure may cause respiratory irritation, eye irritation and skin irritation. The product dust can dry and irritate the skin and cause dermatitis and can irritate eyes and skin through mechanical abrasion.

Chronic Effects: Chronic exposure may cause lung damage from repeated exposure. Prolonged inhalation of respirable crystalline silica above certain concentrations may cause lung diseases, including silicosis and lung cancer. Repeated exposure to dusts containing inorganic bromide salts may affect fertility and/or result in effects to the unborn child.

4.3 Indication of Any Immediate Medical Attention and Special Treatment Needed

Seek first aid or call a doctor or Poison Control Center if contact with eyes occurs and irritation remains after rinsing. Get medical advice if inhalation occurs and respiratory symptoms persist.

Section 5
Firefighting Measures

5.1 Extinguishing Media

Suitable Extinguishing Media:	Product is not flammable. Use extinguishing media appropriate for surrounding fire.
Unsuitable Extinguishing Media:	Not applicable, the product is not flammable.

5.2 Special Hazards Arising from the Substance or Mixture

Hazardous Combustion Products:	None known.

5.3 Advice for Firefighters

Special Protective Equipment and Precautions for Firefighters:	As with any fire, wear self-contained breathing apparatus (NIOSH approved or equivalent) and full protective gear.

Section 6
Accidental Release Measures

6.1 Personal Precautions, Protective Equipment and Emergency Procedures

Personal precautions/Protective Equipment:	See Section 8.2.2 Individual Protective Measures. For concentrations exceeding Occupational Exposure Levels (OELs), use a self-contained breathing apparatus (SCBA).
Emergency procedures:	Use scooping, water spraying/flushing/misting or ventilated vacuum cleaning systems to clean up spills. Do not use pressurized air.

6.2 Environmental Precautions

Environmental precautions:	Prevent contamination of drains or waterways and dispose according to local and national regulations.

6.3 Methods and Material for Containment and Cleaning Up

Methods and materials for containment and cleaning up:	Do not use brooms or compressed air to clean surfaces. Use dust collection vacuum and extraction systems. Large spills of dry product should be removed by a vacuum system. Dampened material should be removed by mechanical means and recycled or disposed of according to local and national regulations.

See Sections 8 and 13 for additional information on exposure controls and disposal.

Section 7
Handling and Storage

7.1 Precautions for Safe Handling

Practice good housekeeping. Use adequate exhaust ventilation, dust collection and/or water mist to maintain airborne dust concentrations below permissible exposure limits (note: respirable crystalline silica dust may be in the air without a visible dust cloud).

Do not permit dust to collect on walls, floors, sills, ledges, machinery, or equipment. Maintain and test ventilation and dust collection equipment. In cases of insufficient ventilation, wear a NIOSH approved respirator for silica dust when handling or disposing dust from this product. Avoid contact with skin and eyes. Wash or vacuum clothing that has become dusty. Avoid eating, smoking, or drinking while handling the material.

7.2 Conditions for Safe Storage, Including any Incompatibilities

Minimize dust produced during loading and unloading.

Section 8
Exposure Controls/Personal Protection

8.1 Control Parameters

OCCUPATIONAL EXPOSURE LIMITS					
SUBSTANCE		**OSHA PEL TWA (mg/m^3)**	**NIOSH REL TWA (mg/m^3)**	**ACGIH TLV TWA (mg/m^3)**	**CA - OSHA PEL (mg/m^3)**
Calcium oxide		5	2	2	2
Particulates Not Otherwise Regulated	Total	15	15	10	10
	Respirable	5	5	3	5
Respirable Crystalline Silica	Respirable Crystalline Silica	0.05	0.05	0.025	0.05
Titanium dioxide	Total	15	2.4 (fine) 0.3 (ultrafine)	10	10
Manganese dioxide (as manganese compounds)	Total	5 (Ceiling)	1 3 (STEL)	0.1	0.2
	Respirable	-	-	0.02	-

8.2 Exposure Controls

8.2.1 Engineering Controls

Provide ventilation to maintain the ambient workplace atmosphere below the occupational exposure limit(s). Use general and local exhaust ventilation and dust collection systems as necessary to minimize exposure.

8.2.2 Personal Protective Equipment (PPE)

Respiratory protection:	Wear a NIOSH approved particulate respirator if exposure to airborne particulates is unavoidable and where occupational exposure limits may be exceeded. If airborne exposures are anticipated to exceed applicable PELs or TLVs, a self-contained breathing apparatus or airline respirator is recommended.
Eye and face protection:	If eye contact is possible, wear protective glasses with side shields. Avoid contact lenses.
Hand and skin protection:	Wear gloves and protective clothing. Wash hands with soap and water after contact with material.

Section 9
Physical and Chemical Properties

9.1 Information on Basic Physical and Chemical Properties

Property: Value	Property: Value
Appearance (physical state, color, etc.): Fine tan/ gray particulate	**Upper/lower flammability or explosive limits:** Not applicable
Odor: Odorless[1]	**Vapor Pressure (Pa):** Not applicable
Odor threshold: Not applicable	**Vapor Density:** Not applicable
pH (25 °C) (in water): Not Determined	**Specific gravity or relative density:** 2.2 – 2.9
Melting point/freezing point (°C): Not applicable	**Water Solubility:** Slight
Initial boiling point/boiling range (°C): NA	**Partition coefficient: n-octane/water:** NA
Flash point (°C): Not determined	**Auto ignition temperature (°C):** Not applicable
Evaporation rate: Not applicable	**Decomposition temperature (°C):** Not determined
Flammability (solid, gas): Not combustible	**Viscosity:** Not applicable

[1] The use of urea or aqueous ammonia injected into the flue gas to reduce nitrogen oxides (NOx) emissions may result in the presence of ammonium sulfate or ammonium bisulfate in the ash at less than 0.1%. When ash containing these substances becomes wet under high pH (>9), free ammonia gas may be released resulting in objectionable/nuisance ammonia odor and potential exposure to ammonia gas especially in confined spaces.

Section 10
Stability and Reactivity

10.1 Reactivity:	The material is an inert, inorganic material primarily composed of elemental oxides.
10.2 Chemical stability:	The material is stable under normal use conditions.
10.3 Possibility of hazardous reactions:	The material is a relatively stable, inert material; however, when ash containing ammonia becomes wet under high pH (>9), free ammonia gas may be released resulting in an objectionable/nuisance ammonia odor and potential exposure to ammonia gas especially in confined spaces. Polymerization will not occur.
10.4 Conditions to avoid:	Product can become airborne in moderate winds. Dry material should be stored in silos. Materials stored out of doors should be covered or maintained in a damp condition.
10.5 Incompatible materials:	None known.
10. 6 Hazardous decomposition products:	None known.

Section 11
Toxicological Information

11.1 Information on Toxicological Effects

Endpoint	Data
Acute oral toxicity	LD50 > 2000 mg/kg
Acute dermal toxicity	LD50 > 2000 mg/kg
Acute inhalation toxicity	LD50 > 5.0 mg/L
Skin corrosion/irritation	Does not meet the classification criteria but may cause slight skin irritation. Product dust can dry the skin which can result in irritation.
Eye damage/irritation	Causes serious eye irritation. Positive scores for conjunctiva irritation and chemosis in 2/3 animals based on average of 24, 48 and 72-hour scores with irritation clearing within 21 days; No corneal or iritis effects observed.
Respiratory/skin sensitization	Not a respiratory or dermal sensitizer.
Germ cell mutagenicity	Not mutagenic in in-vitro and in-vivo assays with or without metabolic activation.
Carcinogenicity	Not available. Respirable crystalline silica has been identified as a carcinogen by OSHA, NTP, ACGIH and IARC.
Reproductive toxicity	No developmental toxicity was observed in available animal studies. Reproductive studies on CCPs showed either no reproductive effects, or some effects on male and female reproductive organs and parameters but without a clear dose response. Inorganic bromide salts have been shown to have adverse effects on reproductive parameters in some animal studies.
STOT-SE	CCPs when present as a nuisance dust may result in respiratory irritation.
STOT-RE	In a 180-day inhalation study with fly ash dust, no effects were observed at the highest dose tested. NOEC = 4.2 mg/m^3; it is not possible to assess the level at which toxicologically significant effects may occur. Repeated inhalation exposures to high levels of respirable crystalline silica may result in lung damage (i.e., silicosis).
Aspiration Hazard	Not applicable based product form.

Section 12
Ecological Information

12.1 Toxicity

Fly Ash C (CAS# 68131-74-8)	
Toxicity to Fish	LC50 > 100 mg/L
Toxicity to Aquatic Invertebrates	Data indicates that the test substance is not toxic to *Daphnia magna* (EC50 undetermined).
Toxicity to Aquatic Algae and Plants	EC50 = 10 mg/L

Calcium oxide CAS# 1305-78-8	
Toxicity to Fish	LC50 = 50.6 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Invertebrates	EC50 = 49.1 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Algae and Plants	NOEC =48 mg/L @ 72 hours based on $Ca(OH)_2$ The initial pH of the test medium was not directly related to the biologically relevant effects. The formation of precipitates is likely the result of the reaction between CO_2 dissolved in the medium.

12.2 Persistence and Degradability

Not relevant for inorganic materials.

12.3 Bioaccumulative Potential

This material does not contain any compounds that would bioaccumulate up the food chain.

12.4 Mobility in Soil

No data available.

12.5 Results of PBT and vPvB Assessment

This material does not contain any compounds classified as “persistent, bioaccumulative or toxic” nor as “very persistent/very bioaccumulative”.

12.6 Other Adverse Effects

None known.

Section 13

Disposal Considerations

See Sections 7 and 8 above for safe handling and use, including appropriate industrial hygiene practices.

Dispose of all waste product and containers in accordance with federal, state and local regulations.

Section 14
Transport Information

Regulatory entity: U.S. DOT	Shipping Name:	Not Regulated
	Hazard Class:	Not Regulated
	ID Number:	Not Regulated
	Packing Group:	Not Regulated

Section 15
Regulatory Information

15.1 Safety, Health and Environmental Regulations/Legislation Specific for the Mixture

- TSCA Inventory Status

  All components are listed on the TSCA Inventory.

- California Proposition 65.

  The following substances are known to the State of California to be carcinogens and/or reproductive toxicants:

  - Respirable crystalline silica

- State Right-to-Know (RTK)

Component	CAS	MA[1,2]	NJ[3,4]	PA[5]	RI[6]
Ammonium bisulfate	7803-63-6	No	Yes	No	No
Ammonium sulfate	7783-20-2	Yes	No	Yes	No
Calcium oxide	1305-78-8	Yes	Yes	Yes	No
Iron oxide	1309-37-1	Yes	Yes	Yes	No
Magnesium oxide	1309-48-4	No	Yes	No	No
Manganese oxide-as manganese compounds	1313-13-9; Various	No	No	Yes	Yes
Phosphorus pentoxide (or phosphorus oxide)	1314-56-3	Yes	Yes	Yes	No
Potassium oxide	12136-45-7	No	Yes	No	No
Silica-crystalline (SiO2), quartz	14808-60-7	Yes	Yes	Yes	No
Sodium oxide	1313-59-3	No	Yes	No	No
Titanium dioxide	13463-67-7	Yes	Yes	Yes	Yes

[1] Massachusetts Department of Public Health, no date
[2] 189th General Court of The Commonwealth of Massachusetts, no date
[3] New Jersey Department of Health and Senior Services, 2010a
[4] New Jersey Department of Health, 2010b
[5] Pennsylvania Code, 1986
[6] Rhode Island Department of Labor and Training, no date

Section 16
Other Information, Including Date of Preparation or Last Revision

16.1 Indication of Changes

Date of preparation or last revision: February 23, 2018

16.2 Abbreviations and Acronyms

- ACGIH: American Conference of Industrial Hygienists
- CA: California
- CAS: Chemical Abstract Services
- CCP: Coal Combustion Product
- CFR: Code of Federal Regulations
- EPA: Environmental Protection Agency

- GHS: Globally Harmonized System of Classification and Labelling
- IARC: International Agency for Research on Cancer
- LC50: Concentration resulting in the mortality of 50 % of an animal population
- LD50: Dose resulting in the mortality of 50 % of an animal population
- MA: Massachusetts
- NA: Not Applicable
- NJ: New Jersey
- NOEC: No observed effect concentration
- NIOSH: National Institute of Occupational Safety and Health
- NOx: Nitrogen oxides
- NTP: US National Toxicology Program
- OEL: Occupational Exposure Limit
- OSHA: Occupational Safety and Health Administration
- PA: Pennsylvania
- PBT: Persistent, Toxic and Bioaccumulative
- PEL: Permissible exposure limit
- PPE: Personal Protective Equipment
- REL: Recommended exposure limit
- RI: Rhode Island
- RCS: Respirable Crystalline Silica
- RTK: Right-to-Know
- SCBA: Self-contained breathing apparatus
- SDS: Safety Data Sheet
- STEL: Short-term exposure limit
- STOT-RE: Specific target organ toxicity-repeated exposure
- STOT-SE: Specific target organ toxicity-single exposure
- TLV: Threshold limit value
- TSCA: Toxic Substances Control Act
- TWA: Time-weighted average
- UEL: Upper explosive limit
- UVCB: Unknown or Variable Composition/Biological
- U.S.: United States
- U.S. DOT: United States of Department of Transportation

16.3 Other Hazards

Hazardous Materials Identification System (HMIS) Degree of hazard (0= low, 4 = extreme)							
Health:	2*	**Flammability:**	0	**Physical Hazards:**	0	**Personal protection:****	

** Chronic Health Effects*
*** Appropriate personal protection is defined by the activity to be performed.*
See Section 8 for additional information.

DISCLAIMER:

This SDS has been prepared in accordance with the Hazard Communication Rule 29 CFR 1910.1200. Information herein is based on data considered to be accurate as of date prepared. No warranty or representation, express or implied, is made as to the accuracy or completeness of this data and safety information. No responsibility can be assumed for any damage or injury resulting from abnormal use, failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

DYNEGY

Safety Data Sheet

Section 1
Identification of the Substance and of the Supplier

1.1 Product Identifier

Product Name/Identification:	ASTM Bottom Ash
Synonyms:	Ash; Ashes; Ash residues; Ashes, residues, bottom; Bottom ash; Bottom ash residues; Coal Fly Ash; Pozzolan; Waste solids.
Formula:	UVCB Substance

1.2 Relevant Identified Uses of the Substance or Mixture and Uses Advices Against

Relevant Identified Uses:	Component of wallboard, concrete, roofing material, bricks, cement kiln feed.
Uses Advised Against:	None known.

1.3 Details of the Supplier of the SDS

Manufacturer/Supplier:	Dynegy, Inc.
Street Address:	601 Travis Street, Suite 1400
City, State and Zip Code:	Houston, TX 77002
Customer Service Telephone:	800-633-4704

Section 2
Hazards Identification

2.1 Classification of the Substance

GHS Classification(s) according to OSHA Hazard Communication Standard (29 CFR 1910.1200):

- Eye Irritant, Category 2A
- STOT-SE, Category 3 (Respiratory Irritation)
- Carcinogen, Category 1A
- STOT-RE, Category 1 (Lungs)
- Toxic to Reproduction, Category 2

2.2 Label Elements

Labelling according to 29 CFR 1910.1200 Appendices A, B and C*	
Hazard Pictogram(s):	
Signal word:	**DANGER**
Hazard Statement(s):	*Causes serious eye irritation.* *May cause respiratory irritation.* *May cause damage to lungs after repeated/prolonged exposure via inhalation.* *May cause cancer of the lung.* *Suspected of damaging fertility or the unborn child.*
Precautionary Statement(s):	*Obtain special instructions before use.* *Do not handle until all safety precautions have been read and understood.* *Avoid breathing dust.* *Wash thoroughly after handling.* *Do not eat drink or smoke when using this product.* *Wear protective gloves/protective clothing/eye protection/face protection.* *Use outdoors or in a well-ventilated area.* *If exposed or concerned: Get medical advice/attention.* *Store in a secure area.* *Dispose of product in accordance with local/national regulations.*

** Fly ash and other coal combustion products (CCPs) are UVCB substances (unknown or variable composition or biological). Various CCPs, noted as ashes/ash residuals; Ashes, residues, bottom; Bottom ash; Bottom ash residues; Waste solids, ashes under TSCA are defined as: "The residuum from the burning of a combination of carbonaceous materials. The following elements may be present as oxides: aluminum, calcium, iron, magnesium, nickel, phosphorus, potassium, silicon, sulfur, titanium, and vanadium." Ashes including fly ash and fluidized bed combustion ash are identified by CAS number 68131-74-8. The exact composition of the ash is dependent on the fuel source and flue additives composed of many constituents. The classification of the final substance is dependent on the presence of specific identified oxides as well as other trace elements.*

2.3 Other Hazards

Listed Carcinogens:

-Respirable Crystalline Silica

IARC: [Yes] **NTP:** [Yes] **OSHA:** [Yes] **Other:** **(ACGIH)** [Yes]

Section 3
Composition/Information on Ingredients

Substance	CAS No.	Percentage (%)	GHS Classification
Crystalline Silica	14808-60-7	20 - 40%	Repeat Dose STOT, Category 1 Carcinogen, Category 1A
Silica, crystalline respirable (RCS)	14808-60-7	See Footnote 1	Repeat Dose STOT, Category 1 Carcinogen. Category 1A
Aluminosilicates[2]	Various, see Footnote 2	10 - 60%	Single Exposure STOT, Category 3
Calcium oxide (CaO)	1305-78-8	10 - 30%	Skin Irritant, Category 2 Eye Irritant, Category 1 Single Exposure STOT, Category 3
Iron oxide	1309-37-1	1 - 10%	Not Classified
Manganese dioxide (MnO_2)	1313-13-9	<2%	Skin Irritant, Category 2 Eye Irritant, Category 2B
Magnesium oxide	1309-48-4	2 - 10%	Not Classified
Phosphorus pentoxide (P_2O_5)	1314-56-3	≤2%	Skin Irritant, Category 2 Eye Irritant, Category 2B
Sodium oxide	1313-59-3	1 - 10%	Not Classified
Potassium oxide (K_2O)	12136-45-7	≤1%	Skin Irritant Category 2 Eye Irritant Category 2B
Titanium dioxide (TiO_2)	13463-67-7	<3%	Not Classified

[1]The percentage of respirable crystalline silica has not been determined. Therefore, a GHS classification of Carcinogen 1A has been assigned.

[2]Aluminosilicates (CAS# 1327-36-2) may be in the form of mullite (CAS# 1302-93-8); aluminosilicate glass; pozzolans (CAS# 71243-67-9); or calcium aluminosilicates such as tricalcium aluminate (C3A), or calcium sulfoaluminate (C4A3S). The form is dependent on the source of the coal and or the process used to create the CCP. Pulverized coal combustion would be more likely to create high levels of pozzolans. Aluminosilicates may have inclusions of calcium, titanium, iron, potassium, phosphorus, magnesium and other metal oxides.

Section 4
First Aid Measures

4.1 Description of First Aid Measures

Inhalation:	If product is inhaled and irritation of the nose or coughing occurs, remove person to fresh air. Get medical advice/attention if respiratory symptoms persist.
Skin Contact:	If skin exposure occurs, wash with soap and water.
Eye Contact:	If product gets into the eye, rinse copiously with water for several minutes. Remove contact lenses, if present and easy to do. Seek medical attention/advice if irritation occurs or persists.
Ingestion:	No specific first aid measures are required.

4.2 Most Important Health Effects, Both Acute and Delayed

Acute Effects: Direct exposure may cause respiratory irritation, eye irritation and skin irritation. The product dust can dry and irritate the skin and cause dermatitis and can irritate eyes and skin through mechanical abrasion.

Chronic Effects: Chronic exposure may cause lung damage from repeated exposure. Prolonged inhalation of respirable crystalline silica above certain concentrations may cause lung diseases, including silicosis and lung cancer.

4.3 Indication of Any Immediate Medical Attention and Special Treatment Needed

Seek first aid or call a doctor or Poison Control Center if contact with eyes occurs and irritation remains after rinsing. Get medical advice if inhalation occurs and respiratory symptoms persist.

Section 5
Firefighting Measures

5.1 Extinguishing Media

Suitable Extinguishing Media:	Product is not flammable. Use extinguishing media appropriate for surrounding fire.
Unsuitable Extinguishing Media:	Not applicable, the product is not flammable.

5.2 Special Hazards Arising from the Substance or Mixture

Hazardous Combustion Products:	None known.

5.3 Advice for Firefighters

Special Protective Equipment and Precautions for Firefighters:	As with any fire, wear self-contained breathing apparatus (NIOSH approved or equivalent) and full protective gear.

Section 6
Accidental Release Measures

6.1 Personal Precautions, Protective Equipment and Emergency Procedures

Personal precautions/Protective Equipment:	See Section 8.2.2 Individual Protective Measures. For concentrations exceeding Occupational Exposure Levels (OELs), use a self-contained breathing apparatus (SCBA).
Emergency procedures:	Use scooping, water spraying/flushing/misting or ventilated vacuum cleaning systems to clean up spills. Do not use pressurized air.

6.2 Environmental Precautions

Environmental precautions:	Prevent contamination of drains or waterways and dispose according to local and national regulations.

6.3 Methods and Material for Containment and Cleaning Up

Methods and materials for containment and cleaning up:	Do not use brooms or compressed air to clean surfaces. Use dust collection vacuum and extraction systems. Large spills of dry product should be removed by a vacuum system. Dampened material should be removed by mechanical means and recycled or disposed of according to local and national regulations.

See Sections 8 and 13 for additional information on exposure controls and disposal.

Section 7
Handling and Storage

7.1 Precautions for Safe Handling

Practice good housekeeping. Use adequate exhaust ventilation, dust collection and/or water mist to maintain airborne dust concentrations below permissible exposure limits (note: respirable crystalline silica dust may be in the air without a visible dust cloud).

Do not permit dust to collect on walls, floors, sills, ledges, machinery, or equipment. Maintain and test ventilation and dust collection equipment. In cases of insufficient ventilation, wear a NIOSH approved respirator for silica dust when handling or disposing dust from this product. Avoid contact with skin and eyes. Wash or vacuum clothing that has become dusty. Avoid eating, smoking, or drinking while handling the material.

7.2 Conditions for Safe Storage, Including any Incompatibilities

Minimize dust produced during loading and unloading.

Section 8
Exposure Controls/Personal Protection

8.1 Control Parameters

OCCUPATIONAL EXPOSURE LIMITS					
SUBSTANCE		**OSHA PEL TWA (mg/m^3)**	**NIOSH REL TWA (mg/m^3)**	**ACGIH TLV TWA (mg/m^3)**	**CA - OSHA PEL (mg/m^3)**
Calcium oxide		5	2	2	2
Particulates Not Otherwise Regulated	Total	15	15	10	10
	Respirable	5	5	3	5
Respirable Crystalline Silica	Respirable	0.05	0.05	0.025	0.05
Manganese dioxide (as manganese compounds)	Total	5 (Ceiling)	1 3 (STEL)	0.1	0.2
	Respirable	-	-	0.02	-

8.2 Exposure Controls

8.2.1 Engineering Controls

Provide ventilation to maintain the ambient workplace atmosphere below the occupational exposure limit(s). Use general and local exhaust ventilation and dust collection systems as necessary to minimize exposure.

8.2.2 Personal Protective Equipment (PPE)

Respiratory protection:	Wear a NIOSH approved particulate respirator if exposure to airborne particulates is unavoidable and where occupational exposure limits may be exceeded. If airborne exposures are anticipated to exceed applicable PELs or TLVs, a self-contained breathing apparatus or airline respirator is recommended.
Eye and face protection:	If eye contact is possible, wear protective glasses with side shields. Avoid contact lenses.
Hand and skin protection:	Wear gloves and protective clothing. Wash hands with soap and water after contact with material.

Section 9
Physical and Chemical Properties

9.1 Information on Basic Physical and Chemical Properties

Property: Value	Property: Value
Appearance (physical state, color, etc.): Fine tan/ gray particulate	**Upper/lower flammability or explosive limits:** Not applicable
Odor: Odorless[1]	**Vapor Pressure (Pa):** Not applicable
Odor threshold: Not applicable	**Vapor Density:** Not applicable
pH (25 °C) (in water): 8 - 11	**Specific gravity or relative density:** 2.2 – 2.9
Melting point/freezing point (°C): Not applicable	**Water Solubility:** Slight
Initial boiling point and boiling range (°C): Not applicable	**Partition coefficient: n-octane/water:** Not determined
Flash point (°C): Not determined	**Auto ignition temperature (°C):** Not applicable
Evaporation rate: Not applicable	**Decomposition temperature (°C):** Not determined
Flammability (solid, gas): Not combustible	**Viscosity:** Not applicable

[1] The use of urea or aqueous ammonia injected into the flue gas to reduce nitrogen oxides (NOx) emissions may result in the presence of ammonium sulfate or ammonium bisulfate in the ash at less than 0.1%. When ash containing these substances becomes wet under high pH (>9), free ammonia gas may be released resulting in objectionable/nuisance ammonia odor and potential exposure to ammonia gas especially in confined spaces.

Section 10
Stability and Reactivity

10.1 Reactivity:	The material is an inert, inorganic material primarily composed of elemental oxides.
10.2 Chemical stability:	The material is stable under normal use conditions.
10.3 Possibility of hazardous reactions:	The material is a relatively stable, inert material; however, when ash containing ammonia becomes wet under high pH (>9), free ammonia gas may be released resulting in an objectionable/nuisance ammonia odor and potential exposure to ammonia gas especially in confined spaces. Polymerization will not occur.
10.4 Conditions to avoid:	Product can become airborne in moderate winds. Dry material should be stored in silos. Materials stored out of doors should be covered or maintained in a damp condition.
10.5 Incompatible materials:	None known.
10. 6 Hazardous decomposition products:	None known.

Section 11
Toxicological Information

11.1 Information on Toxicological Effects

Endpoint	Data
Acute oral toxicity	LD50 > 2000 mg/kg
Acute dermal toxicity	LD50 > 2000 mg/kg
Acute inhalation toxicity	LD50 > 5.0 mg/L
Skin corrosion/irritation	Does not meet the classification criteria but may cause slight skin irritation. Product dust can dry the skin which can result in irritation.
Eye damage/irritation	Causes serious eye irritation. Positive scores for conjunctiva irritation and chemosis in 2/3 animals based on average of 24, 48 and 72-hour scores with irritation clearing within 21 days; no corneal or iritis effects observed.
Respiratory/skin sensitization	Not a respiratory or dermal sensitizer.
Germ cell mutagenicity	Not mutagenic in in-vitro and in-vivo assays with or without metabolic activation.
Carcinogenicity	Not available. Respirable crystalline silica has been identified as a carcinogen by OSHA, NTP, ACGIH and IARC.
Reproductive toxicity	No developmental toxicity was observed in available animal studies. Reproductive studies on CCPs showed either no reproductive effects, or some effects on male and female reproductive organs and parameters but without a clear dose response.
STOT-SE	CCPs when present as a nuisance dust may result in respiratory irritation.
STOT-RE	In a 180-day inhalation study with fly ash dust, no effects were observed at the highest dose tested. NOEC = 4.2 mg/m^3; it is not possible to assess the level at which toxicologically significant effects may occur. Repeated inhalation exposures to high levels of respirable crystalline silica may result in lung damage (i.e., silicosis).
Aspiration Hazard	Not applicable based product form.

Section 12
Ecological Information

12.1 Toxicity

Fly Ash (CAS# 68131-74-8)	
Toxicity to Fish	LC50 > 100 mg/L
Toxicity to Aquatic Invertebrates	Data indicates that the test substance is not toxic to *Daphnia magna* (EC50 undetermined)
Toxicity to Aquatic Algae and Plants	EC50 = 10 mg/L
Calcium oxide CAS# 1305-78-8	
Toxicity to Fish	LC50 = 50.6 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Invertebrates	EC50 = 49.1 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Algae and Plants	NOEC =48 mg/L @ 72 hours based on $Ca(OH)_2$ The initial pH of the test medium was not directly related to the biologically relevant effects. The formation of precipitates is likely the result of the reaction between CO_2 dissolved in the medium.

12.2 Persistence and Degradability

Not relevant for inorganic materials.

12.3 Bioaccumulative Potential

This material does not contain any compounds that would bioaccumulate up the food chain.

12.4 Mobility in Soil

No data available.

12.5 Results of PBT and vPvB Assessment

This material does not contain any compounds classified as “persistent, bioaccumulative or toxic” nor as “very persistent/very bioaccumulative”.

12.6 Other Adverse Effects

None known.

Section 13
Disposal Considerations

See Sections 7 and 8 above for safe handling and use, including appropriate industrial hygiene practices.

Dispose of all waste product and containers in accordance with federal, state and local regulations.

Section 14
Transport Information

Regulatory entity: U.S. DOT	Shipping Name:	Not Regulated
	Hazard Class:	Not Regulated
	ID Number:	Not Regulated
	Packing Group:	Not Regulated

Section 15
Regulatory Information

15.1 Safety, Health and Environmental Regulations/Legislation Specific for the Mixture

- TSCA Inventory Status

  All components are listed on the TSCA Inventory.

- California Proposition 65

  The following substances are known to the State of California to be carcinogens and/or reproductive toxicants:

  - Respirable crystalline silica
  - Titanium dioxide

- State Right-to-Know (RTK)

Component	CAS	MA[1,2]	NJ[3,4]	PA[5]	RI[6]
Ammonium bisulfate	7803-63-6	No	Yes	No	No
Ammonium sulfate	7783-20-2	Yes	No	Yes	No
Calcium oxide	1305-78-8	Yes	Yes	Yes	No
Iron oxide	1309-37-1	Yes	Yes	Yes	No
Magnesium oxide	1309-48-4	No	Yes	No	No
Phosphorus pentoxide (or phosphorus oxide)	1314-56-3	Yes	Yes	Yes	No
Potassium oxide	12136-45-7	No	Yes	No	No
Silica-crystalline (SiO_2), quartz	14808-60-7	Yes	Yes	Yes	No
Sodium oxide	1313-59-3	No	Yes	No	No
Titanium dioxide	13463-67-7	Yes	Yes	Yes	Yes

[1] Massachusetts Department of Public Health, no date
[2] 189th General Court of The Commonwealth of Massachusetts, no date
[3] New Jersey Department of Health and Senior Services, 2010a
[4] New Jersey Department of Health, 2010b
[5] Pennsylvania Code, 1986
[6] Rhode Island Department of Labor and Training, no date

Section 16
Other Information, Including Date of Preparation or Last Revision

16.1 Indication of Changes

Date of preparation or last revision: February 23, 2018

16.2 Abbreviations and Acronyms

- ACGIH: American Conference of Industrial Hygienists
- CA: California
- CAS: Chemical Abstract Services
- CCP: Coal Combustion Product
- CFR: Code of Federal Regulations
- EPA: Environmental Protection Agency
- GHS: Globally Harmonized System of Classification and Labelling
- IARC: International Agency for Research on Cancer
- LC50: Concentration resulting in the mortality of 50 % of an animal population
- LD50: Dose resulting in the mortality of 50 % of an animal population
- MA: Massachusetts
- NA: Not Applicable
- NJ: New Jersey
- NOEC: No observed effect concentration
- NIOSH: National Institute of Occupational Safety and Health
- NOx: Nitrogen oxides
- NTP: US National Toxicology Program
- OEL: Occupational Exposure Limit
- OSHA: Occupational Safety and Health Administration
- PA: Pennsylvania
- PBT: Persistent, Toxic and Bioaccumulative
- PEL: Permissible exposure limit
- PPE: Personal Protective Equipment
- REL: Recommended exposure limit
- RI: Rhode Island
- RCS: Respirable Crystalline Silica
- RTK: Right-to-Know
- SCBA: Self-contained breathing apparatus
- SDS: Safety Data Sheet
- STEL: Short-term exposure limit
- STOT-RE: Specific target organ toxicity-repeated exposure
- STOT-SE: Specific target organ toxicity-single exposure
- TLV: Threshold limit value
- TSCA: Toxic Substances Control Act
- TWA: Time-weighted average
- UEL: Upper explosive limit
- UVCB: Unknown or Variable Composition/Biological
- U.S.: United States
- U.S. DOT: United States of Department of Transportation

16.3 Other Hazards

Hazardous Materials Identification System (HMIS) Degree of hazard (0= low, 4 = extreme)							
Health:	2*	**Flammability:**	0	**Physical Hazards:**	0	**Personal protection:****	

** Chronic Health Effects*
****** Appropriate personal protection is defined by the activity to be performed.*
See Section 8 for additional information.

DISCLAIMER:

This SDS has been prepared in accordance with the Hazard Communication Rule 29 CFR 1910.1200. Information herein is based on data considered to be accurate as of date prepared. No warranty or representation, express or implied, is made as to the accuracy or completeness of this data and safety information. No responsibility can be assumed for any damage or injury resulting from abnormal use, failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

APPENDIX E
SITE PLAN MAP AND ON-SITE TRANSPORTATION PLAN ((845.220(a)(4) AND 845.220(a)(2)(E))

MONITORING WELL
PORE WATER WELL
ONSITE TRANSPORTATION ROUTE FOR CORRECTIVE ACTION
HIGH VOLTAGE OVERHEAD ELECTRIC
BURIED GAS LINE
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 350 700 Feet

SITE PLAN MAP AND TRANSPORTATION PLAN

CONSTRUCTION PERMIT APPLICATION
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

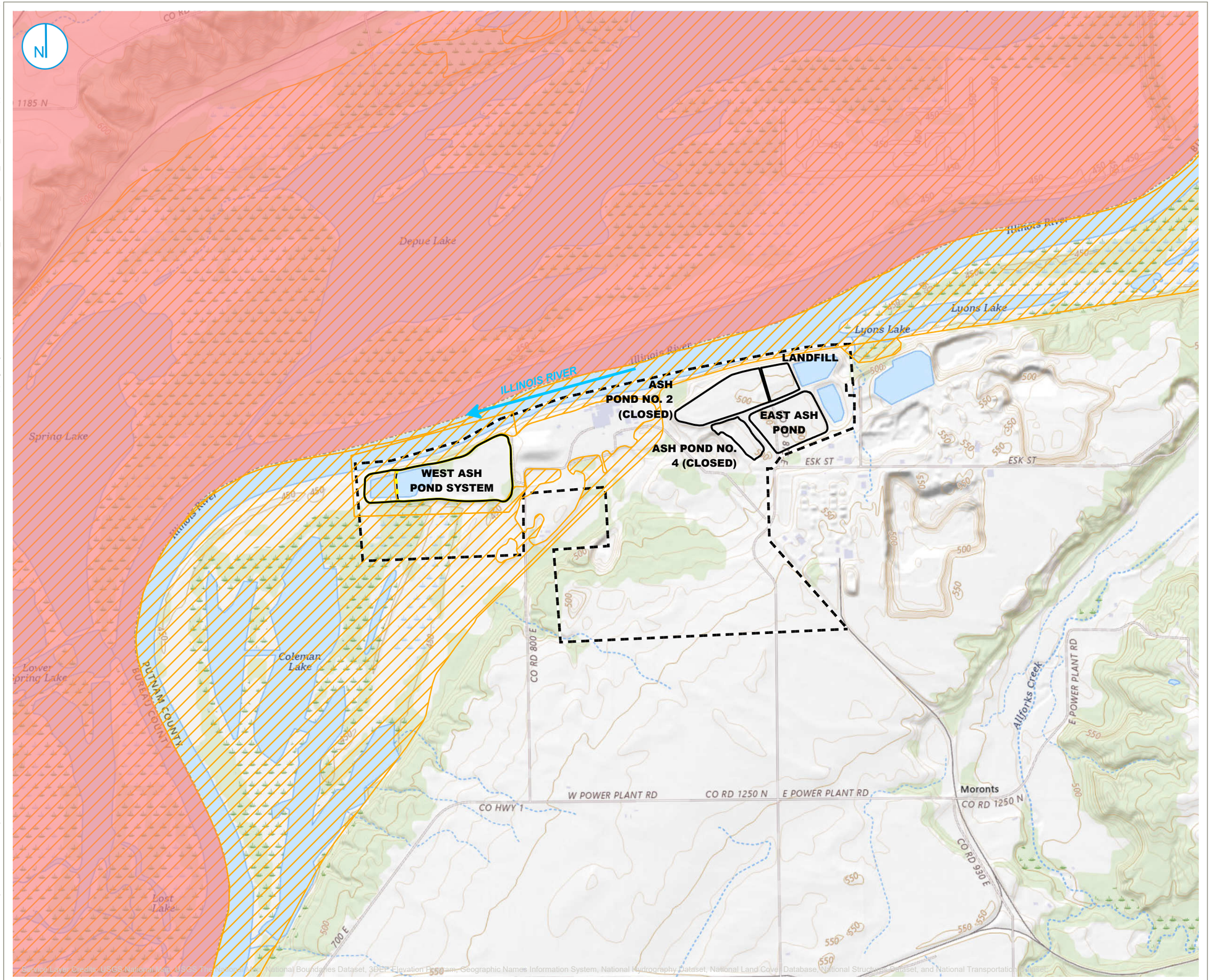
APPENDIX E

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\222285\MXD\Construction_Permit\HEN_WHEN_WAPS_CP aprx\Appendix E. Site Plan Map and Transportation Plan
PROJECT: 1690000XXXX | DATED: 4/17/2025 | DESIGNER: GALARNMC

APPENDIX F
SITE LOCATION MAPS (845.220(a)(3))



SITE FEATURE
PROPERTY BOUNDARY
CRITICAL HABITAT
FEMA 100-YEAR FLOOD ZONE

PREVAILING WIND

NOTES:
SITE BOUNDARY IS BASED ON GEOSYNTEC CONSULTANT 2022. CONSTRUCTION PERMIT APPLICATION, HENNEPIN POWER PLANT, EAST ASH POND, HENNEPIN, ILLINOIS. JANUARY 28.

THE BASEMAP FOR THIS FIGURE INCLUDES THE 2024 USGS US 7.5-MINUTE SERIES QUADRANGLE MAP FOR DEPUE, IL.

CRITICAL HABITAT AREAS DERIVED FROM 2025 US FISH AND WILDLIFE CRITICAL HABITAT FOR THREATENED AND ENDANGERED SPECIES LOCATIONS.

NO DEDICATED ILLINOIS NATURE PRESERVES OR DESIGNATED HISTORIC AND ARCHAEOLOGICAL SITES PER THE ILLINOIS NATIONAL HISTORIC PRESERVATION ACT WERE LISTED WITHIN 1,000 METERS OF THE SITE.

THE FEMA 100-YEAR FLOOD ZONE BOUNDARIES WERE TAKEN FROM THE FEMA FLOOD MAP SERVICE CENTER AND WERE ADJUSTED IN THE VICINITY OF THE OLD WEST ASH POND BASED ON SITE-SPECIFIC SURVEY DATA SHOWING THIS TOP OF FINAL COVER TO BE ABOVE THE 100-YEAR FLOOD LEVEL OF EL. 416.9 FT (CIVIL & ENVIRONMENTAL CONSULTANTS, INC., 2020)

0 750 1,500
Feet

SITE LOCATION MAP

CONSTRUCTION PERMIT APPLICATION
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

APPENDIX F

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community | Esri, HERE, Garmin, USGS, National Geographic, Esri, Delorme, NGA, USGS | The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset

Y:\Mapping\Projects\22\22265\MXD\Construction_Permit\HEN_WHEN_WAPS_CP.aprx\Appendix F. Site Location Map
PROJECT: 169000XXXX | DATED: 4/17/2025 | DESIGNER: GALARNMC

APPENDIX G
CORRECTIVE ACTION PLAN (845.670) AND PROPOSED SCHEDULE, INCLUDING THE CORRECTIVE ACTION ALTERNATIVES ANALYSIS (845.670(e))

Intended for
Vistra Energy, dba
Dynegy Midwest Generation, LLC
13498 E 800th St
Hennepin, Illinois 61327

Date
May 6, 2025

Project No.
1940110241-006

CORRECTIVE ACTION PLAN
DYNEGY MIDWEST GENERATION, LLC, HENNEPIN POWER STATIONS, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

RAMBOLL Bright ideas. Sustainable change.

CORRECTIVE ACTION PLAN
DYNEGY MIDWEST GENERATION, LLC, HENNEPIN POWER STATIONS, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

Project name	**Hennepin West Ash Pond System**
Project no.	**1940110241-006**
Recipient	**Dynegy Midwest Generation**
Document type	**Corrective Action Plan**
Revision	**FINAL**
Date	**May 6, 2025**
Prepared by	**Elizabeth (Richter) Rotstein, PE**
Checked by	**Lucas Carr, PE**
Approved by	**Brian Hennings, PG**
Description	**Corrective Action Plan for 35 I.A.C. § 845**

Lucas Carr, PE
Qualified Professional Engineer

Brian Hennings, PG
Project Officer, Hydrogeology

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TABLES (WITHIN TEXT)

Table A	Estimated Timeframes to Attain GWPS in Groundwater Monitoring Wells

TABLES

Table 1	Summary of 2024 Bedrock Hydraulic Conductivity Testing
Table 2	Proposed Milestone Schedule for Implementing Corrective Action Remedy (Source Control with Continuous Containment System)

APPENDICES

Appendix A	Corrective Action Alternatives Analysis (845.670(e)), including Corrective Measures Assessment (845.660)
Appendix B	Drawings and Material Specifications for Source Control with Continuous Containment System

ACRONYMS AND ABBREVIATIONS

%	percent
35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
bgs	below ground surface
BMP	best management practice
CAAA	Corrective Action Alternatives Analysis
CAAA-SIR	Corrective Action Alternatives Analysis Supporting Information Report
CAP	Corrective Action Plan
CBR	closure-by-removal
CCR	coal combustion residuals
CCS	continuous containment system
CIP	closure-in-place
cm/sec	centimeters per second
CMA	Corrective Measures Assessment
COC	constituent of concern
CP	Construction Permit
CWS	community water supply
DCW	deep cutoff wall
DMG	Dynegy Midwest General, LLC
EAP	East Ash Pond
ft	feet
GMP	Groundwater Monitoring Plan
Gradient	Gradient Corporation
GWP	groundwater polishing
GWPS	groundwater protection standard(s)
HCR	Hydrogeologic Site Characterization Report
HEN	Hennepin Power Station
HPP	Hennepin Power Plant
ID	identification
IEPA	Illinois Environmental Protection Agency
ISGS	Illinois State Geological Survey
ISS	*in-situ* stabilization/solidification
ISWS	Illinois State Water Survey
LLDPE	linear low-density polyethylene
mg/L	milligram per liter
NAVD88	North American Vertical Datum of 1988
NID	National Inventory of Dams
No.	number
O&M	operations and maintenance
OP	Operating Permit
OWAP	Old West Ash Pond
OWPP	Old West Polishing Pond

PRB	permeable reactive barrier
PWS	public water system
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SI	surface impoundment
UA	uppermost aquifer
USEPA	United States Environmental Protection Agency
WAPS	West Ash Pond System
WHPA	wellhead protection area

1. INTRODUCTION

1.1 Plant and Site Information

Dynegy Midwest Generation, LLC (DMG) is the owner of the inactive coal-fired Hennepin Power Plant (HPP), also referred to as the Hennepin Power Station (HEN), in Hennepin, Putnam County, Illinois. DMG intends to complete groundwater corrective action of the coal combustion residuals (CCR) surface impoundment (SI) West Ash Pond System (WAPS), which is identified by Illinois Environmental Protection Agency (IEPA) identification (ID) numbers (No.) W1550100002-01 and W1550100002-03, CCR Unit ID No. 804, and a National Inventory of Dams (NID) No. IL50698. The WAPS is comprised of the Old West Ash Pond (OWAP) and the Old West Polishing Pond (OWPP). The WAPS was constructed as a single unit with a single perimeter dike and subsequently internally divided into the OWAP and OWPP as part of operational practices. Source control (*e.g.*, closure) was completed in 2020; this included leaving CCR in place within the OWAP, removing all CCR from the OWPP, placing it within the OWAP, and installing a geomembrane final cover system over the consolidated OWAP [1, 2]. This document and all past engineering and hydrogeological studies consider the WAPS as a single CCR unit. This Corrective Action Plan (CAP) has been prepared for the WAPS at HPP under the requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments [3] and the requirements of Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257, herein referred to as the Federal CCR Rule [4].

1.2 Organization of the Corrective Action Plan

This CAP is organized in the following manner:

- Section 1 includes an introduction to the WAPS, lists the status of other 35 I.A.C. § 845 permit applications submitted to IEPA, identifies the selected remedy, and provides a narrative of remedy construction;
- Section 2 includes an overview of the corrective action process, including the results of the Corrective Measures Assessment (CMA) and Corrective Action Alternatives Analysis (CAAA);
- Section 3 provides the CAP requirements, the selected remedy, an evaluation of effectiveness and an implementation schedule, as required by 35 I.A.C. § 845.670; and
- Section 4 includes reference documents used in the development of this CAP.

This CAP was prepared as an appendix to a Corrective Action Construction Permit (CP) application, to support obtaining a permit for Corrective Action Construction at the WAPS, as required by 35 I.A.C. § 845.220(a) and (c).

1.3 Permit Status

An Operating Permit (OP) application, as required by 35 I.A.C. § 845.230, was submitted on October 25, 2021 [5]. The permit application is currently under review by IEPA.

1.4 Closure and Source Control Status

DMG completed significant source control efforts in 2020 as part of final closure of the WAPS [1, 2]. The final closure was performed in accordance with the Closure and Post-Closure Care Plan [6] that was developed in accordance with 40 C.F.R. § 257, submitted to IEPA for review, and subsequently approved by IEPA [7]. IEPA found *"…the closure and post-closure care plan…to be*

an adequate corrective action" [8]. The final closure was addressed in accordance with the IEPA Water Pollution Control Permit 202-EA-65026-1.

The WAPS closure included a hybrid consolidate-and-cap approach comprised of closure-by-removal (CBR) of the OWPP and closure-in-place (CIP) of the OWAP. This involved excavating CCR and approximately 1 foot of soil below the CCR from the OWPP and placing it into the OWAP, and installing a geomembrane final cover system over the consolidated OWAP in accordance with 40 C.F.R. § 257.102 [1, 2]. These source control activities serve as the primary groundwater corrective measure for the WAPS.

Since final closure in 2020, groundwater quality has improved evidenced by a decrease in boron concentrations [9] within the groundwater monitoring network. Specifically, many wells where boron concentrations were above the groundwater protection standard (GWPS) of 2 milligrams per liter (mg/L) before closure (*e.g.*, wells 22, 21/21R, and 51) have, since closure, attained GWPS, or concentration levels have steadily decreased.

The remedy presented within this CAP is intended to be supplementary to the primary remedy, which is the completed source control.

1.5 Selected Corrective Action Remedy

A source control with continuous containment system (CCS), which combines source control that has been implemented at WAPS [1, 2] with a proposed deep cutoff wall (DCW) anchored (*i.e.,* extended) into competent bedrock, has been identified as the most appropriate remedy for the WAPS, based on the CAAA provided in **Appendix A**. The CCS will provide a continuous, passive, and essentially maintenance-free containment of the CCR within the WAPS, thereby controlling the source of releases of constituents listed in 35 I.A.C. § 845.60.

Potential remedies evaluated in the CAAA included Source Control with Groundwater Polishing (GWP) and Source Control with DCW. The CAAA, which was prepared by Gradient Corporation (Gradient), was based on a CAAA Supporting Information Report (CAAA-SIR) that was prepared by Ramboll Americas Engineering Solutions, Inc. (Ramboll) and is attached to the CAAA. The CAAA-SIR includes the results of groundwater modeling and feasibility-level design information for each remedy.

A Groundwater Polishing Evaluation Report [10] is also attached to the CAAA. This report presents results from geochemical modeling of exceedance[1] parameters addressed at WAPS by the CAP. Geochemical modeling is intended to contextualize the estimated time to reach the GWPS by evaluating the potential for chemical attenuation of exceedance parameters; and, for evaluating the potential for previously attenuated constituents of concern (COCs) to be remobilized under return-to-background conditions.

1.5.1 Narrative Description of Selected Corrective Action Remedy

Corrective action will consist of supplementing the completed source control [1, 2] through the installation of a vertically- and laterally-continuous, permanent, and low-permeability DCW that

[1] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or GWPS as described in the proposed groundwater monitoring program, which was submitted to the IEPA on October 25, 2021 as part of DMG's OP Application for the HPP WAPS. That OP Application, including the proposed groundwater monitoring program, remains under review by the IEPA and, therefore, DMG has not identified any actual exceedances.

will extend from the perimeter dikes of the WAPS into low-permeability competent bedrock beneath the WAPS. This will result in the CCR within the WAPS being physically isolated from the environment on all sides by a permanent, passive system of continuous low-permeability barriers, including the final cover system on the surface, the DCW laterally, and competent shale bedrock below the base.

Once installed, the CCS will be a permanent corrective action feature. Performance of the CCS as groundwater corrective action will be monitored in accordance with the Corrective Action Groundwater Monitoring Plan (GMP) attached to the CP Application.

Estimated times to reach the GWPS will be periodically reviewed and updated based on observed corrective action performance via an adaptive site management strategy. These periodic, updated estimates will be communicated to IEPA and the public within annual corrective action monitoring reports, in accordance with the Corrective Action GMP.

Corrective action will be considered complete when a demonstration that GWPS compliance beyond the waste boundary has been achieved for at least three years and a Corrective Action Completion Report and Certification have been submitted to IEPA in accordance with 35 I.A.C. § 845.680(e).

1.5.1.1 Narrative Discussion of Remedy Design and Function

The CCS, which includes the DCW, final cover system, and competent bedrock base, includes the following features:

- The DCW portion of the remedy will be a continuous feature that will encircle the perimeter of the OWAP, with a total length of approximately 5,200 feet.
  - Since CCR from the OWPP was excavated and placed in the OWAP during WAPS closure [1, 2], this will encircle the remaining CCR contained within the WAPS.
- The DCW will be anchored (*i.e.,* extended) at least 1 foot into competent, low-permeability shale bedrock beneath the WAPS, which has a typical depth of approximately 90 feet below ground surface (bgs).
  - In 2024, packer testing was conducted at three boreholes (B-100, B-101, and B-102) adjacent to the WAPS. The results are summarized in a technical memorandum that will be included within an appendix to the CAAA (**Appendix A**) at a later date.
  - The competent shale bedrock was determined to have a hydraulic conductivity ranging from 1.1×10^{-5} centimeters per second (cm/sec) to 3.2×10^{-6} cm/sec, with a geometric mean hydraulic conductivity of 3.4×10^{-6} cm/sec.
  - The field measured hydraulic conductivity from wells at the WAPS is approximately 1.2×10^{-2} cm/sec for the gravel deposits of the Henry Formation [11], the geometric mean of the hydraulic conductivity of the shale bedrock is on the order 3,500 times (*i.e.,* nearly 4 orders of magnitude) lower than that of the overlying aquifer materials. Additionally, the observed hydraulic conductivity of the competent shale bedrock either remained consistent or decreased with depth. This demonstrates that the shale bedrock has an appropriately low hydraulic conductivity to function as a lower barrier layer for the CCS.
  - A summary of the 2024 packer testing results at boreholes B-100 through B-102 are presented in **Table 1**.

- The DCW will be constructed using a mixture of either soil and bentonite or cement and bentonite and would have a typical thickness of approximately 3 to 4 feet.
  - The target hydraulic conductivity for the DCW will be 1×10^{-7} cm/sec. This is approximately 120,000 times (*i.e.*, 5 orders of magnitude) lower than that of the surrounding aquifer materials (1.2×10^{-2} cm/sec for the gravel deposits of the Henry Formation [11]). This will result in the wall having an appropriately low hydraulic conductivity to function as a lateral barrier for the CCS.
- After installation of the DCW, the existing final cover system, which utilizes a low-permeability, 40-mil linear low-density polyethylene (LLDPE) geomembrane barrier layer, will be extended over the top of the final cover system.
- After CCS construction is complete, CCR within the WAPS will be continuously contained by low-permeability materials and isolated from the surrounding environment on all sides, including:
  - Surface containment will be provided by the existing and extended final cover system, which utilizes a low-permeability 40-mil LLDPE geomembrane, on the top of the CCR.
  - Lateral containment will be provided by the DCW on all sides of the CCR.
  - Lower containment will be provided by the low-permeability competent shale bedrock beneath the CCR.

Permit-level engineering drawings depicting the proposed DCW and other features, including areas of the WAPS where the final cover will be disturbed, repaired, and extended as part of DCW construction, are provided in **Appendix B**.

1.5.2 Narrative Description of Proposed Remedy Operations

No corrective action operations and maintenance (O&M) is expected to be required following installation of the DCW with integration into the competent bedrock portions of the CCS, as they are passive, below-grade structures. However, O&M of the final cover system portion of the CCS remedy would continue in accordance with current post-closure care O&M practices [6].

1.5.3 Narrative Description of Proposed Groundwater Monitoring

Corrective action groundwater monitoring will be conducted in accordance with the Corrective Action GMP during remedy operation to evaluate the effectiveness of the corrective action remedy and whether groundwater concentrations are achieving the GWPS as predicted by the groundwater model. Groundwater data collected as part of the monitoring program will be analyzed to determine if the remedy is on track to meet GWPS and to inform adaptive management decisions if performance metrics are not achieved. Information associated with each of these activities is described below.

- Regular groundwater monitoring will be conducted utilizing a corrective action groundwater monitoring network designed in accordance with 35 I.A.C. § 845.680(a)(1).
- Laboratory parameters include major ions for evaluating groundwater chemistry and COCs (*i.e.*, reported exceedances in accordance with the Operating GMP) the corrective action is intended to address. Sampling to evaluate corrective action effectiveness will begin the quarter after the corrective action remedy is implemented and commissioned. Samples will be collected on a quarterly basis initially and potentially reduced to a semiannual basis once

five years of monitoring have occurred, in accordance with 35 I.A.C. § 845.650(b)(4). Monitoring results will be submitted to IEPA for each monitoring event, in addition to an Annual Groundwater Monitoring and Corrective Action Report, in accordance with 35 I.A.C. § 845.610(e).

- Routine maintenance of the monitoring well network will include inspecting the wells, making repairs to the wells (as needed), and rehabilitating and/or replacing wells to improve performance (as needed).
- Adaptive site management strategies will be employed as an integral part of ongoing corrective action at the WAPS. The adaptive site management approach will allow timely incorporation of new site information to ensure the achievement of the GWPS. The effectiveness of the remedy at each phase is evaluated using performance metrics designed to assess the goals of that phase. Performance metrics answer questions designed to evaluate multiple aspects of remedy effectiveness with the ultimate goal of holistically guiding management decisions [12]. The goals and performance metrics of each phase of remedy evaluation are presented in Section 3 of the Corrective Action GMP included in the CP Application.
- Documentation of remedy progress metrics will be provided in the Annual Groundwater Monitoring and Corrective Action Report beginning after the second year of data collection: a minimum of eight data points is required to complete meaningful statistical analysis required for evaluation of the remedy progress metrics, which will be available after two years of quarterly sampling. Per United States Environmental Protection Agency (USEPA) guidance [12], a thorough review of corrective action progress and remedy effectiveness will be conducted every five years. A Five-Year Annual Groundwater Monitoring and Corrective Action Report will evaluate the comprehensive data set and, if triggered by the results of the remedy progress evaluation metrics, evaluate whether adaptive management actions are needed. The five-year time frame allows adaptive management decisions to be based on a robust data sufficient to complete meaningful statistical analysis while remaining responsive to changing site conditions [12].
- Corrective Action Confirmation Monitoring and Completion
  - Per 35 I.A.C. § 845.680(c), corrective action is considered complete when compliance with the GWPS has been demonstrated "at all points within the plume of contamination that lies beyond the waste boundary […] for a period of three consecutive years". At that time, an attainment evaluation will be implemented in accordance 35 I.A.C. § 845.680(c).
  - After completion of the corrective action confirmation monitoring period, a Corrective Action Completion Report and Certification will be prepared and submitted to IEPA, in accordance with 35 I.A.C. § 845.680(e).

2. CORRECTIVE ACTION OVERVIEW

This CAP is based on the tiered assessment and analysis of alternative remedial technologies and remedies that were completed via the CMA and CAAA (**Appendix A**). The objective of these assessments was to determine the optimal alternative for the WAPS that, when coupled with the source control that has been previously implemented [1, 2], would remediate groundwater and provide compliance with the GWPS specified under 35 I.A.C. § 845.600.

2.1 Corrective Measures Assessment

The CMA [13] was performed for the WAPS and submitted to the IEPA on May 8, 2024, after the exceedances of the GWPS were identified. The CMA considered a total of five corrective measures for the WAPS, including:

- Source Control with GWP
- Source Control with *In-Situ* Stabilization/Solidification (ISS)
- Source Control with Groundwater Extraction (groundwater pumping wells or collection trenches)
- Source Control with Cutoff Wall
- Source Control with *In-Situ* Chemical Treatment (permeable reactive barrier [PRB])

Based on the CMA, three corrective measures, including source control with GWP, source control with cutoff wall, and source control with ISS[2], were identified as potentially viable corrective measures for the WAPS. The source control with cutoff wall remedy considered by the CMA was expanded into source control with CCS, which extends the cutoff wall to the competent bedrock and integrates it into the previously implemented final cover.

Of these corrective measures, source control with GWP and source control with CCS were selected for further evaluation, design advancement, and comparative assessment within the CAAA for the WAPS.

2.1.1 Corrective Action Alternatives Analysis Supporting Information Report

The CAAA for the WAPS was prepared by Gradient based on a CAAA-SIR prepared by Ramboll. The CAAA-SIR, which is included as Attachment B of the CAAA provided in **Appendix A**, included additional evaluation, design advancement, and comparative assessment of the source control with GWP and source control with CCS corrective measures identified as potentially viable for the WAPS. The evaluation included the completion of feasibility-level design activities for each alternative and incorporated the following tasks:

- Performing predictive groundwater modeling to evaluate the scope (*i.e.,* location and extents) of each alternative and the corresponding estimated time to achieve GWPS;
- Developing feasibility-level design drawings showing the extent in plan and elevation view of each engineered remedy;

[2] The source control with ISS remedy was evaluated further at a preliminary level and determined to be infeasible, as discussed in the CAAA provided in **Appendix A**.

- Estimating the time required to design, construct, and implement each remedy, in addition to ongoing operational and maintenance requirements;
- Identifying future tasks required to implement each alternative, including permitting, investigation, and design efforts; and
- Estimating relevant material quantities, labor hours, delivery miles, equipment miles, and daily commuting miles associated with constructing each remedy.

2.1.2 Corrective Action Alternatives Analysis

The CAAA (**Appendix A**) included a detailed analysis of each of the corrective action alternatives presented in the CAAA-SIR, including an evaluation of:

- Long- and short-term effectiveness and protectiveness;
- Ease or difficulty of implementation;
- Degree to which community concerns are addressed; and
- Relative amount of contamination removed from the environment.

Based on the CAAA, source control with CCS was identified as the most appropriate corrective action for the WAPS and was selected for further design development as part of this CAP.

It should be noted that the permit-level engineering assessments, groundwater modeling, and other information contained within this CAP were developed to a higher level of design and detail than for the source control with CCS within the CAAA; therefore, information on items such as permitting, remedy scope, estimated time to reach GWPS, implementation schedule, etc. may differ between this CAP and the information included in the CAAA-SIR and CAAA. Information for the source control with CCS contained within the CAP should be considered to supersede information contained within the CAAA and CAAA-SIR.

3. CORRECTIVE ACTION PLAN

The 35 I.A.C. § 845 requirements for the CAP and corresponding demonstrations that the proposed corrective measures meet these requirements are discussed individually in this section. Many of the CAP requirements are discussed within the CMA and CAAA documents that have been prepared to support the CAP. Therefore, the demonstrations will also refer to those documents.

3.1 General Requirements

35 I.A.C. § 845.670(c): The corrective action plan must meet the following requirements:

(1) Be based on the results of the corrective measures assessment conducted under 35 I.A.C. § 845.660;

(2) Identify a selected remedy that at a minimum, meets the standards listed in subsection (d);

(3) Contain the corrective action alternatives analysis specified in subsection (e); and

(4) Contain proposed schedules for implementation, including an analysis of the factors in subsection (f).

This CAP is based on the results of the CMA and CAAA, which are included within **Appendix A**. The proposed schedule for implementing source control with CCS is provided in **Table 2**.

3.2 Remedy Selection

35 I.A.C. § 845.670(d): The selected remedy in the corrective action plan must:

(1) Be protective of human health and the environment;

Current conditions at the WAPS pose no risk to human health or environment (**Appendix A**). Concentrations of CCR-derived constituents are anticipated to continue to decline with the final cover that is in place, even without implementation of the DCW component of CCS. Once the DCW is installed, CCR within the WAPS would be contained within a continuous system of low-permeability materials and isolated from the surrounding environment on all sides.

(2) Attain the groundwater protection standards specified in 35 I.A.C. § 845.600;

Groundwater modeling used to support the design of the DCW (Appendix B of the CAAA-SIR) indicates the selected remedy of source control with CCS will attain the GWPS in approximately 33 years after complete implementation.

(3) Control the sources of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents listed in 35 I.A.C. § 845.600 into the environment;

The CCS will result in CCR within the WAPS being contained by a continuous system of low-permeability material on all sides of the WAPS. This includes the final cover system as surface containment, the DCW as lateral containment, and low-permeability competent bedrock as base containment beneath the CCR. This CCS would reduce, to the maximum extent feasible, further releases of constituents listed in 35 I.A.C. § 845.600 from the WAPS into the environment.

(4) Remove from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and

No known releases of CCR due to a structural integrity issue have occurred at the WAPS.

(5) Comply with standards for management of wastes as specified in 35 I.A.C. § 845.680(d).

The CCR managed during construction of the selected remedy (source control with CCS) will be done in accordance with all 35 I.A.C. § 845 requirements and the submitted closure plan [14].

3.3 Schedule for Implementation

The CCS is an effective engineered control as it provides hydraulic isolation at the limits of the WAPS and has been demonstrated as a reliable remedy by the USEPA [15]. The CCS will provide permanent hydraulic isolation of CCR within the WAPS from the surrounding environment. The CCS will remain in-place and functional even after GWPS have been met.

The CCS remedy was evaluated to determine if the DCW component of CCS can be successfully implemented to achieve GWPS compliance in a timely manner. Timeframes to attain GWPS in the corrective action monitoring network wells are estimated in **Table A**:

Table A. Estimated Timeframes to Attain GWPS in Groundwater Monitoring Wells

	2 years‡	5 years‡	10 years‡	20 years‡	33 years‡
Percentage of wells predicted to attain GWPS†	67%	67%	67%	89%	100%

†: Nine wells were used to estimate time to reach GWPS in the 2025 Groundwater Modeling Technical Memorandum.
‡: Years counted starting from 2028, presumed completion of implementation of DCW portion of CCS.

35 I.A.C. § 845.670(f): The owner or operator must specify, as part of the corrective action plan, a schedule for implementing, of and completing, remedial activities. The schedule must require the completion of remedial activities within a reasonable time, taking into consideration the factors in this subsection (f). The owner or operator of the CCR surface impoundment must consider the following factors in determining the schedule of remedial activities:

The schedule for implementation and completion of the DCW component of the CCS remedy at the WAPS is included in **Table 2**. Implementation of the remedy will occur within 90 days of approval of the CAP, in accordance with 35 I.A.C. § 845.680(a)(1).

The schedule was developed considering the factors required by 35 I.A.C. §§ 845.670(f)(1) through (5), as summarized below.

35 I.A.C. § 845.670(f)(1): Extent and nature of contamination, as determined by the characterization required under 35 I.A.C. § 845.650(d);

The Nature and Extent Report [16], which was submitted to the IEPA on May 8, 2024 and is included as an attachment to the CAAA (**Appendix A)**, details exceedances of GWPS. Groundwater modeling and geochemical analysis were performed by Ramboll as part of the CAAA-SIR to design the remedy, and the modeling considered the nature and extent of contamination.

35 I.A.C. § 845.670(f)(2): Reasonable probabilities of remedial technologies achieving compliance with the GWPS established by 35 I.A.C. § 845.600 and other objectives of the remedy;

Several remedies were evaluated in the CAAA (**Appendix A**), and results of groundwater modeling indicated that the selected remedy (source control with CCS) is expected to achieve compliance with 35 I.A.C. § 845.600. Groundwater modeling was performed to evaluate future groundwater quality in the vicinity of the WAPS. The results of the modeling indicate that groundwater will attain the GWPS for all constituents identified as having potential exceedances in the primary migration pathway (the uppermost aquifer [UA] groundwater unit) within approximately 33 years. As documented in the Groundwater Polishing Evaluation Report attached to the CAAA (**Appendix A**), attenuation of COCs, boron, lithium, sulfate, and TDS through sorption and chemical mechanisms will complement results of the groundwater transport modeling, in that time to reach GWPS may be shorter than the simulated timeframes. Remobilization of arsenic, which exceeds GWPS at two wells (51 and 21R), may increase the time to reach GWPS from the simulated results.

35 I.A.C. § 845.670(f)(3): Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;

Excavated soils (*e.g.,* spoils) are expected to primarily be non-CCR material and will be placed into off-road dump trucks and disposed of in the East Ash Pond (EAP) as contouring fill to support EAP closure in accordance with the submitted closure plan [14]. The EAP is expected to have sufficient disposal capacity for CCR wastes generated during remedy construction. After construction, the DCW component of CCS is not anticipated to result in the management of an appreciable volume of CCR.

35 I.A.C. § 845.670(f)(4): Potential risks to human health and the environment from exposure to contamination before completion of the remedy;

A Human Health and Ecological Risk Assessment was completed and included as an attachment to the CAAA (**Appendix A**). The overall conclusion is that groundwater from the WAPS impoundments and potential COC concentrations in groundwater contributions to surface water and sediment in the Illinois River pose no unacceptable risks to human health or the environment. However, the CAAA indicated that short-term negative impacts on surface water and sediment quality immediately adjacent to the site due to erosion and runoff from construction activities could occur but will be mitigated using stormwater best management practices (BMP) in accordance with applicable land disturbance permit requirements.

This conclusion is based on modeled and detected maximum concentrations of all COCs in surface water and sediment in the Illinois River, which were below conservative risk-based screening benchmarks. This conclusion was reached using methodology consistent with applicable USEPA risk assessment principles. The assessment relied on conservative assumptions meant to overestimate possible exposures and risks and provide an additional level of certainty in the conclusions.

35 I.A.C. § 845.670(f)(5): Resource value of the aquifer, including:

The resource value of the aquifer is discussed in the Hydrogeologic Site Characterization Report (HCR), which is included as Appendix B to the closure CP Application [11]. The HCR addresses paragraphs (A) through (F) from 35 I.A.C. § 845.670(f)(5), as summarized below.

35 I.A.C. § 845.670(f)(5)(A): Current and future uses, including potential residential, agricultural, commercial industrial and ecological uses;

Current uses and users of the groundwater are discussed in the HCR Section 3.5 and Appendix F. A water well inventory was completed in 2009 utilizing federal and state databases to assess nearby pumping wells, drinking water receptors, and other uses of water in the vicinity of the HEN property boundary inclusive of WAPS. Based on records obtained from IEPA, Illinois State Geological Survey (ISGS), and Illinois State Water Survey (ISWS), there are 2 wells located within 2,500 meters of WAPS. The two wells were reportedly constructed in 1844 and 1922 according to State of Illinois records that have been verified and were most likely abandoned decades ago [11]. There are no public water system (PWS), community water supply (CWS) or non-CWS wells, or wellhead protection areas (WHPAs) within 2,500 feet of WAPS. There are four wells owned by DMG within the HPP property boundary all of which are non-potable and non-contact industrial wells.

35 I.A.C. § 845.670(f)(5)(B): Proximity and withdrawal rate of users;

See preceding discussion on 35 I.A.C. § 845.670(f)(5)(B) for a discussion on the proximity and withdrawal rates of users.

35 I.A.C. § 845.670(f)(5)(C): Groundwater quantity and quality;

Per 35 I.A.C. § 620.210, groundwater within the UA at the WAPS meets the definition of Class I – Potable Resource Groundwater. The Human Health and Ecological Risk Assessment (Appendix A in CAAA) concluded that groundwater from the WAPS impoundment and potential groundwater contributions to surface water pose no unacceptable risks to human health or the environment.

35 I.A.C. § 845.670(f)(5)(D): The potential impact to the subsurface ecosystem, wildlife, other natural resources, crops, vegetation, and physical structures caused by exposure to CCR constituents;

Potential surface receptors are discussed in the HCR for HPP East Ash Pond Sections 3.5 [17]. A survey to identify surface water features, nature preserves, and historic sites was conducted for a 1,000-meter radius around the WAPS. Section 3.5.1 of the Human Health and Ecological Risk Assessment included as Appendix A of the CAAA Report stated there are no current unacceptable risks to ecological receptors at the WAPS.

35 I.A.C. § 845.670(f)(5)(E): The hydrogeologic characteristic of the facility and surrounding land; and

The hydrogeological assessment identified that the stratigraphy within and immediately surrounding the WAPS consists of fill, unlithified river alluvium, and Pleistocene-age glacial outwash deposits overlying Pennsylvanian-age shale bedrock. Where undisturbed or partially excavated, the native surficial soil at the site is poorly drained, moderately permeable silty clay loam formed as alluvium in floodplains.

There are two hydrostratigraphic units:

- **Uppermost Aquifer (UA)**: Includes the unlithified natural geologic materials of the Cahokia Alluvium and Henry Formation extending from the upper saturated zone to the bedrock. The UA contains variable amounts of cobbles and boulders within a sand and gravel matrix. Both the prevalence and size of the cobbles and boulders increase with depth.

- **Bedrock Confining Unit**: Comprised of shales with thin limestone, sandstone, and coal beds. This bedrock confining unit is encountered at elevations ranging from 374.3 to 410.2 feet.[3]

35 I.A.C. § 845.670(f)(5)(F): The availability of alternative water supplies.

As discussed in subsection A, there are no extraction wells within 2,500 meters of the site. Therefore, an alternate water supply is not necessary.

3.3.1 Other Relevant Factors

35 I.A.C. § 845.670(f)(6): Other relevant factors.

No additional factors were identified for consideration.

3.4 Necessity of Interim Measures

Source control using the consolidate-and-cap approach has been completed [1, 2] and shown to be effective at remediating groundwater. Completion of DCW portion of CCS is projected to be complete within five to seven years after approval of the CAP. Source control followed by GWP alone was predicted by the groundwater supporting the closure plan would result in the decrease in CCR constituent concentrations in groundwater, and a contraction of the groundwater contaminant plume [6]. The prediction of the groundwater model is further supported by decreases in boron concentrations at a number of wells within the monitoring network upon closure. Therefore, no interim measure is required. Further, all subsections of this requirement are discussed as follows.

35 I.A.C. § 845.680(a)(3)(A): Time required to develop and implement a final remedy.

The final cover portion of the CCS remedy (source control) was implemented at the site in 2020 utilizing a consolidation and cap final closure approach [1, 2]. As presented in the Groundwater Modeling Technical Memorandum, source control alone is predicted to achieve the GWPS in approximately 30 years. The DCW portion of the CCS remedy is supplemental to the current source control. Implementation of the DCW portion of the CCS is anticipated to take up to seven years following approval of the CAP. Therefore, no interim measures are required as the primary corrective action has already been implemented.

35 I.A.C. § 845.680(a)(3)(B): Actual or potential exposure of nearby populations or environmental receptors to any of the constituents listed in 35 I.A.C. § 845.600.

There are no current unacceptable risks to human or ecological receptors at the site (**Appendix A**). It was concluded the UA was not a source of drinking water [11].

35 I.A.C. § 845.680(a)(3)(C): Actual or potential contamination of sensitive ecosystems or current or potential drinking water supplies.

The nature and extent of exceedances have been evaluated in the Nature and Extent Report [16]. Although there are exceedances of GWPS, there are no impacts to current or potential drinking water supplies. As stated above, there are no current unacceptable risks to human or ecological receptors at the site.

[3] All elevations in this report are in the North American Vertical Datum of 1988 (NAVD88), unless otherwise noted.

35 I.A.C. § 845.680(a)(3)(D): Further degradation of the groundwater that may occur if remedial action is not initiated expeditiously.

The final cover portion of the CCS remedy (source control) was implemented at the site in 2020 utilizing a consolidation and cap final closure approach [1, 2], and corresponding decreases in boron concentrations have already been observed. No additional interim measures are needed to prevent further degradation of the groundwater more expeditiously than implementation of the selected remedy.

35 I.A.C. § 845.680(a)(3)(E): Weather conditions that may cause any of the constituents listed in 35 I.A.C. § 845.600 to migrate or be released.

As stated above, the final cover portion of the CCS was implemented in 2020 and provides surface containment that isolates CCR within the WAPS from typical site weather conditions.

35 I.A.C. § 845.680(a)(3)(F): Potential for exposure to any of the constituents listed in 35 I.A.C. § 845.600 as a result of accident or failure of a container or handling system.

The WAPS is closed-in-place within a consolidated footprint, therefore no container or handling systems are currently in use, nor will they be in use in the future.

35 I.A.C. § 845.680(a)(3)(G): *Other situations that may pose threats to human health and the environment.*

No situations have been identified where WAPS CCR leachate poses threats to human health and environment.

4. REFERENCES

[1] Dynegy Midwest Generation, LLC, "Hennepin Power Station; Old West Ash Pond, Ash Pond No. 2, Notification of Completion of Closure," Luminant, December 17, 2020.

[2] Dynegy Midwest Generation, LLC, "Hennepin Power Station; Old West Polishing Pond, Notification of Completion of Closure," Luminant, December 17, 2020.

[3] Illinois Administrative Code, "Title 35, Subtitle G, Chapter I, Subchapter J, Part 845: Standards for The Disposal Of Coal Combustion Residuals In Surface Impoundments," effective April 21, 2021.

[4] Code of Federal Regulations, "Title 40, Chapter I, Subchapter I, Part 257, Subpart D, Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," April 17, 2015.

[5] Burns & McDonnell, "Initial Operating Permit, Hennepin West Ash Pond System," October 25, 2021.

[6] Geosyntec Consultants, "Closure and Post-Closure Care Plan Old West Ash Pond Old West Polishing Pond at Hennepin Power Station," 2017.

[7] Illinois Environmental Protection Agency, "Letter from William Buscher to Phil Morris," June 19, 2018.

[8] Illinois Environmental Protection Agency, "Correspondence with Luminant (formerly Dynegy Midwest Generation, LLC) regarding the Closure and Post-Closure Care Plan for Hennepin Old West Ash Pond System," July 19, 2018.

[9] Natural Resource Technology, "Groundwater Model Report - Hennepin West Ash Pond System," 2017.

[10] Geosyntec Consultants, Inc, "Groundwater Polishing Evaluation Report, Hennepin Power Plant, West Ash Pond System," 2025.

[11] Natural Resource Technology, Inc., "Hydrogeologic Site Characterization Report, Hennepin West Ash Pond System, Hennepin, Illinois," December 20, 2017.

[12] United States Environmental Protection Agency (USEPA), "Groundwater Remedy Completion Strategy: Moving Forward with the End in Mind," Office of Solid Waste and Emergency Response, 2014.

[13] Ramboll, "Corrective Measures Assessment, Hennepin Power Plant, West Ash Pond," 2024.

[14] Geosyntec Consultant, "CCR Surface Impoundment Final Closure Plan, Hennepin Power Plant, East Ash Pond," 2022.

[15] United States Environmental Protection Agency (USEPA), "Community Guide to Vertical Engineered Barriers. https://semspub.epa.gov/work/HQ/401627.pdf," 2021.

[16] Ramboll Americas Engineering Solutions, "Nature and Extent Report, Hennepin Power Plant, West Ash Pond System," 2024, May 8.

[17] Ramboll Americas Engineering Solutions, Inc., "Hydrogeologic Site Characterization Report, East Ash Pond, Hennepin Power Plant, Hennepin, Illinois," October 25, 2021.

TABLES

Table 1. Summary of 2024 Bedrock Hydraulic Conductivity Testing

Bedrock Elevation Summary						Bedrock Packer Test Investigation		
Boring		Weathered Bedrock		Competent Bedrock		Packer Test Elevation Intervals		Hydraulic Conductivity
Number	Surface El. (ft)	Depth (ft-bgs)	Top El. (ft)	Depth (ft-bgs)	Top El. (ft)	Depth (ft-bgs)	El. (ft)	K_H (cm/s)
B-100	449.7	70.0	379.7	85.4	364.3	86.0 – 90.8	363.7 – 358.9	2.4×10^{-6}
						90.0 – 94.8	359.7 – 354.9	2.4×10^{-6}
						95.0 – 99.8	354.7 – 349.9	2.3×10^{-6}
B-101	459.3	85.0	374.3	95.0	364.3	95.0 – 98.3	364.3 – 361.0	2.3×10^{-6}
						98.0 – 101.3	361.3 – 358.0	2.2×10^{-6}
						100.0 – 103.3	359.3 – 356.0	2.2×10^{-6}
B-102	455.0	70.0	385.0	90.0	365.0	92.0 – 96.8	363.0 - 358.2	1.1×10^{-5}
						96.0 – 100.8	359.0 - 354.2	1.1×10^{-5}
						100.0 – 104.8	355.0 - 350.2	3.2×10^{-6}
Summary		Mean	379.7	Mean	364.5	Summary	Geomean	3.4×10^{-6}
		Min.	374.3	Min.	364.3		Min.	2.2×10^{-6}
		Max.	385.0	Max.	365.0		Max.	1.1×10^{-5}

Notes
El.: Elevation
ft: feet
Bgs: below ground surface
Surface El.: Reported in North American Vertical Datum of 1988 (NAVD88)
Geomean: Geometric mean
Min.: Minimum
Max.: Maximum
Detailed information on the hydraulic conductivity testing will be provided in an attachment to the Nature and Extent Report Addendum.

Table 2. Proposed Milestone Schedule for Implementing Corrective Action Remedy (Source Control with Continuous Containment System)

Implementation Phase	Implementation Task	Timeframe (Preliminary Estimates)
1: Pre-Construction Activities	Agency Coordination, Approvals, and Permitting	18 to 24 months
	Final Design and Bid Process	24 to 36 months
	Timeframe to Complete Corrective Pre-Construction Activities	42 to 60 months after CAP Approval
2: Corrective Action Construction	Corrective Action Construction	18 to 24 months
	Timeframe to Complete Corrective Action Construction	18 to 24 months
3: Corrective Action Monitoring and Closeout	Corrective Action Monitoring (Time to Meet GWPS)	396 months (33 years)
	Corrective Action Groundwater Confirmation Monitoring	36 months
	Corrective Action Completion	6 months
	Timeframe to Complete Corrective Action O&M and Closeout	438 months
Total Timeline to Complete Corrective Action (after approval of CAP)		498 to 522 months (42 to 44 years)

[1]All timeframes are preliminary and may change as the project develops. Timeframes may also be affected by regulatory review and/or permit approval processes, for both 35 I.A.C. § 845 and non-35 I.A.C. § 845 permits.

APPENDIX A
CORRECTIVE ACTION ALTERNATIVES ANALYSIS (845.670(e)), INCLUDING CORRECTIVE MEASURES ASSESSMENT (845.660)

Corrective Action Alternatives Analysis for the West Ash Pond System at the Hennepin Power Station, Hennepin, Illinois

May 6, 2025

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Abbreviations

BCU	Bedrock Confining Unit
BMP	Best Management Practice
CAAA	Corrective Action Alternatives Analysis
CCR	Coal Combustion Residual
CCS	Continuous Containment System
CIP	Closure-in-Place
cm/s	Centimeters per Second
CMA	Corrective Measures Assessment
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DMG	Dynegy Midwest Generation, LLC
HPP	Hennepin Power Plant
GHG	Greenhouse Gas
GMP	Groundwater Monitoring Plan
GWP	Groundwater Polishing
GWPS	Groundwater Protection Standard
IAC	Illinois Administrative Code
ID	Identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ISS	*In-Situ* Stabilization
LLDPE	Linear Low-Density Polyethylene
MW	Megawatt
N_2O	Nitrous Oxide
NID	National Inventory of Dams
NO_x	Nitrogen Oxide
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OWAP	Old West Ash Pond
OWPP	Old West Polishing Pond
PCB	Polychlorinated Biphenyl
PM	Particulate Matter
QA	Quality Assurance
QC	Quality Control
Source Control-CCS	Source Control with a Continuous Containment System
Source Control-GWP	Source-Control with Groundwater Polishing
Source Control-ISS	Source-Control with *In-Situ* Stabilization
TDS	Total Dissolved Solids
UA	Uppermost Aquifer
US DOT	United States Department of Transportation
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WAPS	Western Ash Pond System

Summary of Findings

Title 35, Part 845 of the Illinois Administrative Code (IAC) (IEPA, 2021) requires that a Corrective Action Alternatives Analysis (CAAA) be performed as part of the remedy selection, prior to undertaking any corrective actions at certain coal combustion residual (CCR)-containing impoundments, where exceedances of groundwater protection standards (GWPSs) have been identified. This report presents a CAAA for the West Ash Pond System (WAPS) at the Hennepin Power Plant (HPP) pursuant to the requirements under IAC Section 845.670. The goal of performing a CAAA is to holistically evaluate the potentially viable corrective actions identified in the Corrective Measures Assessment (CMA) (Appendix C; Ramboll, 2024a) in order to remediate groundwater and achieve compliance with the groundwater protection standards (GWPSs) specified under IAC Section 845.600 (IEPA, 2021). These analyses assess potentially viable corrective action alternatives based on a wide range of factors, including the efficiency, reliability, and ease of implementation of a corrective action; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by the community (IEPA, 2021).

It is important to note that many CCR sites are complex groundwater environments where remedial actions will inherently take many years to complete. While no formal definition of a complex groundwater environment exists, most would agree that there are a number of common characteristics at complex groundwater sites, including the following (National Research Council, 2013):

- Highly heterogeneous subsurface environments;
- Large source zones;
- Multiple, recalcitrant constituents; and
- Long timeframes over which releases occurred.

Each of these characteristics are common at CCR sites. Surface impoundments are often tens to hundreds of acres in size and many have operated for decades, leading to large source zones and prolonged releases. Furthermore, CCR impoundments are often located in alluvial geologic settings where sands are interbedded with silts and clays. This results in a heterogeneous environment where constituent mass may persist for many years in low-permeability deposits. Finally, the constituents that are most common at CCR sites include metals and inorganics that do not naturally biodegrade. The combination of these factors results in a complex groundwater environment where remediation, even under the best of circumstances, may take many years to achieve GWPSs. It is for these reasons that the United States Environmental Protection Agency (US EPA) refused to specify what is a reasonable *vs.* an unreasonable timeframe for groundwater corrective actions at CCR sites, stating that it "was truly unable to establish an outer limit on the necessary timeframes – including even a presumptive outer bound" (US EPA, 2015a).

In this CAAA, all corrective actions that have been evaluated consist of source control and residual plume management. Source control is generally considered to be one of the more effective remedial action approaches. Source control involves removing the hydraulic head from an impoundment (*i.e.*, unwatering and dewatering) and preventing further downward migration of constituents. US EPA has found that "releases from surface impoundments [to groundwater] drop dramatically after closure" (US EPA, 2014, pp. 5-18 to 5-19). US EPA has also stated that source control is the most effective means of ensuring the

timely attainment of remediation objectives (US EPA, 2015b). As a result, the implementation of source control often has a substantial and immediate effect on groundwater quality improvements.

The specific source control method that is the central component of all the corrective action alternatives evaluated in this CAAA is closure-in-place (CIP) using a consolidate-and-cap approach for the WAPS, which was approved of by IEPA in 2018 and completed in 2020 (Buscher, 2018; Tickner, 2020a,b). The WAPS consists of two sub-units, specifically, the Old West Ash Pond (OWAP) and the Old West Polishing Pond (OWPP). The source control included dewatering of coal combustion residuals (CCRs), excavation and consolidation of material from the OWPP into the OWAP, followed by the installation of an impermeable cap on the OWAP. Closure activities specifically included removal of impounded water and excavation of CCR and one foot of soil below the CCR from the OWPP, construction of a sheet pile wall and compacted clay buttress to separate the OWAP from the OWPP, and installation of a final cover system over the OWAP consisting of a geosynthetic layer, a protective soil layer to limit infiltration of precipitation into the impoundment, and establishment of a vegetative cover. These activities were designed to control, minimize or eliminate, post closure infiltration of liquids into the impounded CCR. As demonstrated by groundwater modeling in support of the Closure and Post-Closure Care Plan and this CAAA (Geosyntec Consultants, Inc., 2017; Appendix B; Ramboll, 2025a), the hydraulic pressure beneath the final cover system would drop to "near-zero levels" within 7 years after closure and cause constituent concentrations in groundwater to decrease and the groundwater plume to contract (Geosyntec Consultants, Inc., 2017). Due to the reduction in the hydraulic flux out of the WAPS, the mass flux out of the WAPS would also be controlled and minimized.

Two potential corrective actions are evaluated in this CAAA: Source Control with Groundwater Polishing (Source Control-GWP) and Source Control with a Continuous Containment System (Source Control-CCS). Both alternatives consist of source control and residual plume management; residual plume management for the two remedial approaches are groundwater polishing and a continuous containment system. Both alternatives were identified as viable approaches in the CMA (Appendix C; Ramboll, 2024a). It should be noted that Source Control-GWP, Source Control with a Cutoff Wall, and Source Control-ISS (Source Control with *In-Situ* Stabilization [ISS]) were identified in the CMA as viable remedial approaches (Appendix C; Ramboll, 2024a). However, during subsequent evaluations, the remedial approaches were modified. Remedy modifications include the following:

- Source Control-ISS was determined infeasible and excluded for further evaluation due to significant potential risks, including the need to temporarily remove half of the previously installed WAPS final cover. Removal of the final cover system would result in significant stormwater infiltration and potentially lead to reducing the effectiveness of the completed source control. In addition, ISS would involve managing tens of thousands of cubic yards of CCR and CCR-impacted cuttings on the WAPS surface, increasing the risk of releasing CCR-contaminated stormwater and sediments during construction, which could negatively impact nearby sensitive areas.
- Source Control-Cutoff Wall was expanded into the Source Control-CCS alternative, which is evaluated in this report. The continuous containment system (CCS) integrates the cutoff wall with the existing final cover to provide full lateral and surface isolation of CCR from the surrounding environment. The wall would be keyed into competent shale bedrock to provide additional base subsurface containment below the WAPS.

Under the Source Control-GWP alternative, active groundwater monitoring would supplement source control to verify and document the attenuation by natural physical and geochemical mechanisms of constituent concentrations in groundwater. Site-specific evaluations demonstrated that groundwater polishing is appropriate at the WAPS because Site conditions are favorable for natural attenuation of

inorganic contaminants *via* adsorption and precipitation. However, it should be noted that some arsenic[1] re-mobilization may occur as groundwater returns to background conditions (Appendix E; Geosyntec Consultants, Inc., 2025). Under the Source Control-CCS alternative, the final cover system would be temporarily removed in the areas where the cutoff wall would be installed. An approximately 90 ft deep cutoff wall consisting of low-permeability material (either a mixture of soil and bentonite or cement and bentonite) would be constructed, extending from the top of the WAPS perimeter dikes completely through the Uppermost Aquifer (UA) and penetrate into the underlying competent shale bedrock. The final cover system would be extended across the top of the cutoff wall after installation. The final cover, the cutoff wall, and the competent shale bedrock would enclose the OWAP, which is the portion of the WAPS that was closed by CIP, resulting in CCR being contained within a continuous containment system, and would isolate CCR from the surrounding environment on all sides (Appendix B; Ramboll, 2025a).

Table S.1 evaluates the two potentially viable corrective actions evaluated in this CAAA (Source Control-GWP and Source Control-CCS) with regard to each of the factors specified under IAC Section 845.670(d) and IAC Section 845.670(e) (IEPA, 2021). Based on this evaluation and the details provided in Section 2 of this report, the most appropriate corrective action for this Site is Source Control-CCS. Although the expected impacts on workers, nearby communities, and the environment under the Source Control-GWP alternative are lower than the Source Control-CCS alternative, the Source Control-CCS alternative would provide full containment of the CCR within WAPS and be more effective at controlling sources of releases than Source Control-GWP. Controlling the source of releases using CCS is particularly important at this Site because of the high groundwater transmissivity associated with the sands and gravels in the UA. Thus, Source Control-CCS is the most appropriate corrective action alternative for the WAPS.

[1] It should be noted that not all arsenic in groundwater is associated with the WAPS. Some of the arsenic is likely naturally occurring and/or associated with other sources.

Table S.1 Comparison of Proposed Corrective Action Alternatives with Respect to Factors Specified in IAC Section 845.670(d) and IAC Section 845.670(e)

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
Magnitude of Reduction of Existing Risks/Be Protective of Human Health and the Environment (Section 2.2.1; IAC Section 845.670(e)(1)(A)/ IAC Section 845.670(d)(1))	Because current conditions do not present a risk to human health or the environment at the WAPS, there will be no unacceptable risk to human health or the environment for future conditions since the unit was closed and source control was implemented. Concentrations of CCR-related constituents will decline over time and, consequently, potential exposures to CCR-related constituents in the environment will also decline. The magnitude of the reduction of existing risks is the same for all of the potential corrective action alternatives, and both corrective action alternatives are equally protective of human health and the environment.	Because current conditions do not present a risk to human health or the environment at the WAPS, there will be no unacceptable risk to human health or the environment for future conditions since the unit was closed and source control was implemented. Concentrations of CCR-related constituents will decline over time and, consequently, potential exposures to CCR-related constituents in the environment will also decline. The magnitude of the reduction of existing risks is the same for all of the potential corrective action alternatives, and both corrective action alternatives are equally protective of human health and the environment.
Effectiveness of the Remedy in Controlling the Source (Section 2.2.2; IAC Section 845.670(e)(2))		
Extent to Which Containment Practices Will Reduce Further Releases/Control the Sources of Releases to Reduce or Eliminate, to the Maximum Extent Feasible (IAC Section 845.670(e)(2)(A)/ IAC Section 845.670(d)(3))	Both alternatives include source control (which is the primary remedial measure) and residual plume management. Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Modeling results in support of the Closure Plan indicated that source control would result in a significant reduction in groundwater concentrations and, overtime, reduce the extent of groundwater impacts to within the footprint of the impoundment (Geosyntec Consultants, Inc., 2017). Under residual plume management for this alternative, physical and geochemical attenuation mechanisms would mitigate impacts to downgradient groundwater quality and control the residual plume. However, it should be noted that some arsenic re-mobilization may occur as groundwater returns to background conditions, which may cause an impact to the time	Both alternatives include source control (which is the primary remedial measure) and residual plume management. Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Modeling results in support of the Closure Plan indicated that source control would result in a significant reduction in groundwater concentrations and, overtime, reduce the extent of groundwater impacts to within the footprint of the impoundment (Geosyntec Consultants, Inc., 2017). Under residual plume management for this alternative, a cutoff wall would be constructed and incorporated into the existing final WAPS cover system. This would create a continuous low-permeability barrier that fully contains the CCR within the WAPS. This system ensures isolation from the surrounding environment through lateral containment by the deep cutoff wall,

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
	required to achieve GWPS (Appendix E; Geosyntec Consultants, Inc., 2025). If necessary, remedy optimizations would be implemented under the adaptive site management program.	surface containment by the existing geomembrane cover, and a natural barrier provided by the competent shale bedrock below. Thus, this subsurface barrier will isolate the CCR from the surrounding environment and will control the sources of releases to the environment. If necessary, remedy optimizations would be implemented under the adaptive site management program. Source Control-CCS would be more effective at controlling releases than Source Control-GWP. CCS would isolate CCR from the surrounding environment on all sides and in particular would prevent releases of CCR-related constituents associated with the high groundwater transmissivity of the sand and gravel deposits in the UA.
Extent to Which Treatment Technologies May Be Used (IAC Section 845.670(e)(2)(B))	Source Control-GWP would rely on physical and geochemical attenuation processes. If necessary, remedy optimizations would be implemented under the adaptive site management program.	The Source Control-CCS alternative would utilize an engineered physical barrier to contain the CCR within WAPS. Contact stormwater may be generated during the construction phase, which would be pumped to the on-Site treatment pond before discharging *via* an NPDES permitted outfall. No additional treatment technologies would be required once the cutoff wall has been constructed. If necessary, remedy optimizations would be implemented under the adaptive site management program.
Likelihood of Future Releases of CCR (Section 2.2.3; IAC Section 845.670(e)(1)(B))	Both corrective action alternatives include source control using CIP with a consolidate-and-cap approach; the CIP source control was completed in in 2020 in compliance with 40 CFR Part 257, Subpart D. This included a geosynthetic layer, a protective soil layer to limit infiltration, and a vegetative cover. This cover system provides increased protection against berm and surface erosion, precipitation infiltration, and other adverse effects that could potentially trigger a release of CCR. Thus, there is minimal risk of	Both corrective action alternatives include source control using CIP with a consolidate-and-cap approach; the CIP source control was completed in in 2020 in compliance with 40 CFR Part 257, Subpart D. This included a geosynthetic layer, a protective soil layer to limit infiltration, and a vegetative cover. This cover system provides increased protection against berm and surface erosion, precipitation infiltration, and other adverse effects that could potentially trigger a release of CCR. Any CCR-contact stormwater

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
	accidental CCR releases occurring post-closure under either of the alternatives.	generated during the construction phase would be managed through a contact stormwater management system. Thus, there would be minimal risk of accidental CCR releases occurring post-closure under either of the alternatives.
Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (Section 2.2.4; IAC Section 845.670(e)(1)(C))	Minimal long-term O&M efforts would be required under Source Control-GWP because it would not require the installation, operation, or maintenance of any engineered systems or structures other than maintenance of the monitoring wells. Corrective action groundwater monitoring would continue until GWPSs have been achieved. Post-closure care groundwater monitoring would continue for a minimum of 30 years as required by IAC Section 845.780(c). Additionally, corrective action groundwater monitoring would continue for 3 years after GWPS have been achieved. Based on the adaptive site management approach, remedy optimizations might be implemented to ensure achievement of the GWPSs.	Residual plume management for the Source Control-CCS alternative would require construction of a deep cutoff wall that would occur in three phases. Once the cutoff wall has been installed, no O&M efforts would be required, because it is a passive and below-grade structure. However, post-construction quality assurance (QA) programs may be required to validate the quality of the constructed cutoff wall. Corrective action groundwater sampling would continue until GWPSs have been achieved. Post-closure care groundwater monitoring will continue for a minimum of 30 years as required by IAC Section. 845.780(c). Additionally, corrective action groundwater monitoring would continue for 3 years after GWPS have been achieved. Based on the adaptive site management approach, remedy optimizations may be implemented to ensure achievement of the GWPSs.
Short-Term Risks to the Community or the Environment During Implementation of Remedy (Section 2.2.5; IAC Section 845.670(e)(1)(D))		
Safety Impacts	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there is no further risk of accidents and injuries occurring during the implementation of the source control remedy. Overall, no worker accidents or injuries would be expected under the Source Control-GWP alternative because no installation, operation, and	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there is no further risk of accidents and injuries occurring during the implementation of the source control remedy. Overall, considering worker accidents occurring during residual plume management both on- and off-Site, 0.65 worker injuries and 0.013 worker

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
	maintenance of engineered systems or structures would be required. Similarly, no off-Site impacts on nearby residents would be expected under the Source Control-GWP alternative.	fatalities would be expected under the Source Control-Cutoff Wall alternative. In total, an estimated 0.21 injuries and 2.5×10^{-3} fatalities would be expected to occur among community members due to off-Site activities under the Source Control-CCS alternative.
Cross-Media Impacts to Air	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. No further air impacts associated with the implementation of the source control remedy are expected. Cross-media impacts to air associated with residual plume management can result from the emission of air pollutants and greenhouse gases (GHGs) from construction vehicles and equipment. These emissions are proportional to the use of construction vehicles and equipment that are required for residual plume management. Residual plume management for the Source Control-GWP alternative would be expected to have minimal air impacts, because it would not require the construction of any engineered systems or structures.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. No further air impacts associated with the implementation of the source control remedy are expected. Cross-media impacts to air associated with residual plume management can result from the emission of air pollutants and GHGs from construction vehicles and equipment. These emissions are proportional to the use of construction vehicles and equipment that are required for residual plume management. Residual plume management for the Source Control-CCS alternative would have greater air impacts than the Source Control-GWP alternative due to the increased construction activity required for this alternative.
Cross-Media Impacts to Surface Water and Sediments	Source control was implemented in 2020 for both corrective action alternatives, and constituent mass flux from groundwater into surface water will decline over time (Geosyntec Consultants, Inc., 2017). The source control approach minimizes the amount of water retained within the impoundment, which reduces the hydraulic flux through the CCR. Due to the reduction in the hydraulic flux out of the WAPS, the mass flux out of the WAPS will also be controlled or minimized. As demonstrated by the groundwater modeling in support of the Closure Plan, source control would result in a significant reduction in groundwater concentrations and, overtime, reduce the extent of groundwater impacts to within the	Source control was implemented in 2020 for both corrective action alternatives, and constituent mass flux from groundwater into surface water will decline over time (Geosyntec Consultants, Inc., 2017). The source control approach minimizes the amount of water retained within the impoundment, which reduces the hydraulic flux through the CCR. Due to the reduction in the hydraulic flux out of the WAPS, the mass flux out of the WAPS will also be controlled or minimized. As demonstrated by the groundwater modeling in support of the Closure Plan, source control would result in a significant reduction in groundwater concentrations and, overtime, reduce the extent of groundwater impacts to within the

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
	footprint of the impoundment (Geosyntec Consultants, Inc., 2017). Under residual plume management for the Source Control-GWP alternative, minimal surface water and sediment impacts would be expected, because it would not require the construction of any engineered systems or structures.	footprint of the impoundment (Geosyntec Consultants, Inc., 2017). Under residual plume management for the Source Control-CCS alternative, surface water and sediment impacts would be higher than the Source Control-GWP alternative due to the construction of the cutoff wall. Any associated impacts would be addressed through best management practices (BMPs) in accordance with Site land disturbance permits.
Control of Exposure to Any Residual Contamination During Implementation of the Remedy	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there are no further risks of CCR exposure associated with source control implementation. Risks to workers arising from potential contact with residual contamination during construction activities associated with residual plume management would be minimal under the Source Control-GWP alternative, which would not involve exposure to soil or groundwater waste streams.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there are no further risks of CCR exposure associated with source control implementation. Risks to workers arising from potential contact with residual contamination during construction activities associated with residual plume management would be higher for the Source Control-CCS alternative than for the Source Control-GWP alternative because the Source Control-CCS alternative would involve removal of a portion of the previously installed final cover system and excavation and subsequent disposal of Site spoils. Any potential CCR-exposures during the Source Control-CCS alternative would be managed through the use of rigorous safety protocols and personal protective equipment.
Other Identified Impacts	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there are no further impacts associated with the implementation of source control. The energy demands of construction equipment and vehicles associated with residual plume management would be lower under the Source Control-GWP alternative, because this alternative	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there are no further impacts associated with the implementation of source control. The energy demands of construction equipment and vehicles associated with residual plume management would be greater under the Source Control-CCS compared to the Source Control-GWP alternative, because the Source Control-

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
	would not require any significant construction activity. Similarly, traffic and noise impacts associated with residual plume management are expected to be minimal because no installation, operation, and maintenance of engineered systems or structures would be required. There would be no impacts to natural resources and habitat under the Source Control-GWP alternative because no additional construction activities would be required.	CCS alternative would involve the construction of the barrier wall. Similarly, traffic and noise impacts associated with residual plume management are expected to be higher under the Source Control-CCS alternative than the Source Control-GWP alternative due to the construction activities that would be required to construct the cutoff wall. Under the Source Control-CCS alternative, some negative impacts on scenic and recreational value may occur along the Illinois River and within the Donnelley/DePue State Fish and Wildlife Areas complex, which borders the Site to the north and west. Given the proximity between these areas and the expected construction, it is likely that these areas would experience some adverse impacts such as visual disturbance, obstruction of view, and noise during the construction period. However, these impacts are expected to diminish once the construction is completed in 18 to 24 months. In addition, the construction of the cutoff wall under the Source Control-CCS alternative is expected to use a significant amount of cement or bentonite, which would be introduced into the UA and BCU. Adding substantial quantities of these materials into the subsurface environment may cause alteration in groundwater pH levels and affect geochemical conditions in the UA.
Time Until Groundwater Protection Standards Are Achieved/Attain the Groundwater Protection Standards Specified in Section 845.600 (Section 2.2.6; IAC Section 845.670(e)(1)(E); IAC Section 845.670(d)(2))	Groundwater modeling was performed in support of the Closure Plan (Geosyntec Consultants, Inc., 2017). The modeling predicted that source control would result in the reduction of leachate production, which facilitates the contraction of the contaminant plume in groundwater (Geosyntec Consultants, Inc., 2017).	Groundwater modeling was performed in support of the Closure Plan (Geosyntec Consultants, Inc., 2017). The modeling predicted that source control would result in the reduction of leachate production, which facilitates the contraction of the contaminant plume in groundwater (Geosyntec Consultants, Inc., 2017).

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
	Additional modeling was conducted for each of the corrective action alternatives to evaluate future groundwater quality in the vicinity of the WAPS as a result of residual plume management (Appendix B; Ramboll, 2025b). The results of the modeling indicate that groundwater would attain the GWPSs for all of the constituents identified as having potential groundwater exceedances in the monitoring network within 29 years after approval of the Corrective Action Plan when the Source Control-GWP alternative is presumed to be initiated (Appendix B; Ramboll, 2025a).	Additional modeling was conducted for each of the corrective action alternatives to evaluate future groundwater quality in the vicinity of the WAPS as a result of residual plume management (Appendix B; Ramboll, 2025b). The results of the modeling indicate that groundwater would attain the GWPSs for all of the constituents identified as having potential groundwater exceedances in the monitoring network within 38 to 40 years (5 to 7 years of pre-construction and construction activities and 33 years after installation) after approval of the Corrective Action Plan when the Source Control-CCS alternative is presumed to be initiated (Appendix B; Ramboll, 2025a).
Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (Section 2.2.7; IAC Section 845.670(e)(1)(F))	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Therefore, both corrective action alternatives are equally and fully protective with regard to exposure to residual CCR. As a result of the source control, there would be no risk of CCR releases post-closure. The Source Control-GWP alternative would not involve exposure to the soil or groundwater waste streams and thus, there is no potential for exposure of humans and environmental receptors to wastes.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Therefore, both corrective action alternatives are equally and fully protective with regard to exposure to residual CCR. As a result of the source control, there would be no risk of CCR releases post-closure. For construction workers, risks arising from potential contact with residual contamination during construction, operation, and maintenance activities associated with residual plume management would be higher for the Source Control-CCS than for the Source Control-GWP alternative, because the Source Control-CCS alternative would involve the excavation and subsequent management of Site soils. In addition, Source Control-CCS would involve temporarily removing a portion of the final cover previously installed, which could potentially allow stormwater to be in contact with CCR material during construction. CCR-contact stormwater would be generated and managed through a CCR-contact stormwater management system during the times when the final cover would be removed.

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
		Any potential CCR exposures occurring under Source Control-CCS during the installation of the cutoff wall would be managed through the use of rigorous safety protocols, personal protective equipment, and appropriate disposal practices. Hydrogeological changes would be expected under the Source Control-CCS alternative, such as altering flow patterns in the UA, redirecting groundwater flow around the cutoff wall, and causing changes to normal hydraulic gradients. However, changes to groundwater flow would not be expected to have an effect on the potential for the exposure of humans and environmental receptors to any wastes.
Long-Term Reliability of the Engineering and Institutional Controls (Section 2.2.8; IAC Section 845.670(e)(1)(G))	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, long-term reliability of source control would be same for both corrective action alternatives. Residual plume management under the Source Control-GWP alternative would be reliable because it would rely on physical and geochemical attenuation processes and active monitoring. If necessary, remedy optimizations would be implemented under the adaptive site management program.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, long-term reliability of source control would be same for both corrective action alternatives. Cutoff walls are a proven remedy and have been implemented at many sites. Thus, residual plume management under the Source Control-CCS alternative would be reliable, provided it is constructed in accordance with standard design specifications. The remedy consists of a passive, below-grade structure, which would not require any O&M activities once it is installed. The construction of the cutoff wall would require temporarily removing a portion of the previously installed WAPS final cover. This procedure may allow additional stormwater to infiltrate the CCR, potentially leading to a temporary reversal of some positive effects that have occurred since the completion of the final cover system in 2020. A CCR-contact stormwater management

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
		system would be required to manage and discharge the contact stormwater *via* an NPDES permitted outfall. Quality control (QC) and quality assurance (QA) programs will be required during and after the construction to ensure the effectiveness of the cutoff wall. If necessary, remedy optimizations would be implemented under the adaptive site management program.
Potential Need for Replacement of the Remedy (Section 2.2.9; IAC Section 845.670(e)(1)(H))	Replacement of the residual plume management remedy under the Source Control-GWP alternative would likely be unnecessary, because it would not require the installation, operation, and maintenance of engineered systems or structures. Adaptive site management strategies would be used to implement remedy optimizations, if necessary, to ensure that remedial goals are achieved.	Replacement of the residual plume management remedy under the Source Control-CCS alternative would likely be unnecessary, because the cutoff wall is a robust, engineered, and maintenance-free subsurface structure. The final cover system portion of this alternative would need ongoing maintenance per the IEPA approved Post-Closure Care Plan, but it is a passive and engineered structure that is unlikely to need replacement. Adaptive site management strategies would be used to implement remedy optimizations, if necessary, to ensure that remedial goals are achieved.
Degree of Difficulty Associated with Constructing the Remedy (Section 2.3.1; IAC Section 845.670 (e)(3)(A))	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there would be no further construction difficulties associated with the implementation of source control. Residual plume management under the Source Control-GWP alternative would rely on physical and geochemical attenuation processes and therefore would not pose any significant construction challenges.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there would be no further construction difficulties associated with the implementation of Source Control. Residual plume management under the Source Control-CCS alternative would rely on a continuous containment system to enclose the CCR within the WAPS, and physical and geochemical attenuation processes to address downgradient groundwater quality impacts. Some challenges may be encountered during the construction of the cutoff wall, including the following: 1. Specialized equipment, including large cranes, clamshells, slurry cutters, batch plants, and grading

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
		equipment may be needed to construct the cutoff wall. 2. Construction challenges, such as encountering highly permeable layers leading to slurry loss, facing obstructions that necessitate specialized techniques and/or equipment for progression, or experiencing sidewall instability, may arise. These challenges could be managed during cutoff wall construction. 3. Additional engineering assessments and monitoring programs would be necessary to monitor the embankment for indications of distress, such as deformation or cracking, throughout the cutoff wall construction process, because the cutoff wall would be installed through an existing impoundment embankment. 4. The construction of the cutoff wall would require temporarily removing a portion of the previously installed WAPS final cover in areas where conflict with the cutoff wall. This procedure may allow additional stormwater to infiltrate the CCR, potentially leading to a temporary reversal of some positive effects that have occurred since the completion of the final cover system in 2020. A CCR-contact stormwater management system would be required to manage and discharge the contact stormwater *via* an NPDES permitted outfall. 5. Ongoing QC is essential during construction, as part of QA activities, to prevent defective features. Additionally, post-construction QA programs, such as coring and testing, may be necessary to validate the quality of the constructed barrier.

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
		6. Ongoing monitoring and QA/QC testing for slurry mixing, placement, or soil-bentonite mixing are critical to ensure the performance of the cutoff wall.
Expected Operational Reliability of the Remedy (Section 2.3.2; IAC Section 845.670 (e)(3)(B))	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. The operational reliability of the source control would be the same for both corrective action alternatives. Residual plume management under the Source Control-GWP alternative would have high operational reliability because this alternative would rely on natural processes and active monitoring. However, it should be noted that some arsenic re-mobilization may occur as groundwater returns to background conditions, which may cause an impact to the time to achieve GWPS (Appendix E; Geosyntec Consultants, Inc., 2025). Adaptive site management strategies would be used to implement remedy optimizations, if necessary.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. The operational reliability of the source control would be the same for both corrective action alternatives. Residual plume management under the Source Control-CCS alternative would have high operational reliability because it is an established technology, as long as the cutoff wall is constructed in accordance with standard design specifications. This CCS would provide full isolation of all CCR from the surrounding environment as a result of the cutoff wall extending into bedrock and from the existing cover. However, this alternative would require the temporary removal of a portion of the completed cover over the WAPS, which could potentially cause additional stormwater to percolate into the CCR and result in a temporary reversal of certain positive effects that have occurred since the completion of source control in 2020. These temporary impacts would diminish once the final cover system is repaired. Adaptive site management strategies would be used to implement remedy optimizations, if necessary.
Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies (Section 2.3.3; IAC Section 845.670 (e)(3)(C))	Specific permits and approvals associated with source control were the same for both corrective action alternatives and were discussed in the Closure Plan (Geosyntec Consultants, Inc., 2017). Residual plume management under the Source Control-GWP alternative would	Specific permits and approvals associated with source control were the same for both corrective action alternatives and were discussed in the Closure Plan (Geosyntec Consultants, Inc., 2017). The Source Control-CCS alternative would require approvals and permits,

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
	not need additional permits from other agencies, other than the approval of the Corrective Action Plan.	including construction stormwater controls and BMPs, a joint water pollution control construction and operating permit. An IDNR Dam Safety modification permit would be required for modifications of the WAPS embankment. A modification to the existing NPDES permit would be necessary to discharge the CCR-contact stormwater generated during the construction phase.
Availability of Necessary Equipment and Specialists (Section 2.3.4; IAC Section 845.670 (e)(3)(D))	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there are no further equipment and specialist needs associated with the implementation of the source control remedy. Residual plume management under the Source Control-GWP alternative would require standard environmental monitoring equipment and groundwater professionals. Specialists such as geologists, hydrogeologists, statisticians (*i.e.*, statistical analysis), and geochemists would be available to collect and evaluate the data.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there are no further equipment and specialist needs associated with the implementation of the source control remedy. Residual plume management under the Source Control-CCS alternative would require standard environmental monitoring equipment similar to those under the Source Control-GWP alternative. In addition, building the cutoff wall requires the expertise of a specialized contractor with a background in constructing similar types of walls in comparable geologic environments. Specialized equipment, including large cranes, clamshell buckets, slurry cutters, batch plants, or other equipment would be required to construct the cutoff wall. Specialists, such as design engineers, construction managers, and contractor staff, involved in the design and construction of cutoff walls would be essential during both phases. Monitoring the WAPS embankments during cutoff wall construction would require expertise in geotechnical instrumentation, including the use of inclinometers, survey prisms, vibrating wire piezometers, and visual inspection for signs of distress. Equipment and experts with geosynthetics design and installation, specifically with seaming new geosynthetics to an existing final cover

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
		system, would be required for the final cover system restoration. There may be backlogs associated with the equipment and specialists discussed above, due to the high existing demand for specialty ground improvement contractors and design specialists who are engaged with similar projects in sectors like electric utilities, dams/levees, solid waste management, and other areas.
Available Capacity and Location of Needed Treatment, Storage, and Disposal Services/Comply with Standards for Management of Wastes as Specified in Section 845.680(d) (Section 2.3.5; IAC Section 845.670 (e)(3)(E)/ IAC section 845.670(d)(5))	No treatment, storage, or disposal services would be required for residual plume management under Source Control-GWP alternative, as GWP would not generate any significant volume of waste or wastewater.	Residual plume management for the Source Control-CCS alternative would generate waste during the cutoff wall construction phase; waste would include geosynthetics and other debris from removing the final cover system, cutoff wall spoils, and contact stormwater. 1. Geosynthetics and other debris would be disposed of in an off-Site landfill that has sufficient volume. 2. CCR-containing cutoff wall spoils would be temporarily staged on-Site and then disposed off-Site or beneficially used on-Site as compacted contouring fill. 3. Non CCR-impacted spoils would be disposed of at an appropriate on-Site location. 4. CCR-contact stormwater generated during construction would be pumped to the on-Site treatment pond and then discharged *via* an NPDES permitted outfall. No wastes would be expected to be generated during operation of the cutoff wall; consequently, no additional treatment, storage, or disposal services would be necessary for this remedy.
The Degree to Which Community Concerns Are Addressed by the Remedy (Section 2.4; IAC Section 845.670(e)(4))	Some communities have expressed concerns over groundwater quality at CCR surface impoundments. The combination of source control (*i.e.*, CIP using a consolidate-and-cap approach)	Some communities have expressed concerns over groundwater quality at CCR surface impoundments. The combination of source control (*i.e.*, CIP using a consolidate-and-cap approach)

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
	and residual plume management would cause groundwater concentrations to decline over time under all of the corrective action alternatives, as suggested by the groundwater modeling (Geosyntec Consultants, Inc., 2017; Appendix B Ramboll, 2025b), thus addressing these concerns. A public meeting was held on April 8, 2025, pursuant to requirements under IAC Section 845.710(e). Questions raised by attendees were addressed at the meeting;, a written summary of the questions and responses were prepared.	and residual plume management would cause groundwater concentrations to decline over time under all of the corrective action alternatives, as suggested by the groundwater modeling (Geosyntec Consultants, Inc., 2017; Appendix B; Ramboll, 2025b), thus addressing these concerns. A public meeting was held on April 8, 2025, pursuant to requirements under IAC Section 845.710(e). Questions raised by attendees were addressed at the meeting; a written summary of the questions and responses were prepared.
Remove from the Environment as Much of the Contaminated Material That Was Released from the CCR Surface Impoundment as Is Feasible, Taking into Account Factors Such as Avoiding Inappropriate Disturbance of Sensitive Ecosystems (Section 2.5; IAC Section 845.670(d)(4))	There have been no known releases of CCR at the WAPS. Both potential corrective action alternatives include source control and residual plume management efforts. The source control included the a consolidate-and-cap approach to control, minimize or eliminate, post-closure infiltration of liquids into the impounded CCR. Therefore, this approach is preventing the release of contaminated material from the WAPS to the extent that is feasible. Additionally, residual plume management under the Source Control-GWP alternative would address impacted groundwater by relying on natural physical and geochemical attenuation processes to reduce the residual concentrations of CCR-related constituents in groundwater. Site-specific evaluations have shown that groundwater polishing would reduce the groundwater concentrations and mobility of inorganic contaminants (including boron and sulfate), through physical and geochemical attenuation mechanisms, especially after the implementation of source control (Appendix E; Geosyntec Consultants, Inc., 2025). However, it should be noted some arsenic re-mobilization may	There have been no known releases of CCR at the WAPS. Both potential corrective action alternatives include source control and residual plume management efforts. The source control included the a consolidate-and-cap approach to control, minimize or eliminate, post-closure infiltration of liquids into the impounded CCR. Therefore, this approach is preventing the release of contaminated material from the WAPS to the extent that is feasible. Additionally, residual plume management under the Source Control-CCS alternative would employ a cutoff wall which would be incorporated into the final WAPS cover system to create a continuous low-permeability barrier that fully contains the CCR within the WAPS. This system ensures isolation from the surrounding environment through lateral containment by the deep cutoff wall, surface containment by the existing geomembrane cover, and a natural barrier provided by the competent shale bedrock below. The temporary removal of the final cover system implemented during closure in 2020 would also occur during construction, which would generate

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-CCS
	occur as groundwater returns to background conditions at the WAPS, which may cause an impact to the time required to achieve GWPS (Appendix E; Geosyntec Consultants, Inc., 2025). No ecosystems would be disturbed because no construction activities are expected under the Source Control-GWP alternative.	CCR-contact stormwater that would be managed appropriately. The construction activities may cause some negative impacts on natural resources and habitat located atop the WAPS final cover system and near the Site. However, the total duration of the construction is expected to be 18 to 24 months, so any construction-related impacts to ecosystems would be limited to the short term. Source Control-CCS would be more effective at controlling releases than Source Control-GWP. CCS would isolate CCR from the surrounding environment on all sides and in particular would prevent releases of CCR-related constituents associated with the high groundwater transmissivity of the sand and gravel deposits in the UA.

Notes:
BCU = Bedrock Confining Unit; CCR = Coal Combustion Residual; CCS = Continuous Containment System; CIP = Closure-in-Place; GWP = Groundwater Polishing; GWPS = Groundwater Protection Standard; IAC = Illinois Administrative Code; IDNR = Illinois Department of Natural Resources; NPDES = National Pollutant Discharge Elimination System; O&M = Operations and Maintenance; Source Control-CCS = Source Control with a Continuous Containment System; Source Control-GWP = Source Control with Groundwater Polishing; UA = Uppermost Aquifer; WAPS = Western Ash Pond System.

1 Introduction

1.1 Site Description and History

1.1.1 Site Location and History

Dynegy Midwest Generation, LLC's (DMG) Hennepin Power Plant is an electric power generating facility with coal-fired units located approximately 4 miles northeast of the Village of Hennepin, Illinois, along the Illinois River. The facility began operating in the early 1950s and was retired in 2019 (Ramboll, 2021). The plant had two coal-fired units constructed in 1953 and 1959 with a capacity of 70 megawatt (MW) and 210 MW, respectively (Ramboll, 2021).

1.1.2 CCR Impoundment

The Hennepin Power Plant produced and stored coal combustion residuals (CCRs) as a part of its historical operations. The West Ash Pond System (WAPS; which includes Illinois Environmental Protection Agency [IEPA] identification [ID] number [No.] W1550100002-01 and No. W1550100002-03, Vistra CCR Unit ID 804, and a National Inventory of Dams [NID] No. IL50698; Appendix B) is the subject of this report.

The WAPS was operated from 1952 through 1996. The impoundment is composed of two inactive sub-units, the Old West Ash Pond (OWAP) and the Old West Polishing Pond (OWPP) (Figure 1.1). Both sub-units were originally constructed as a single unit with a single perimeter dike and subsequently divided as part of operational procedures. The OWAP was approximately 27.7 acres in size and accepted mainly bottom ash, slag, as well as mixed coal ash. The 4.7-acre OWPP was used as a secondary pond and is located at the western end of the impoundment. Effluent from the impoundment was discharged to surface water until 1989 when the Ponds No. 1 and No. 3 were consolidated as OWAP and divided into primary and secondary cells within the OWAP. This report refers to the three sub-units as a single CCR unit, *i.e.*, WAPS (OBG, Part of Ramboll, 2019).

A Closure and Post-Closure Plan for the WAPS was developed in accordance with Title 40 Part 257 and was approved by IEPA in 2018. Source control using a consolidate-and-cap approach was completed in 2020 (Appendix C; Ramboll, 2024a), which is discussed in Section 2.1.

Figure 1.1 Site Location Map. Adapted from Ramboll (2025c).

1.1.3 Surface Water Hydrology

The WAPS is located within the DePue Lake-Ohio River Watershed (12-digit Hydrologic Unit Code: 071300010804), which is located in the greater Lower Illinois-Senachwine Lake (8-digit Hydrologic Unit Code: 07130001) (USGS, 2024). The Illinois River is located less than 200 ft north of the WAPS and flows from east to west (Geosyntec Consultants, Inc., 2017). As described below (Section 1.1.4, Hydrogeology), the Illinois River acts as a regional sink for surface water and groundwater in the vicinity of the Site.

The Illinois River is the largest surface water body in the area. The IEPA classifies the river as a General Use Water: it is designated for aquatic life and use in primary contact recreation; however, it is not designated for use in food processing or as a public water supply. The segment of the Illinois River adjacent to the Site (Section D-16) is listed on the 2022 Illinois Section 303(d) List as being impaired for fish consumption, due to mercury and polychlorinated biphenyls (PCBs). DePue Lake, which is located north of the Site along the north bank of the Illinois River, is listed as impaired for aquatic life due to cadmium, endrin, silver and zinc; it is also listed as impaired for fish consumption due to mercury and polychlorinated biphenyls (IEPA, 2022, 2019).

The former National Pollutant Discharge Elimination System (NPDES) permit (IL001554) outfall 005, which was a discharge culvert at the OWPP, was removed during closure of the WAPS in 2020 (IEPA, 2011; Geosyntec Consultants, Inc., 2017). During closure, residual liquids pumped from the WAPS was eventually discharged through Outfall 003, which is located approximately one mile east of the WAPS, under the same permit (Geosyntec Consultants, Inc., 2017).

1.1.4 Hydrogeology

The geology underlying the Site in the vicinity of the WAPS consists of three distinct hydrostratigraphic units (Appendix C; Ramboll, 2024a; Geosyntec Consultants, Inc., 2017):

- **Uppermost Aquifer (UA):** The UA composed of mixed alluvial deposits (classified as Cahokia alluvium consisting of clay, silt, and sand), which overlie coarser grained outwash sand and gravel deposits (classified as Henry Formation). This unit is highly permeable and is the uppermost aquifer and primary groundwater transport pathway in the vicinity of the West Ash Pond System.
- **Bedrock Confining Unit (BCU):** The BCU is defined by Pennsylvanian age shale with minor layers of limestone, sandstone, and coal. This low permeability unit defines the lower boundary of the Uppermost Aquifer Unit at WAPS.

The groundwater movement in the unconsolidated materials is consistent with surface topography and flows north and west near the Site towards the Illinois River, which serves as a large regional hydraulic boundary. Precipitation infiltration recharges groundwater. Groundwater typically flows horizontally within the three hydrostratigraphic units at the Site, with converging upward flow near and beneath the river. Prior to the closure during the impoundment operations, substantial local recharge to groundwater from sluicing of ash created radial flow conditions near the impoundment. Groundwater flow direction is primarily northwest towards the river during post-closure conditions (Appendix C; Ramboll, 2024a; Appendix D; Ramboll, 2024b).

During groundwater's interaction with surface water, CCR-related constituents may partition between sediments and the surface water column. It should be noted that many CCR-related constituents can also arise from other industrial sources and occur naturally in sediments and surface water. As a result, their presence in the sediments and/or surface water of the Illinois River does not necessarily signify contributions from the WAPS.

1.1.5 Site Vicinity

The WAPS is surrounded by the Illinois River to the north, industrial properties to the east (Tri-Con Materials) and south (Tri-Con Materials and Washington Mills), agricultural land to the southwest, and the Hennepin Power Station to the west. Tri-Con Materials produces various fill and washed sand, gravel, rock and boulder products (Ramboll, 2018-2020). Washington Mills produces abrasive grains and specialty electro-fused minerals (Ramboll, 2018-2020).

Notable natural areas and recreational areas in the vicinity of the WAPS include the Illinois River and the Donnelley/DePue State Fish and Wildlife Areas complex, which is located opposite the WAPS along the northern bank of the Illinois River. The Illinois River is popular for canoeing and other forms of water recreation (IDNR, 2021). The nearby DePue Lake and Lyons Lake are popular areas for recreational boating and fishing (Illinois River Road National Scenic Byway, 2021; HookandBullet.com, 2021).

1.2 Part 845 Regulatory Review and Requirements

Title 35, Part 845 of the Illinois Administrative Code (IAC) (IEPA, 2021) requires that a Corrective Action Alternatives Analysis (CAAA) be performed as part of the remedy selection, prior to undertaking any corrective actions at certain CCR-containing impoundments where exceedances of GWPSs have been identified. Because exceedances[2] of GWPSs in groundwater associated with the WAPS have been identified for arsenic, boron, lithium, sulfate, and total dissolved solids (TDS) (Appendix D; Ramboll, 2024b), this report presents a CAAA for the WAPS pursuant to the requirements under IAC Section 845.670. The goal of a CAAA is to holistically evaluate a range of factors for the various corrective actions being considered at an impoundment, including the efficiency, reliability, and ease of implementation of the corrective action; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by the community (IEPA, 2021). A CAAA is a decision-making tool that is designed to aid in the selection of a corrective action alternative.

[2] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or Groundwater Protection Standards (GWPS) as described in the proposed groundwater monitoring program, which was submitted to IEPA on October 25, 2021 as part of Dynegy Midwest Generation's operating permit application for the WAPS (Burns & McDonnell, 2021). The operating permit application, including the proposed groundwater monitoring program, remains under review by IEPA and therefore Dynegy Midwest Generation has not identified any actual exceedances.

2 Corrective Action Alternatives Analysis

This section presents the CAAA pursuant to requirements under IAC Section 845.670 (IEPA, 2021). The goal of a CAAA is to fully evaluate proposed viable corrective measures that were identified in the CMA. The CAAA evaluates potential corrective actions with respect to a wide range of factors, including the performance, reliability, and ease of implementation of the corrective action; its potential impacts on human health and the environment; and its ability to address concerns raised by the community (IEPA, 2021).

Per IAC Section 845.670(d) (IEPA, 2021), any corrective actions selected under a Corrective Action Plan must:

1. Be protective of human health and the environment;
2. Attain the groundwater protection standards specified in Section 845.600;
3. Control the sources of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents listed in Section 845.600 into the environment;
4. Remove from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
5. Comply with standards for management of wastes as specified in Section 845.680(d).

At the WAPS, a CAAA is required because groundwater monitoring associated with the WAPS identified exceedances of the GWPSs. Groundwater monitoring was conducted in accordance with the proposed groundwater monitoring plan (GMP) between 2015 and 2023 (Appendix D; Ramboll, 2024b). The groundwater samples collected from groundwater compliance monitoring wells were used to evaluate compliance with the groundwater quality standards listed in IAC Section 845.600(a). As of the date of this report, arsenic, boron, lithium, sulfate, and total dissolved solids (TDS) were identified as constituents/parameters with exceedances of their corresponding GWPSs (Appendix D; Ramboll, 2024b).

Two potential corrective actions are evaluated in this CAAA: Source Control with Groundwater Polishing (Source Control-GWP), and Source Control with a Continuous Containment System (Source Control-CCS). Both alternatives were identified as viable approaches in the CMA (Appendix C; Ramboll, 2024a). Each of these corrective action alternatives is described below in Section 2.1.

It should be noted that Source Control-GWP, Source Control with a Cutoff Wall, and Source Control with *In-Situ* Stabilization (ISS) were identified in the CMA as viable remedial approaches (Appendix C; Ramboll, 2024a). However, during subsequent evaluations, the remedial approaches were modified. Remedy modifications include the following:

- Source control-ISS was determined infeasible and excluded for further evaluation due to significant potential risks, including the need to temporarily remove half of the previously installed WAPS final cover. Removal of the final cover system would result in significant stormwater infiltration and potentially lead to reducing the effectiveness of the completed source control. In addition, ISS would involve managing tens of thousands of cubic yards of CCR and CCR-impacted cuttings on

the WAPS surface, increasing the risk of releasing CCR-contaminated stormwater and sediments during construction, which could negatively impact nearby sensitive areas.

- Source Control-Cutoff Wall was expanded into the Source Control-CCS alternative, which is evaluated in this report. The continuous containment system (CCS) integrates the cutoff wall with the existing final cover to provide full lateral and surface isolation of CCR from the surrounding environment. The wall would be keyed into competent shale bedrock to provide base subsurface containment below the WAPS.

2.1 Corrective Action Alternative Descriptions

For both corrective actions evaluated in this CAAA, source control is the primary remedy. US EPA has stated that source control is the most effective means of ensuring the timely attainment of remediation objectives (US EPA, 2015b). The source control for the WAPS consisted of closure-in-place (CIP) using a consolidate-and-cap approach (Geosyntec Consultants, Inc., 2017). Specific elements of this approach competed in 2020 included:

- Removal of residual liquids (unwatering) within the OWAP and OWPP *via* a pumping system and discharge through existing NPDES Outfall 003.
- Installation of a sheet pile wall and a compacted clay buttress at the splitter dike between the OWAP and OWPP for dike support and seepage control during excavation of the OWPP. The sheet pile and buttress remain in place after closure to physically separate CCR that were capped in the OWAP from the excavated area in the OWPP.
- Excavation of CCR and dike soils from the OWPP and placement of the excavated CCR in the OWAP as structural fill. The excavated area in OWPP resulted in a 6-acre depression, which was seeded to foster native vegetation growth and currently functions as an ephemeral pond for wildlife habitat.
- Placement of a geosynthetic cover system over the OWAP, which consisted of a 40-mil linear low-density polyethylene (LLDPE) geomembrane liner, 1.5 ft of soil cover and 0.5 ft vegetative layer.
- Removal of existing NPDES Outfall 005 and the associated discharge culvert at the OWPP.
- Establishing and maintaining native vegetative growth on the OWAP final cover, to minimize erosion.
- Establishing a gravel roadway along the south and west of the OWPP to allow for vehicular access to the adjacent Donnelly Wildlife Management Area.
- Installation of a stormwater management system.

These above source control activities included excavation of CCR from the OWPP and consolidation into OWAP, and the installation of a low-permeability final cover system. These activities were designed to control, minimize or eliminate, post closure infiltration of liquids into the impounded CCR. Closure activities specifically included removal of impounded water and excavation of CCR and one foot of soil below the CCR from OWPP to consolidate into OWAP, and installation of a final cover system consisting of a geosynthetic layer, a protective soil layer and establishment of a vegetative cover. These measures (installation of a geosynthetic cap and consolidation of CCR) control to the maximum extent feasible the migration of CCR constituents to groundwater, thus facilitating the achievement of the GWPSs in accordance with IAC Section 845.600. As demonstrated by the groundwater modeling in support of the Closure Plan, source control would result in a drop of hydraulic pressure beneath the final cover system, a

significant reduction in groundwater concentrations, and over time would result in a reduction in the extent of groundwater impacts to within the footprint of the impoundment (Geosyntec Consultants, Inc., 2017). Due to the reduction in the hydraulic flux out of the WAPS, the mass flux out of the WAPS would also be controlled and minimized.

In addition to source control, the corrective actions evaluated in this CAAA include residual plume management. Two potential corrective actions, identified as viable in the CMA and after further assessment, are evaluated in this CAAA for the WAPS (Appendix B; Ramboll, 2025a):

- **Alternative 1:** Source Control with Groundwater Polishing (Source Control-GWP);
- **Alternative 2:** Source Control with a Continuous Containment System (Source Control-CCS).

For both corrective action alternatives, adaptive site management strategies would be integrated into residual plume management. This approach ensures the timely incorporation of new Site information throughout the corrective action process in order to optimize the remediation and expedite achievement of the GWPSs. As part of the adaptive site management approach, system performance and residual plume conditions would be monitored throughout the implementation of the selected corrective action. If groundwater concentrations do not respond as expected to the corrective action, the adaptive site management approach would enable prompt adjustments, optimizations, or replacement of the remedy to ensure overall effectiveness.

2.1.1 Alternative 1: Source Control-GWP

The first corrective action alternative is Source Control-GWP. This remedy includes source control (*i.e.*, CIP using a consolidate-and-cap approach) combined with residual plume management based on physical and geochemical processes that would reduce groundwater concentrations downgradient of the WAPS. Groundwater polishing mechanisms were evaluated using geochemical speciation and reaction models. The primary objective of the geochemical model was to support the evaluation of groundwater polishing as a potential remedy for the Site. The model focused on evaluating the dominant geochemical reactions that may occur at time scales relevant to groundwater flow, including adsorption and mineral dissolution/precipitation reactions (*i.e.*, iron and aluminum hydroxides, carbonates, and some sulfates) (Appendix E; Geosyntec Consultants, Inc., 2025). Model inputs included geochemically reactive solid mineral phases, downgradient groundwater composition, and background groundwater composition derived from Site-specific data. Speciation models analyzed the distribution of chemical constituents between solid and aqueous phases, while reaction models assessed how these distributions may shift in response to changing Site conditions (US EPA, 2015).

Components of residual plume management for the Source Control-GWP alternative include:

- Groundwater concentrations would be reduced in the downgradient plume as a result of physical and geochemical attenuation processes. Site-specific evaluations have shown that groundwater polishing would reduce the groundwater concentrations and mobility of inorganic contaminants (including boron, lithium, and sulfate), through natural physical and geochemical attenuation mechanisms, especially after the implementation of source control (Appendix E; Geosyntec Consultants, Inc., 2025). Specifically, chemical attenuation of contaminants is feasible *via* sorption to aquifer solids, particularly iron and aluminum oxides under current conditions. Attenuation *via* sorption onto mineral surfaces should remain stable for boron and sulfate under post-closure

conditions. However, it should be noted some arsenic[3] re-mobilization may occur as groundwater returns to background conditions at the WAPS, which may cause an impact to the time to achieve GWPS (Appendix E; Geosyntec Consultants, Inc., 2025).

- Corrective action groundwater monitoring using a corrective action groundwater monitoring network designed in accordance with IAC Section 845.680(c), which would be installed within the plume that lies beyond the waste facility boundary.
- Adaptive site management strategies for this alternative would include geochemical modeling. Groundwater monitoring results would be evaluated and compared to the model-predicted concentrations. In situations in which observed groundwater concentrations deviate significantly from modeled conditions, alternative methods or techniques to achieve the GWPSs would be evaluated, and if viable, incorporated as per IAC Section 845.680(b).
- Corrective action confirmation groundwater sampling would be performed for 3 years after GWPSs have been achieved.
- Following the completion of the corrective action confirmation monitoring period, a report and certification for Corrective Action Completion would be prepared and submitted to IEPA as per IAC Section 845.680(e).

The overall corrective action implementation duration for this alternative is approximately 33 years (390 months) after approval of the corrective action plan (Appendix B; Ramboll, 2025a), including:

- Approximately 29 years (348 months) of corrective action monitoring (*i.e.*, time to meet GWPSs),
- At least 3 years (36 months) of corrective action confirmation monitoring,[4] and
- Approximately 6 months associated with post-closure reporting (Appendix B; Ramboll, 2025a).

2.1.2 Alternative 2: Source Control-CCS

The second corrective action alternative is Source Control-CCS. This remedy includes source control and uses a continuous containment system (*i.e.*, a deep groundwater cutoff wall tied into the existing the final cover system) as the residual plume management approach. The cutoff wall would extend from the top of the WAPS perimeter dikes completely through the UA and penetrate into the underlying competent shale bedrock. The total length of the cutoff wall is expected to be approximately 5,200 ft, enclosing the CIP portions of the WAPS. The wall would be constructed from ground surface to a depth of 90 ft below ground surface (bgs)[5] (Appendix B; Ramboll, 2025a). The cutoff wall would be constructed using either a mixture of soil and bentonite or cement and bentonite, with a thickness ranging from 2 to 3 ft, and would have a hydraulic conductivity of approximately 1.0×10^{-7} centimeters per second (cm/s). The existing final cover system would be extended and integrated with the cutoff wall, creating a continuous low-permeability physical barrier. This would fully contain the CCR within the WAPS, isolating it from the surrounding environment on all sides through:

- A deep cutoff wall ensuring lateral containment on all sides of the CCR;

[3] It should be noted that not all arsenic in groundwater is associated with the WAPS. Some of the arsenic is likely naturally occurring and/or associated with other sources.
[4] It should be noted that post-closure care groundwater monitoring would continue for a minimum of 30 years as required by IAC Section. 845.780(c).
[5] This depth corresponds to an approximate elevation of 375 ft. All elevations in this report are in the North American Vertical Datum of 1988 (NAVD88), unless otherwise noted.

- The existing low-permeability geomembrane final cover system providing surface containment over the CCR;
- Competent shale bedrock acting as a low-permeability barrier beneath the CCR.

The continuous containment system is a long-term, low-maintenance physical barrier between the WAPS and the surrounding environment. As indicated by groundwater modeling, the continuous containment system is unlikely to cause liquid buildup within the contained CCR mass, and thus supplemental groundwater extraction or active gradient control within the WAPS would be unnecessary. As a result, the system would control the source of releases of constituents to the environment.

Implementation of the Source Control-CCS is expected to include various tasks distributed across three major phases: pre-construction activities (Phase 1), corrective action construction (Phase 2), and corrective action operations and maintenance (O&M), groundwater monitoring, and closeout (Phase 3). The activities associated with the Source Control-CCS alternative are summarized below.

- **Phase 1:** Pre-construction activities including obtaining permits from agencies and completing Site investigations and engineering designs.
- **Phase 2:** Construction of the cutoff wall. Details pertaining to the construction activities are outlined below:
  - Mobilization of equipment and materials to the Site, and preparation for Site construction;
  - The final cover system previously installed would be temporarily removed in the areas where conflicts with the cutoff wall alignment; existing Site infrastructure (*i.e.*, access roads, piezometers, monitoring wells, stormwater structures, pressure relief vents) may also be removed.
  - Construction of a 60 ft wide working pad and temporary access road to allow construction equipment access and traffic;
  - Low-permeability backfill for the cutoff wall would be generated using an on-Site batch plant. A geotechnical monitoring system would be implemented during construction to monitor the WAPS perimeter dikes. The cutoff wall would be constructed using appropriate equipment, such as crane-mounted conventional constructional equipment. Other innovative methods would be utilized if determined to be appropriate during later phase.
  - Once the construction is completed, CCR-impacted spoils and/or work pad materials would be either disposed off-Site or beneficial used within the Hennepin East Ash Pond as compacted fill beneath the final cover system. Non-CCR impacted spoils would be disposed of at an appropriate on-Site location.
  - Appropriate stormwater management system would be constructed to discharge to an NPDES permitted outfall for any contact stormwater.
  - Site restoration would occur, which include replacement of Site infrastructure that are damaged or removed during construction, as well as the repair of the final cover system.
- **Phase 3:** Corrective action operations, maintenance (O&M), and closeout. Details pertaining to each of these activities are outlined below.
  - Corrective Action O&M: Because the deep cutoff wall is a passive, below-grade structure, no O&M would be needed following its installation. Maintenance of the final WAPS cover system (as part of the CCS) would proceed in accordance with current post-closure care O&M practices.

- Adaptive site management strategies would be employed to track remediation progress and incorporate new Site information to assure the achievement of the GWPSs.
- Corrective action monitoring would be performed using a corrective action groundwater monitoring network designed in accordance with IAC Section 845.680(c), which would be installed within the plume contamination that lies beyond the waste boundary.
- Corrective action confirmation monitoring would be performed for 3 years after GWPSs have been achieved.
- Following the completion of the corrective action confirmation monitoring period, a report and certification for Corrective Action Completion would be prepared and submitted to IEPA as per IAC Section 845.680(e).

The overall corrective action implementation duration is approximately 42 to 44 years (498 to 522 months) after approval of the corrective action plan (Appendix B), including:

- Approximately 4 to 5 years (42 to 60 months) of pre-construction activities (Phase 1),
- Approximately 18 to 24 months of corrective action construction (Phase 2), and
- Approximately 37 years (438 months) of O&M and closeout (Phase 3);
    - It includes 33 years (396 months) of corrective action monitoring (*i.e.*, time to meet GWPSs), at least 3 years (36 months) of corrective action confirmation monitoring,[6] and 6 months associated with post-closure reporting.

[6] It should be noted that post-closure care groundwater monitoring would continue for a minimum of 30 years as required by IAC Section 845.780(c).

Key parameters for the Source Control-Cutoff Wall corrective action alternative are shown in Table 2.1, below.

Table 2.1 Key Parameters for the Source Control-CCS Corrective Action Alternative[a]

Parameter[b]	Value[c]
Labor Hours	
Total On-Site Labor	29,400 hours
Total Off-Site Labor	0 hours
40% Contingency	11,800 hours
Total Labor Hours:	41,100 hours
Vehicle and Equipment Travel Miles	
Vehicles On-Site	95,600 miles
On-Site Haul Trucks (Unloaded + Loaded)	3,350 miles
Labor Mobilization	446,000 miles
Equipment Mobilization (Unloaded + Loaded)	54,100 miles
Off-Site Haul Trucks (Unloaded + Loaded)	121,000 miles
Material Deliveries (Unloaded + Loaded)	210,000 miles
Total On-Site Vehicle and Equipment Travel Miles:	99,000 miles
Total Off-Site Vehicle and Equipment Travel Miles:	831,000 miles
Total Vehicle and Equipment Travel Miles:	930,000 miles

Notes:
Source Control-CCS = Source Control with Continuous Containment System.
(a) Although source control (*i.e.*, closure-in-place [CIP]) is a primary component of the corrective action, the source control was previously completed in 2020 and the associated labor time, equipment usage, and mileage are not discussed in this analysis.
(b) Site activities are only expected to occur during the corrective action construction phase for this alternative.
(c) Values reported in this table were rounded to reflect 3 significant figures.
Source: Appendix B, Ramboll, 2025a.

2.2 Long- and Short-Term Effectiveness and Protectiveness of Corrective Action Alternative (IAC Section 845.670(e)(1))

2.2.1 Magnitude of Reduction of Existing Risks/Be Protective of Human Health and the Environment (IAC Section 845.670(e)(1)(A)/IAC Section 845.670(d)(1))

There are no current unacceptable risks to human or ecological receptors at this Site associated with the WAPS (Appendix A; Gradient, 2025). Because current conditions do not present a risk to human health or the environment at the WAPS, there will be no unacceptable risk to human health or the environment for future conditions since the unit was already closed and source control was implemented. Concentrations of CCR-related constituents will decline over time and, consequently, potential exposures to CCR-related constituents in the environment will also decline. As a result of this, the magnitude of the reduction of existing risks is the same for the two potential corrective action alternatives (IAC Section 845.670(e)(1)(A)), and both corrective action alternatives are equally protective of human health and the environment (IAC Section 84.670(d)(1)).

2.2.2 Effectiveness of the Remedy in Controlling the Source (IAC Section 845.670(e)(2)/IAC Section 845.670(d)(3))

Extent to Which Containment Practices Will Reduce Further Releases/Control the Sources of Releases to Reduce or Eliminate, to the Maximum Extent Feasible (IAC Section 845.670(e)(2)(A)/IAC Section 845.670(d)(3))

Source control was implemented for both corrective action alternatives in 2020. Source control (*i.e.*, CIP using a dewatering-and-cap approach) which included dewatering and excavation of CCR from the OWPP and consolidation into the OWAP portion of the WAPS and the installation of a low-permeability final cover system. These source control activities would limit the infiltration of precipitation into the CCR, result in a significant reduction in groundwater concentrations, and, overtime, reduce the extent of groundwater impacts to within the footprint of the impoundment based on groundwater modeling conducted in support of the Closure Plan (Geosyntec Consultants, Inc., 2017). Therefore, both corrective action alternatives would be equally and fully protective with regard to source control. The effectiveness of residual plume management for each of the corrective action alternatives with respect to source control is summarized below.

- Under the Source Control-GWP alternative, the attenuation of dissolved constituent concentrations remaining after source control would be achieved through natural physical and geochemical processes. Site-specific evaluations have shown that groundwater polishing would reduce the groundwater concentrations and mobility of inorganic contaminants (including boron and sulfate), through natural physical and geochemical attenuation mechanisms, especially after the implementation of source control (Appendix E; Geosyntec Consultants, Inc., 2025). Specifically, chemical attenuation of contaminants is feasible to some extent *via* sorption to aquifer solids, particularly iron and aluminum oxides under current conditions. Attenuation *via* sorption onto mineral surfaces should remain stable for boron and sulfate under post-closure conditions. However, it should be noted some arsenic[7] re-mobilization may occur as groundwater returns to background conditions at WAPS, which may cause an impact to the time required to achieve GWPS (Appendix E; Geosyntec Consultants, Inc., 2025). In cases in which observed groundwater concentrations deviate significantly from modeled conditions, alternative methods or techniques would be evaluated under the adaptive site management program, and if viable, incorporated as per IAC Section 845.680(b);
- Under the Source Control-CCS alternative, residual plume management would be achieved by the installation of the continuous containment system. Cutoff walls are a frequently used corrective measures that have been determined to be an effective approach in preventing dissolved-phase groundwater plume migration. The final WAPS cover system would be extended and integrated with the cutoff wall, creating a continuous low-permeability barrier that fully contains the CCR within the WAPS. This system ensures isolation from the surrounding environment through lateral containment by the deep cutoff wall, surface containment by the existing geomembrane cover, and a natural barrier provided by the competent shale bedrock below. Thus, this continuous barrier will isolate the CCR from the surrounding environment thus reducing and eliminating further releases. If necessary, remedy optimizations would be implemented under the adaptive site management program.

[7] It should be noted that not all arsenic in groundwater is associated with the WAPS. Some of the arsenic is likely naturally occurring and/or associated with other sources.

Although both corrective action alternatives include source control and residual plume management, Source Control-CCS would be more effective at controlling sources of releases than Source Control-GWP. Source Control-CCS would isolate CCR from the surrounding environment on all sides and in particular would prevent releases of CCR-related constituents associated with the high groundwater transmissivity of the sand and gravel deposits of the UA.

Extent to Which Treatment Technologies May Be Used (IAC Section 845.670(e)(2)(B))

Because Source Control-GWP would rely on natural attenuation processes, no additional treatment technologies would be required under this alternative. Under the Source Control-CCS alternative, contact stormwater may be generated during the construction phase, which would be pumped to the on-Site treatment pond before discharging *via* an NPDES permitted outfall. No additional treatment technologies would be required for the Source Control-CCS alternative during the operation of the CCS, because the cutoff wall is an engineered physical barrier that does not require maintenance.

2.2.3 Likelihood of Future Releases of CCR (IAC Section 845.670(e)(1)(B))

Both corrective action alternatives include source control using CIP with a consolidate-and-cap approach. A geosynthetic cover system was installed over the WAPS in 2020 in compliance with 40 CFR Part 257, Subpart D, which included a geosynthetic layer, a protective soil layer to limit infiltration, and a vegetative cover. This cover system provides increased protection against berm and surface erosion, precipitation infiltration, and other adverse effects that could potentially trigger a release of CCR. During the construction phases of the Source Control-CCS alternative, a portion of the previously installed cover system would be temporarily removed near where the cutoff wall. Any CCR-contact stormwater generated during this time would be pumped to the on-Site treatment pond before discharged *via* an NPDES permitted outfall.

There would be minimal risk of accidental CCR releases occurring post-closure under either of the corrective action alternatives.

2.2.4 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.670(e)(1)(C))

The type and degree of long-term residual groundwater plume management associated with each corrective action alternative is summarized below.

- Residual plume management for the Source Control-GWP alternative would not require the installation, operation, or maintenance of any engineered systems or structures, other than maintenance of the monitoring well network. The only long-term management activity required under this alternative would be corrective action groundwater monitoring and routine maintenance of the monitoring wells, which would continue for at least 3 years after GWPSs have been achieved for all wells, in accordance with IAC Section 845.680(c)(2). Post-closure care groundwater monitoring would continue for a minimum of 30 years as required by IAC Section 845.780(c). Based on the adaptive site management approach, remedy optimization (additional methods or techniques) may be implemented to ensure the achievement of the GWPSs.
- Residual plume management for the Source Control-CCS alternative would require construction of a deep cutoff wall. Multiple tasks would be completed over three phases: pre-construction activities (Phase 1), corrective action construction (Phase 2), and corrective action operations, maintenance, and closeout (Phase 3). CCR-impacted spoils and/or work pad materials generated

during construction would be either disposed off-Site or beneficial used within the East Ash Pond as compacted fill beneath the final cover system. Non-CCR impacted spoils would be disposed of at an appropriate on-Site location (Appendix B; Ramboll, 2025a). After the installation of the cutoff wall, no O&M efforts will be required, because it is a passive, below-grade structure. However, quality assurance (QA) and quality control (QC) programs would be required as part of construction to validate the integrity of the constructed cutoff wall. Corrective action groundwater sampling and routine maintenance of the monitoring well network would continue for at least 3 years after GWPSs have been achieved for all wells, in accordance with IAC Section 845.680(c)(2). Post-closure care groundwater monitoring would continue for a minimum of 30 years as required by IAC Section 845.780(c). Based on the adaptive site management approach, remedy optimization (additional methods or techniques) may be implemented to ensure the achievement of the GWPSs.

2.2.5 Short-Term Risks to the Community or the Environment During Implementation of Remedy (IAC Section 845.670(e)(1)(D))

2.2.5.1 Safety Impacts

Best practices would be employed during construction in order to ensure worker safety and comply with all relevant regulations, permit requirements, and safety plans. However, it is impossible to completely eliminate risks to workers during construction and/or other corrective action activities. For example, injuries and fatalities can occur due to truck accidents or equipment malfunctions. Truck accidents that occur off-Site can also result in injuries or fatalities to community members. Because the source control was implemented in 2020, there is no further risk of accidents and injuries occurring during the implementation of the source control remedy. The safety impacts associated with residual plume management (*i.e.*, construction and/or O&M) for each corrective action alternative are described below.

- The Source Control-GWP alternative would not require the construction of any engineered systems or structures, and therefore no safety impacts are expected.
- The Source Control-CCS would include the construction of a deep cutoff wall to contain CCR within the WAPS. Because the cutoff wall is a passive, subsurface structure, no O&M would be needed following installation. Therefore, potential safety concerns are only associated with the construction of the cutoff wall.

Worker Risks

On-Site accidents include injuries and deaths arising from the use of heavy equipment and/or earthmoving operations during Site activities. Off-Site accidents include injuries and deaths due to vehicle accidents during labor and equipment mobilization/demobilization, as well as materials/supplies hauling and deliveries.

As discussed in Section 2.1.1, there are no construction activities or operational requirements associated with residual plume management for the Source Control-GWP alternative. Thus, no worker injuries or fatalities are expected under the Source Control-GWP alternative. Ramboll estimates that residual plume management for the Source Control-CCS corrective action alternative would require 29,400 on-Site labor hours (Appendix B; Ramboll, 2025a). The US Bureau of Labor Statistics (US DOL, 2020a,b) provides an estimate of the hourly fatality and injury rates for construction workers. Based on the accident rates reported by the US Bureau of Labor Statistics and the on-Site labor hours reported in Appendix B, we estimate that

approximately 0.30 worker injuries and 2.7×10^{-3} worker fatalities would occur on-Site under the Source Control-CCS corrective action alternative (Table 2.2).

Table 2.2 Expected Number of On-Site Worker Accidents Under Each Corrective Action Alternative[a,b]

Corrective Action Alternative	Injuries	Fatalities
Source Control-GWP	0	0
Source Control-CCS	0.30	2.7×10^{-3}

Notes:
Source Control-CCS = Source Control with Continuous Containment System; Source Control-GWP = Source Control with Groundwater Polishing.
(a) Although source control (*i.e.*, closure-in-place [CIP]) is a primary component of the corrective action, the worker accidents associated with source control were previously estimated in the Closure and Closure Care Plan and are not repeated in this analysis.
(b) Worker accidents associated with groundwater sampling and monitoring are not included in this analysis for any of the alternatives.

The Source Control-CCS alternative would result in off-Site hauling, labor and equipment mobilization/demobilization, and material deliveries (Table 2.1). For residual plume management under the Source Control-CCS alternative, a total of approximately 831,000 off-Site vehicle and equipment travel miles would be required. In contrast, for residual plume management under the Source Control-GWP corrective action alternative, no off-Site vehicle and equipment travel miles would be required (Appendix B; Ramboll, 2025a). The United States Department of Transportation (US DOT) provides estimates of the expected number of fatalities and injuries "per vehicle mile driven" for drivers and passengers of large trucks and passenger vehicles (US DOT, 2023). Table 2.3 shows the expected number of off-Site accidents under each corrective action alternative due to all categories of off-Site vehicle usage. For these calculations, it was assumed that labor mobilization/demobilization would rely upon passenger vehicles (cars or light trucks, including pickups, vans, and sport utility vehicles) and that hauling, equipment mobilization/demobilization, and material deliveries would rely upon large trucks. Based on US DOT's accident statistics and the mileage estimates in Appendix B, an estimated 0.35 worker injuries and 0.013 worker fatalities would be expected to occur due to off-Site activities under the Source Control-CCS alternative while there are no off-Site accidents expected under the Source Control-GWP alternative.

Table 2.3 Expected Number of Off-Site Worker Accidents Related to Off-Site Car and Truck Use Under Each Corrective Action Alternative[a]

Off-Site Vehicle Use Category	Source Control-GWP		Source Control-CCS	
	Injuries	Fatalities	Injuries	Fatalities
Hauling	0	0	0.025	1.9×10^{-3}
Labor Mobilization/Demobilization	0	0	0.27	4.2×10^{-3}
Equipment Mobilization/Demobilization	0	0	0.011	8.5×10^{-4}
Material Deliveries	0	0	0.044	3.3×10^{-3}
Total:	0	0	0.35	0.013

Notes:
Source Control-CCS = Source Control with Continuous Containment System; Source Control-GWP = Source Control with Groundwater Polishing.
(a) Although source control (*i.e.*, closure-in-place [CIP]) is a primary component of the corrective action, the source control was previously completed in 2020, and the worker accidents associated with source control are not discussed in this analysis.

Overall, considering accidents occurring both on- and off-Site, no worker injuries and worker fatalities would be expected to occur for residual plume management under the Source Control-GWP alternative;

and 0.65 worker injuries and 0.013 worker fatalities would be expected to occur for residual plume management under the Source Control-CCS alternative. Thus, overall risks to workers would be higher under the Source Control-CCS alternative and lower under Source Control-GWP alternative.

Community Risks

Vehicle accidents that occur off-Site can result in injuries or fatalities among community members as well as workers. Based on the accident statistics reported by US DOT (2023) and the off-Site travel mileages reported in Appendix B (and summarized in Table 2.1), off-Site vehicle accidents could result in an estimated 0.21 injuries and 2.5×10^{-3} fatalities among community members (*e.g.*, people involved in haul truck accidents that are neither haul truck drivers nor passengers, including pedestrians, drivers of other vehicles, *etc*.) for residual plume management under the Source Control-CCS alternative (Table 2.4). No off-Site mileage is expected under the Source Control-GWP alternative, and thus no off-Site risks are expected under the Source Control-GWP alternative. Therefore, off-Site impacts on nearby residents, including injuries or fatalities, would be higher under the Source Control-CCS alternative.

Table 2.4 Expected Number of Community Accidents Under Each Corrective Action Alternative[a]

Off-Site Vehicle Use Category	Source Control-GWP		Source Control-CCS	
	Injuries	Fatalities	Injuries	Fatalities
Hauling	0	0	0.032	2.3×10^{-4}
Labor Mobilization/Demobilization	0	0	0.11	1.7×10^{-3}
Equipment Mobilization/Demobilization	0	0	0.014	1.1×10^{-4}
Material Deliveries	0	0	0.055	4.1×10^{-4}
Total:	0	0	0.21	2.5×10^{-3}

Notes:
Source Control-CCS= Source Control with Continuous Containment System; Source Control-GWP = Source Control with Groundwater Polishing.
(a) Although source control (*i.e.*, closure-in-place [CIP]) is a primary component of the corrective action, the source control was previously completed in 2020, and the worker accidents associated with source control are not discussed in this analysis.

2.2.5.2 Cross-Media Impacts to Air

Air pollution can occur both on-Site (*e.g*., construction activities) and off-Site (*e.g*., along transportation routes), potentially impacting workers as well as community members. Diesel emissions are a major source of air pollutants and greenhouse gas (GHG) emissions at construction sites. Diesel exhaust contains air pollutants, including nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), and volatile organic compounds (VOCs) (Hesterberg *et al*., 2009; Mauderly and Garshick, 2009). Construction equipment also emits GHGs, including carbon dioxide (CO_2) and possibly nitrous oxide (N_2O). The potential impact of each corrective action alternative on GHG emissions is proportional to the use of construction vehicles and equipment that are required for residual plume management.

Source control (*i.e*., CIP using a consolidate-and-cap approach) was implemented for both potential corrective action alternatives, and there are no further air impacts associated with source control. On-Site emissions would be higher for residual plume management under the Source Control-CCS alternative, due to the greater amount of on-Site vehicle travel miles required under this corrective action alternative (99,000 total on-Site travel miles under the Source Control-CCS alternative while no on-Site travel miles under the Source Control-GWP; Section 2.1.1 and Tables 2.1). Off-Site emissions would similarly be higher for residual plume management under the Source Control-CCS alternative due to the greater amount of off-Site vehicle and equipment travel miles required under this alternative (831,000 total off-Site travel miles

under the Source Control-CCS alternative while no off-Site travel miles under the Source Control-GWP alternative). In summary, air impacts would be higher for the Source Control-CCS alternative than the Source Control-GWP alternative.

2.2.5.3 Cross-Media Impacts to Surface Water and Sediments

Under both corrective action alternatives, the source control was implemented in 2020 (*i.e.*, CIP using a consolidate-and-cap approach), and constituent mass flux from groundwater into surface water will decline over time (Geosyntec Consultants, Inc., 2017). The source control approach removes the amount of water retained within the impoundment, which further reduces the hydraulic flux through the CCR. Due to the reduction in the hydraulic flux out of the WAPS, the mass flux out of the WAPS would also be controlled and minimized. As demonstrated by the groundwater modeling in support of the Closure Plan, Source Control would result in a significant reduction in groundwater concentrations and, overtime, reduce the extent of groundwater impacts to within the footprint of the impoundment (Geosyntec Consultants, Inc., 2017).

Under the Source Control-GWP alternative, minimal surface water and sediment impacts would be expected to be associated with residual plume management because it would not require the construction of any engineered systems or structures (other than utilizing existing monitoring wells).

Under the Source Control-CCS alternative, surface water and sediment impacts would be higher than the Source Control-GWP alternative due to the construction of the cutoff wall. Due to erosion and runoff, construction can have short-term negative impacts on surface water and sediment quality immediately adjacent to a site. Any associated impacts would be addressed through best management practices (BMPs) in accordance with Site land disturbance permits.

2.2.5.4 Control of Exposure to Any Residual Contamination During Implementation of the Remedy

Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there are no further risks of CCR exposure associated with source control implementation. However, impacted soils and groundwater can be a source of CCR-related constituent exposure for workers. Risks to workers arising from potential contact with residual contamination during construction activities associated with residual plume management would be higher for the Source Control-CCS alternative than for the Source Control-GWP alternative, because the Source Control-CCS alternative would involve removal of a portion of the previously installed final cover system and excavation and subsequent disposal of Site spoils. In contrast, the Source Control-GWP alternative would not involve exposure to either of these soil or groundwater waste streams. Any potential CCR-exposures during the Source Control-CCS alternative would be managed through the use of rigorous safety protocols and personal protective equipment.

2.2.5.5 Other Identified Impacts

Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there are no further risks associated with source control implementation.

In addition to safety impacts, cross-media impacts, and the potential for workers to be exposed to residual contamination, construction activities and remedial operations can have significant energy demands and can cause nuisance impacts such as traffic and noise. Energy consumption at a construction site is synonymous with fossil fuel consumption, because the energy to power construction vehicles and

equipment comes from the burning of fossil fuels. Fossil fuel demands considered here include the burning of diesel fuel during construction equipment and vehicle travel miles. Because GHG emission impacts and energy consumption impacts both arise from the same sources at construction sites, the trends discussed in Section 2.2.5.2 with respect to GHG emissions also apply to the evaluation of energy demands. Specifically, the energy demands of construction equipment and vehicles associated with residual plume management would be greater under the Source Control-CCS alternative, while the energy demands under the Source Control-GWP alternative associated with residual plume management are expected to be lower because this alternative would not require any significant construction activity. There is no operational energy expected under either of the alternatives, because the Source Control-GWP alternative would rely on physical and geochemical processes, while the Source Control-CCS alternative would rely on the constructed barrier wall.

Similarly, traffic and noise impacts associated with residual plume management are expected to be higher under the Source Control-CCS alternative than the Source Control-GWP alternative, due to the construction activities that would be required to construct the barrier wall. Traffic may increase temporarily around the Site under these alternatives due to the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. However, these impacts would be expected to largely occur at the beginning or end of each workday (for the arrival/departure of the work force), at the beginning or end of the construction period (for equipment mobilization/demobilization), and at specific times throughout the construction period (for material deliveries). Traffic and noise impacts associated with residual plume management from the Source Control-GWP are expected to be minimal due to the limited amount of construction and operation of the groundwater monitoring wells required.

Construction activities can negatively impact natural resources and habitat near the Site, as well as scenic, historical, and recreational value. Based on a review of the Illinois Department of Natural Resources (IDNR) Historic Preservation Division database and the Illinois State Archaeological Survey database, there are no historic sites located within 1,000 meters of the WAPS (Ramboll, 2021). There would be no impacts under the Source Control-GWP alternative because no additional construction activities would occur. However, negative impacts resulted from construction activities on scenic and recreational value may occur along the Illinois River and within the Donnelley/DePue State Fish and Wildlife Areas complex, under the Source Control-CCS alternative. The Donnelley/DePue State Fish and Wildlife Areas border the Hennepin Site to the north and west and includes DePue Lake, Spring Lake, and Coleman Lake. Under the Source Control-CCS, large cranes, batch plants, and other equipment could be utilized during construction phases. The Illinois River is popular for canoeing and other forms of water recreation (IDNR, 2021). Given the proximity between these areas and the expected construction, it is likely that these areas would experience some adverse impacts such as visual disturbance, obstruction of view, and noise during the construction period. However, these impacts are expected to diminish once the construction is completed in 18 to 24 months for the Source Control-CCS alternative.

In addition, the construction of the cutoff wall under the Source Control-CCS alternative is expected to use a significant amount of cement or bentonite, which would be introduced into the UA and the BCU. The process would use bentonite-based drilling mud with various additives, similar to the methods employed in well drilling but on a notably larger scale. Adding substantial quantities of these materials into the subsurface environment may cause alteration in groundwater pH levels and affect geochemical conditions in the UA.

2.2.6 Time Until Groundwater Protection Standards Are Achieved/Attain the Groundwater Protection Standards Specified in Section 845.600 (IAC Section 845.670(e)(1)(E)/IAC Section 845.680(d)(2))

This section of the report evaluates the time required to achieve GWPSs, pursuant to requirements under IAC Section 845.670(e)(1)(E) (IEPA, 2021) and under IAC Section 845.680(d)(2).

The groundwater movement in the unconsolidated materials is consistent with surface topography and flows north and west near the Site towards the Illinois River, which serves as a large regional hydraulic boundary. Precipitation infiltration recharges groundwater. Under normal post-closure conditions, groundwater flows northward toward the river at the WAPS (Appendix B; Ramboll, 2025b).

The source control activities were completed in 2020. Groundwater modeling was performed in support of the Closure Plan (Geosyntec Consultants, Inc., 2017). The modeling predicted that source control would result in the reduction of leachate production, which facilitates the contraction of the contaminant plume in groundwater (Geosyntec Consultants, Inc., 2017). Additional modeling was conducted for each of the corrective action alternatives to evaluate future groundwater quality in the vicinity of the WAPS as a result of residual plume management (Appendix B; Ramboll, 2025b). The results of the modeling and subsequent evaluation (Appendix E; Geosyntec Consultants, Inc., 2025) indicate that groundwater would attain the GWPSs for all of the constituents[8] identified as having potential groundwater exceedances in the groundwater monitoring network within 29 years under the Source Control-GWP alternative and 38 to 40 years under the Source Control-CCS alternative (5 to 7 years of pre-construction and construction activities followed by 33 years post-construction).[9] Both alternatives are assumed to start after approval of the Corrective Action Plan (Appendix B; Ramboll, 2025a). Table 2.5 summarizes and compares timeline and overall implementation schedule for both alternatives (also discussed in Sections 2.1.1 and 2.1.2).

[8] Boron was selected as a surrogate for the contaminant fate and transport simulations to evaluate the effectiveness of each of the corrective action alternative. Boron was detected in the greatest number of WAPS groundwater wells exceeding its GWPS, a statistically significant correlation has been identified between observations of boron in groundwater and observations of lithium and sulfate in groundwater and boron is expected to take the longest time to achieve GWPS. Modeling all constituents that exceed GWPS or have been detected at lower concentrations relative to their GWPSs is unnecessary, as these constituents will likely achieve their GWPSs more quickly (Appendix B; Ramboll, 2025).

[9] As suggested by the site-specific evaluations, some arsenic re-mobilization may occur as groundwater returns to background conditions at the Site, which may cause an impact and result uncertainty to the time to achieve GWPS (Section 2.1.1; Appendix E; Geosyntec Consultants, Inc., 2025).

Table 2.5 Estimated Timeline and Implementation Schedule for Source Control-GWP *vs.* Source Control-CCS

Implementation Phase[a]	Implementation Task	Timeframe	
		Source Control-GWP	Source Control-CCS
1: Pre-Construction Activities[a]	Agency Coordination, Approvals, and Permitting	NA	18 to 24 months
	Final Design and Bid Process		24 to 36 months
	Total Timeframe to Complete Corrective		42 to 60 months after CAP Approval (3.5 to 5 years)
	Pre-Construction Activities		
2: Corrective Action Construction	Corrective Action Construction	NA	18 to 24 months
	Total Timeframe to Complete Corrective Action Construction		18 to 24 months
3: Corrective Action O&M and Closeout	Corrective Action Monitoring (Time to Meet GWPS)	348 months (29 years)	396 months (33 years)
	Corrective Action Confirmation Monitoring	36 months	36 months
	Corrective Action Completion Reporting	6 months	6 months
	Total Timeframe to Complete Corrective Action O&M and Closeout	390 months (33 years)	438 months (36.5 years)
Total Timeline to Complete Corrective Action (All Phases)		390 months (33 years)	498 to 522 months (42 to 44 years)

Notes:
CAP = Corrective Action Plan; NA = Non-applicable; Source Control-CCS = Source Control with Continuous Containment System; Source Control-GWP = Source Control with Groundwater Polishing.
(a) Both corrective action alternatives are assumed to start after the approval of the corrective action plan.
Source: Appendix B; Ramboll, 2025a.

2.2.7 Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (IAC Section 845.670(e)(1)(F))

Section 2.2.1 describes the magnitude of reduction of existing risks under each corrective action alternative. Section 2.2.2 describes the effectiveness of the remedy in controlling the source, including the extent to which containment practices would reduce further releases. Section 2.2.3 describes the likelihood of future releases of CCR occurring under each corrective action alternative, and Section 2.2.5 describes the short-term risks to workers, the community, and the environment during implementation of the remedy, including safety impacts and control of exposure to any residual contamination. In summary, source control measures (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, both corrective action alternatives would essentially eliminate the potential for a sudden CCR release to occur post-closure (*e.g.*, a dike failure event) due to the absence of both impounded water within the unit, and are equally and fully protective with regard to exposure to residual CCR.

For construction workers, risks arising from potential contact with residual contamination during construction, operation, and maintenance activities associated with residual plume management would be higher for the Source Control-CCS alternative than for the Source Control-GWP alternative, because the Source Control-CCS alternative would involve the excavation and subsequent management of Site spoils.

In addition, Source Control-CCS would involve temporarily removing a portion of the final cover previously installed, which could potentially allow stormwater to be in contact with CCR material during construction. CCR-contact stormwater would be generated and managed through CCR-contact stormwater management system under this alternative while a portion of the final cover would be removed. Any potential CCR exposures occurring under Source Control-CCS during the installation of the cutoff would be managed through the use of rigorous safety protocols, personal protective equipment, and appropriate disposal practice. The Source Control-GWP alternative would not involve exposure to either of these soil or groundwater waste streams and thus, there is no potential for exposure of humans and environmental receptors to wastes.

Hydrogeological changes would be expected under the Source Control-CCS alternative, such as altering flow patterns in the UA, redirecting groundwater flow around the cutoff wall, and causing changes to normal hydraulic gradients. However, changes to groundwater flow would not be expected to have an effect on the potential for the exposure of humans and environmental receptors to any wastes.

2.2.8 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.670(e)(1)(G))

Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, the long-term reliability of source control would be the same for both corrective action alternatives (Geosyntec Consultants, Inc., 2017). The long-term reliability of the engineering and institutional controls associated with residual plume management of each corrective action alternative are summarized below.

- Residual plume management under the Source Control-GWP alternative would be reliable because it would rely on physical and geochemical processes, rather than the installation, operation, and maintenance of engineered systems or structures. Under this alternative, engineering failure would not occur and no O&M activities would be required to ensure the success of the alternative (other than those required for groundwater monitoring). Active groundwater monitoring would be in place to track the remediation progress. Should the predicted decrease in groundwater concentrations not occur, the adaptive site management approach would enable prompt adjustments or enhancements to the corrective action in accordance with IAC Section 845.680(b). This strategy would allow continuous improvement of the WAPS groundwater remediation in response to new Site information and/or the performance of the corrective action alternative.
- Cutoff walls are proven remedies that have been implemented at many sites. Thus, residual plume management under the Source Control-CCS alternative would be reliable provided it is constructed in accordance with standard design and specifications. The remedy consists of a passive, below-grade physical barrier, which would not require any O&M activities once it is installed. The final cover system would require ongoing maintenance per existing Post-Closure Care Plan but is a durable, engineered structure. Some challenges are expected during construction, necessitating specialized equipment deployment. Since the cutoff wall would be installed through an existing impoundment embankment, additional engineering assessments and monitoring programs would be necessary to the embankment for indications of distress, such as deformation or cracking, throughout the cutoff wall construction process. Appropriate measures would be taken to stabilize the embankment if instability is detected. The construction of the cutoff wall would require temporarily removing a portion of the previously installed WAPS final cover. This procedure may allow additional stormwater to infiltrate the CCR, potentially leading to a temporary reversal of some positive effects that have occurred since the completion of the final cover system in 2020. A CCR-contact stormwater management system would be required to manage and discharge the contact stormwater *via* an NPDES permitted outfall. The effectiveness of the cutoff wall relies on precise construction techniques, demanding ongoing QC. Other challenges include the

management of the temporary removal of the already finished final cover system, which would require a contact stormwater management system during this time. However, post-construction QA programs may be required to validate the quality of the constructed cutoff wall. Ongoing monitoring of the system may be required to ensure reliable operation. Active groundwater monitoring would be in place, similar to the monitoring required under the Source Control-GWP alternative.

- For both corrective action alternatives, remedy optimizations would be implemented if necessary under the adaptive site management.

2.2.9 Potential Need for Replacement of the Remedy (IAC Section 845.670(e)(1)(H))

The potential need for the eventual replacement of the residual plume management remedy under each corrective action alternative is summarized as follows:

- Residual plume management under Source Control-GWP would rely on physical and geochemical processes to achieve reductions in groundwater concentrations to below GWPSs. Because no installation, operation, and maintenance of engineered systems or structures would be required, it would be unlikely that the residual plume management remedy under the Source Control-GWP alternative would need to be replaced. Adaptive site management strategies would be used to implement remedy optimizations or replacement, as necessary based on data that are collected, to ensure that remedial goals are achieved.
- Residual plume management under Source Control-CCS would rely on a cutoff wall as a physical barrier to contain the CCR mass within the WAPS and achieve reductions in groundwater concentrations to below GWPSs. The deep cutoff wall is a robust, engineered, and maintenance-free subsurface structure. The final cover system portion of this alternative would need ongoing maintenance per the IEPA approved Post-Closure Care Plan, but it is a passive and engineered structure that is unlikely to need replacement. Therefore, it is unlikely that the residual plume management remedy under the Source Control-CCS alternative would need to be replaced. Adaptive site management strategies would be used to implement remedy optimizations or replacement, as necessary based on data that are collected, to ensure that remedial goals are achieved.

2.3 The Ease or Difficulty of Implementing a Remedy (IAC Section 845.670 (e)(3))

2.3.1 Degree of Difficulty Associated with Constructing the Remedy (IAC Section 845.670(e)(3)(A))

Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there would be no further construction difficulties associated with source control. The expected degree of difficulty associated with residual plume management for each of the corrective action alternatives is summarized below.

- Residual plume management under the Source Control-GWP alternative would rely on physical and geochemical attenuation processes and therefore would not pose any significant construction

challenges. Therefore, there would be minimal difficulty in constructing the Source Control-GWP remedy.

- Residual plume management under the Source Control-CCS alternative would rely on a continuous containment system to enclose the CCR within the WAPS, and physical and geochemical attenuation processes to address downgradient groundwater quality impacts. However, it may have the following challenges during construction of the cutoff wall (Appendix B; Ramboll, 2025a):
  - Implementing the remedy entails the mobilization of specialized equipment to the Site, including large cranes, clamshells, and slurry cutters, *etc*. Supporting equipment such as batch plants, excavation, and grading equipment may also be used.
  - Although cutoff walls are commonly constructed to similar depths in comparable geologic environments, challenges during the cutoff wall's construction may still arise. These challenges may involve encountering highly permeable layers (leading to slurry loss), obstructions that necessitate specialized techniques and/or equipment for progression, or sidewall instability. These challenges could be particularly significant at the WAPS due to the presence of boulders and cobbles in the subsurface soils. While these challenges could be managed during cutoff wall construction, they may lead to potential schedule delays.
  - The cutoff wall would be installed through an existing impoundment embankment, which is a dam regulated by IDNR. Therefore, additional engineering assessments and monitoring programs would be necessary to monitor the embankment for indications of distress, such as deformation or cracking, throughout the cutoff wall construction process. Appropriate measures would be taken to stabilize the embankment if instability is detected.
  - The construction of the cutoff wall would require temporarily removing a portion of the previously installed WAPS final cover in areas where conflict with the cutoff wall. This procedure may allow additional stormwater to infiltrate the CCR, potentially leading to a temporary reversal of some positive effects that have occurred since the completion of the final cover system in 2020. A CCR-contact stormwater management system would be required to manage and discharge the contact stormwater *via* an NPDES permitted outfall.
  - The effectiveness of the cutoff wall relies on the construction techniques employed to prevent gaps, voids, or other discontinuities in the structure. Ongoing QC is essential during construction as part of QA activities to prevent such defective features. Additionally, QA programs, such as coring and testing, may be necessary to validate the quality of the constructed barrier.
  - The performance of the wall is contingent on its actual hydraulic conductivity. This necessitates ongoing monitoring and QA/QC testing for slurry mixing, placement, or soil-bentonite mixing. The goal is to ensure adherence to the designed mix and involves routine testing of samples from the wall material.

2.3.2 Expected Operational Reliability of the Remedy (IAC Section 845.670(e)(3)(B))

Source control (*i.e*., CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, the operational reliability of the remedy would be the same for both corrective action alternatives. Both corrective action alternatives would likely be highly reliable with respect to operational controls associated with residual plume management; specific details for each corrective action alternative are discussed below.

- Residual plume management under the Source Control-GWP alternative would have high operational reliability because it would rely on physical and geochemical processes and active

monitoring, rather than the installation, operation, and maintenance of engineered systems or structures (other than monitoring wells). Under the Source Control-GWP alternative, engineering failure would not occur, and no O&M activities would be required to ensure the success of the alternative. However, it should be noted that some arsenic re-mobilization may occur as groundwater returns to background conditions at WAPS, which may cause an impact to the time to achieve GWPS (Appendix E; Geosyntec Consultants, Inc., 2025).

- Residual plume management under the Source Control-CCS alternative would also have high operational reliability, because it is an established remedial technology, as long as it is constructed in accordance with standard design specifications for barrier walls, and the final cover system is maintained according to the existing Post-Closure Care Plan. This continuous containment system would provide full lateral (*i.e.*, through the deep cutoff wall), surface (*i.e.*, through the existing cover) isolation of CCR from the surrounding environment. The wall would be keyed into competent shale bedrock to provide additional subsurface containment below the WAPS. However, the remedy would require the temporary removal of a portion of the completed cover over the WAPS and potentially cause additional stormwater to percolate into the CCR and result in a temporary reversal of certain positive effects that have occurred since the completion of source control in 2020. These temporary impacts would diminish once the final cover system is repaired, and the continuous containment system would be present.
- Adaptive site management strategies would be used to implement remedy optimizations, if necessary under both corrective action alternatives.

2.3.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies (IAC Section 845.670(e)(3)(C))

Both corrective action alternatives would require regulatory approvals. Specific permits and approvals associated with source control were the same for both corrective action alternatives and were discussed in the Closure Plan (Geosyntec Consultants, Inc., 2017). The specific approvals and permits associated with residual plume management for both corrective action alternatives are discussed below.

- The Source Control-GWP alternative would not need additional permits from other agencies, other than the approval of the eventual Corrective Action Plan.
- The Source Control-CCS alternative would require approvals and permits, including construction stormwater controls and BMPs, a joint water pollution control construction and operating permit. An IDNR Dam Safety modification permit would also be required for modifications of the WAPS embankment. A modification to the existing NPDES permit would be necessary to discharge the CCR-contact stormwater generated during the construction phase. These permits and plans typically take 18 to 24 months to obtain.

2.3.4 Availability of Necessary Equipment and Specialists (IAC Sections 845.670(e)(3)(D) and 845.660(c)(1), "Ease of Implementation")

Source control (*i.e.*, CIP using a consolidate-and-cap approach) was implemented in 2020. Thus, there are no further equipment and specialist needs associated with the implementation of the source control remedy. Specialized equipment and personnel are essential for field data collection and groundwater sampling for residual plume management under both potential corrective action alternatives. Additionally, the assessment of groundwater concentrations for Site constituents would necessitate laboratory equipment and

specialists for both alternatives. The availability of equipment and specialists for each corrective action alternative is summarized below.

- Residual plume management under the Source Control-GWP alternative would require groundwater professionals, such as geologists, hydrogeologists, statisticians, and geochemists to conduct statistical analyses, ensuring that natural geochemical processes functions as anticipated in this alternative. The equipment and specialists needed for Site groundwater monitoring and analysis are currently engaged in these tasks as part of the routine groundwater monitoring program outlined in accordance with IAC Section 845.220(c)(4).
- Residual plume management under the Source Control-CCS alternative would require specialists for the construction phase of the cutoff wall.
    - Building the cutoff wall requires the expertise of a specialized contractor with a background in constructing similar types of walls in comparable geologic environments, like those found in the Illinois, Mississippi, and Ohio River Valleys. The contractor would probably need specialized equipment, including large cranes, clamshell buckets, slurry cutters, batch plants, or other equipment.
    - Specialists involved in the design and construction of cutoff walls would be essential during both phases. This team of specialists should include design engineers, construction managers, and contractor staff with expertise in cutoff wall construction and equipment operation.
    - Monitoring the WAPS embankments during cutoff wall construction would require expertise in geotechnical instrumentation, including the use of inclinometers, survey prisms, vibrating wire piezometers, and visual inspection for signs of distress. Specialized drilling and installation contractor would be needed to construct the geotechnical instrumentation system.
    - The types of equipment and specialists should have been employed for projects similar to designing and building cutoff walls. However, there may be backlogs associated with the equipment and specialists, due to the high existing demand for specialty ground improvement contractors and design specialists who are engaged with similar projects in sectors like electric utilities, dams/levees, and other areas.
    - Equipment and experts with geosynthetics design and installation, specifically with seaming new geosynthetics to an existing final cover system, would be required for the final cover system restoration. However, the experts and equipment's availability could be limited due to the high existing backlog due to ongoing projects in the solid waste management, electric utility, and other areas.
    - This alternative would also require the use of equipment and the expertise of specialists for tasks such as field data collection, groundwater sampling, groundwater sample analysis, and periodic corrective action groundwater monitoring and reporting. Similar to those in the Source Control-GWP alternative, these activities are already being conducted as part of routine groundwater monitoring in accordance with IAC Section 845.220(c)(4).

2.3.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services/Comply with Standards for Management of Wastes as Specified in Section 845.680(d) (IAC Section 845.670(e)(3)(E)/IAC Section 845.670(d)(5))

The available capacity and location of needed treatment, storage, and disposal services associated with residual plume management under each corrective action alternative is summarized below. All the practices employed in the three alternatives would comply with standards for the management of wastes as specified in IAC Section 845.670(e)(3)(E) and IAC Section 845.680(d)(5).

- Residual plume management for the Source Control-GWP remedy would not require any treatment, storage, or disposal services, because groundwater polishing (GWP) is not anticipated to produce a substantial amount of waste or wastewater, aside from minor purge water volumes generated during routine groundwater sampling activities for residual plume management. This could be managed by a standard waste management contractor.
- Residual plume management for the Source Control-CCS alternative would generate waste during the cutoff wall construction phase, which would include geosynthetics and other debris from removing the final cover system, cutoff wall spoils and contact stormwater.
    - Geosynthetics and other debris would be disposed of in an off-Site landfill that has sufficient volume to receive the relatively small amount of waste materials.
    - CCR-impacted cutoff wall spoils would be temporarily staged on-Site and then disposed either off-Site or beneficially used on-Site as compacted contouring fill beneath the East Ash Pond final cover system. The later disposal would require coordination with the East Ash Pond closure activities.
    - Non CCR-impacted spoils would be disposed of at an appropriate on-Site location.
    - CCR-contact stormwater generated during construction would be pumped to the on-Site treatment pond and then discharged *via* an NPDES permitted outfall.
    - No wastes would be expected to be generated after the cutoff wall is installed, and consequently, no additional treatment, storage, or disposal services would be necessary for this remedy.

2.4 The Degree to Which Community Concerns Are Addressed by the Remedy (IAC Section 845.670(e)(4))

Several nonprofits raised concerns regarding the potential impacts of the WAPS on groundwater and surface water quality (Earthjustice *et al*., 2018; Sierra Club and CIHCA, 2014). The combination of source control (*i.e*., CIP using a consolidate-and-cap approach) and residual plume management would cause groundwater concentrations to decline over time under all of the corrective action alternatives, as suggested by the groundwater modeling (Geosyntec Consultants, Inc., 2017; Appendix B; Ramboll, 2025b), thus addressing these concerns.

A public meeting was held on April 8, 2025, pursuant to requirements under IAC Section 845.710(e). Questions raised by attendees were answered at the meeting; a written summary of the questions and responses were prepared.

2.5 Remove from the Environment as Much of the Contaminated Material that Was Released from the CCR Surface Impoundment as Is Feasible, Taking into Account Factors such as Avoiding Inappropriate Disturbance of Sensitive Ecosystems (IAC Section 845.670(d)(4))

There have been no known releases of CCR at the WAPS (Ramboll, 2025d). Both potential corrective action alternatives include source control and would have residual plume management efforts. The source control included the consolidation of CCR excavated from the OWPP into the OWAP portion of the WAPS

and the installation of a low-permeability final cover system designed to limit the infiltration of precipitation into the impounded CCR. Groundwater modeling was performed in support of the Closure Plan (Geosyntec Consultants, Inc., 2017) predicted that source control would result in the reduction of leachate production, a decrease in CCR leachate constituent concentrations, and a contraction of the groundwater contaminant plume (Geosyntec Consultants, Inc., 2017). Due to the reduction in the hydraulic flux out of the WAPS, the mass flux out of the WAPS would also be controlled. Therefore, source control is preventing further releases of CCR constituents into the environment.

Moreover, residual plume management under each corrective action alternative will further result in the removal of contaminated material from the environment and/or the improvement of downgradient groundwater quality. Groundwater modeling has predicted that GWPSs would be achieved in all monitoring wells within 29 years, and 38 to 40 years (33 years as suggested by groundwater modeling and 5 to7 years of pre-construction under the Source Control-GWP and Source Control-CCS alternatives, respectively, assuming both alternatives start after approval of the corrective action plan) (Appendix B; Ramboll, 2025a). Specific considerations for residual plume management for each alternative are provided below.

- Residual plume management under the Source Control-GWP alternative would address impacted groundwater by relying on physical and geochemical attenuation processes to reduce the residual concentrations of CCR. Site-specific evaluations have shown that groundwater polishing would reduce the groundwater concentrations and mobility of inorganic contaminants (including boron and sulfate), through physical and geochemical attenuation mechanisms, especially after the implementation of source control (Appendix E; Geosyntec Consultants, Inc., 2025). However, it should be noted some arsenic re-mobilization may occur as groundwater returns to background conditions at WAPS, which may cause an impact to the time required to achieve GWPS (Appendix E; Geosyntec Consultants, Inc., 2025). In cases in which observed groundwater concentrations deviate significantly from modeled conditions, alternative methods or techniques would be evaluated under the adaptive site management, and if viable, incorporated as per IAC Section 845.680(b). No ecosystems would be disturbed because no construction activities are expected under the Source Control-GWP alternative.
- Residual plume management under the Source Control-CCS alternative would employ the cutoff wall which would be incorporated into the final WAPS cover system to create a continuous low-permeability barrier that fully contains the CCR within the WAPS. This system ensures isolation from the surrounding environment through lateral containment by the deep cutoff wall, surface containment by the existing geomembrane cover, and a natural barrier provided by the competent shale bedrock below. The temporary removal of a portion of the final cover system implemented during closure in 2020 would occur during construction, which would generate CCR-contact stormwater that would be managed appropriately. These construction activities may cause some negative impacts on natural resources and habitat located atop the WAPS final cover system and near the Site. However, the total duration of the construction is expected to be 18 to 24 months, so any construction-related impacts to ecosystems would be limited to the short term and would diminish once construction is completed.
- Although both corrective action alternatives include source control and residual plume management, Source Control-CCS would be more effective at controlling sources of releases than Source Control-GWP for the WAPS.

2.6 Summary

This CAAA evaluates both corrective action alternatives identified as potentially viable in the CMA with regard to each of the factors specified in IAC Section 845.670(d) and 845.670(e) (IEPA, 2021). Based on this evaluation, the most appropriate corrective action for this Site is Source Control-CCS.

Although the expected impacts on workers, nearby communities, and the environment under the Source Control-GWP alternative are lower than the Source Control-CCS alternative, the Source Control-CCS alternative would provide full containment of the CCR within WAPS and be more effective at controlling sources of releases than Source Control-GWP. Controlling the source of releases using CCS is particularly important at this Site because of the high groundwater transmissivity associated with the sands and gravels in the UA. Thus, Source Control-CCS is the most appropriate corrective action alternative for the WAPS.

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Appendix A

Human Health and Ecological Risk Assessment

Human Health and Ecological Risk Assessment
West Ash Pond System
Hennepin Power Plant
Hennepin, Illinois

May 6, 2025

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Abbreviations

ADI	Acceptable Daily Intake
BCF	Bioconcentration Factor
BCU	Bedrock Confining Unit
CAAA	Corrective Action Alternative Analysis
CCR	Coal Combustion Residual
CEM	Conceptual Exposure Model
CIP	Closure-In-Place
COI	Constituent of Interest
COPC	Constituent of Potential Concern
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
CWS	Community Water Supply Well
DMG	Dynegy Midwest Generation
ESV	Ecological Screening Value
GWPS	Groundwater Protection Standards
GWQS	Groundwater Quality Standards
HPP	Hennepin Power Plant
HTC	Human Threshold Criteria
IAC	Illinois Administrative Code
ID	Identification
IEPA	Illinois Environmental Protection Agency
ISGS	Illinois State Geological Survey
MCL	Maximum Contaminant Level
NRWQC	National Recommended Water Quality Criteria
ORNL RAIS	Oak Ridge National Laboratory's Risk Assessment Information System
OWAP	Old West Ash Pond
OWPP	Old West Polishing Pond
PWS	Public Water System
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
SDWIS	Safe Drinking Water Information System
SWQS	Surface Water Quality Standards
TDS	Total Dissolved Solids
TEC	Threshold Effect Concentration
UAU	Uppermost Aquifer Unit
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
USGS	US Geological Survey
WAPS	West Ash Pond System

1 Introduction

Dynegy Midwest Generation (DMG) Company's Hennepin Power Plant (HPP, or "the Site") is an electric power-generating facility with coal-fired units located in Hennepin, Illinois. The facility began operations in the early 1950s and was retired in 2019 (Ramboll, 2021). The HPP produced and stored coal combustion residuals (CCRs) as a part of its historical operations in several CCR ash ponds. Ponds located east of the power plant include East Ash Pond No. 2, East Ash Pond No. 4, East Ash Pond, Leachate Pond, and Polishing Pond. The West Ash Pond System (WAPS) consists of the Old West Ash Pond (OWAP, which includes Pond No. 1 and Pond No. 3) and Old West Polishing Pond (OWPP) (Vistra identification [ID] number [No.] 804, Illinois Environmental Protection Agency [IEPA] ID No. W1550100002-01 and W1550100002-03), and is the subject of this report.

This report presents the results of an evaluation that characterizes potential risk to human and ecological receptors that may be exposed to CCR constituents in environmental media potentially impacted by the WAPS. This risk evaluation was performed to support the Corrective Action Alternative Analysis (CAAA) for the WAPS in accordance with requirements in Title 35 Part 845.670 of the Illinois Administrative Code (IAC) (IEPA, 2021). Human and ecological risks were evaluated for Site-specific constituents of interest (COIs). The conceptual site model (CSM) assumed that Site-related COIs in groundwater may migrate to the Illinois River and affect surface water and sediment in the vicinity of the Site.

Consistent with United States Environmental Protection Agency (US EPA) guidance (US EPA, 1989), this report uses a tiered approach to evaluate potential risks, including the following steps:

1. Identify complete exposure pathways and develop a conceptual exposure model (CEM).
2. Identify Site-related COIs: Constituents detected in groundwater were considered COIs if their maximum detected concentration over the period from 2015 to 2021 exceeded a groundwater protection standard (GWPS), identified in Part 845.600 (IEPA, 2021), or a relevant surface water quality standard (IEPA, 2019a; US EPA Region IV, 2018).
3. Perform screening-level risk analysis: Compare maximum measured or modeled COI concentrations in surface water and sediment to conservative, health-protective benchmarks to determine constituents of potential concern (COPCs).
4. Perform refined risk analysis: If COPCs are identified, perform a refined analysis to evaluate potential risks associated with the COPCs.
5. Formulate risk conclusions and discuss any associated uncertainties.

This assessment relies on a conservative (*i.e.*, health-protective) approach and is consistent with the risk approaches outlined in US EPA guidance. Specifically, we considered evaluation criteria detailed in IEPA guidance documents (*e.g.*, IEPA, 2013, 2019a), incorporating principles and assumptions consistent with the Federal CCR Rule (US EPA, 2015a) and US EPA's "Human and Ecological Risk Assessment of Coal Combustion Residuals" (US EPA, 2014).

US EPA has established acceptable risk metrics. Risks above these US EPA-defined metrics are termed potentially "unacceptable risks." Based on the evaluation presented in this report, no unacceptable risks to human and ecological receptors resulting from CCR exposures associated with the WAPS were identified. Specific risk assessment results include the following:

- No completed exposure pathways were identified for any groundwater receptors; consequently, no risks were identified relating to the use of groundwater.
- No unacceptable risks were identified for recreators swimming or boating in the Illinois River adjacent to the Site.
- No unacceptable risks were identified for recreators exposed to sediment in the Illinois River adjacent to the Site.
- No unacceptable risks were identified for anglers consuming locally caught fish.
- No unacceptable risks were identified for ecological receptors exposed to surface water or sediment.
- No bioaccumulative ecological risks were identified.

It should be noted that this evaluation incorporates a number of conservative assumptions that tend to overestimate exposure and risk. Moreover, it should be noted that because current conditions do not present a risk to human health or the environment, there will also be no unacceptable risk to human health or the environment for future conditions because the WAPS was already closed in 2020. For all future closure scenarios, potential releases of CCR-related constituents will decline over time and consequently potential exposures to CCR-related constituents in the environment will also decline.

2 Site Overview

2.1 Site Description

The HPP is located four miles northeast of the Village of Hennepin in north central Illinois in Putnam County. The HPP property is bordered on the north by the Illinois River, on the south and east by industrial properties, and on the west by agricultural land. The Illinois River flows past the facility from east to west.

The CCR ash ponds located to the west of the power plant include the OWAP and the OWPP, collectively known as the WAPS (OBG, 2019) (Figure 2.1). The WAPS was closed in 2020 using closure-in-place (CIP) with a consolidate-and-cap approach, which included "removal of CCR and dike soils in the OWPP and consolidation of these materials into the OWAP" (OBG, 2019), and "capping [the OWAP] with a geosynthetic and soil final cover system" (Ramboll, 2025a). The WAPS is the subject of this report.

2.2 Geology/Hydrogeology

The geology underlying the Site in the vicinity of the WAPS consists of unlithified deposits of the Cahokia Alluvium and the Henry Formation, underlain by a thick shale bedrock (NRT, 2017; OBG, 2019). The Cahokia Alluvium consists of fine-grained silt, clay, and sand, whereas the underlying Henry Formation is composed of highly permeable sand and gravel (NRT, 2017; OBG, 2019). The Cahokia Alluvium deposits are absent in the eastern portion of the WAPS; in this area, the WAPS lies directly over Henry Formation (OBG, 2019). The thickness of the Cahokia Alluvium in the western part of the WAPS ranges from 10 to 40 ft (NRT, 2017). The Henry formation ranges from 5 to 35 ft thick (NRT, 2017).

Three distinct hydrostratigraphic units have been identified in the area near the WAPS (NRT, 2017; OBG, 2019):

- **Fill Unit:** The Fill Unit directly underlies the WAPS. It is comprised primarily of fly ash, with small amounts of bottom ash and slag mixed with sand, silt, and clay. During closure of the OWPP in 2020, CCRs in the ash pond and one foot of soils below the ash pond were removed.
- **Uppermost Aquifer Unit (UAU):** The UAU is comprised of mixed alluvial deposits (classified as Cahokia alluvium consisting of clay, silt, and sand) and coarser grained outwash sand and gravel deposits (classified as Henry Formation).
- **Bedrock Confining Unit (BCU):** The BCU consists of Pennsylvanian age shale bedrock with minor layers of limestone, sandstone, and coal. This low permeability unit defines the lower boundary of the Uppermost Aquifer Unit at the WAPS.

The Illinois River, located less than 0.1 mile north of the WAPS, is the major surface water body in the area. Groundwater in the UAU predominantly flows to the north/northwest, consistent with the surface topography, into the Illinois River (OBG, 2019). Prior to the closure during the impoundment operations, substantial local recharge to groundwater from sluicing of ash created radial flow conditions near the Site (Ramboll, 2025a). A groundwater flow reversal (*i.e.*, groundwater flows in a south to southwest direction toward the wetlands) may occur during high river stages or flooding events when the Illinois River stage elevation is higher than surrounding groundwater elevations. The normal horizontal hydraulic gradient

near the WAPS is approximately 0.005 ft/ft (NRT, 2017; OBG, 2019). Under normal post-closure conditions, groundwater flows northward toward the river from the WAPS (Ramboll, 2025a). The low permeability bedrock aquitard acts as a barrier to downward migration of groundwater from the UAU (NRT, 2017).

2.3 Conceptual Site Model

A CSM describes sources of contamination, the hydrogeological units, and the physical processes that control the transport of water and solutes. In this case, the CSM describes how groundwater underlying the WAPS migrates and interacts with surface water and sediment in the adjacent Illinois River. The CSM was developed using available hydrogeological data (NRT, 2017; OBG, 2019; USGS, 2021a; Tetra Tech, 2012), including information on groundwater flow and surface water characteristics.

The highly permeable Henry Formation of the UAU, consisting of sands and gravels, is the primary conduit for groundwater flowing into the Illinois River (Ramboll, 2021). The downward groundwater migration from the UAU to underlying units is significantly limited due to the presence of thick, low-permeability shale bedrock, which acts as a confining layer (NRT, 2017). Other than flow into the Illinois River, no other potential groundwater transport pathways have been identified for the UAU (NRT, 2017). Because the Illinois River is a large regional hydraulic boundary (*i.e.*, serves as a sink for groundwater discharges in the area), all shallow groundwater underlying the WAPS is expected to flow into the river.

Near the WAPS, groundwater flowing into the Illinoi River mixes with surface water. During mixing, dissolved constituents in groundwater may partition between sediments and surface water.

Figure 2.1 Site Location Map. Source: Ramboll (2025b).

2.4 Groundwater Monitoring

Thirteen wells screened in the UAU have been used to monitor the groundwater quality near and downgradient of the WAPS (Table 2.1). The analyses presented in this report relied on all available data from the 13 wells collected between 2018 and 2023. Groundwater samples were analyzed for a suite of metals, both total and dissolved, specified in Illinois CCR Rule Part 845.600 (IEPA, 2021).[1] A summary of the groundwater data used in this risk evaluation is presented in Table 2.2. The WAPS-related well locations are shown in Figure 2.2. The use of groundwater data in this risk evaluation does not imply that detected constituents are associated with the WAPS or that they have been identified as potential groundwater exceedances.

[1] Samples were analyzed for a longer list of inorganic constituents and general water quality parameters (chloride, fluoride, sulfate, and total dissolved solids), but these constituents were not evaluated in the risk evaluation.

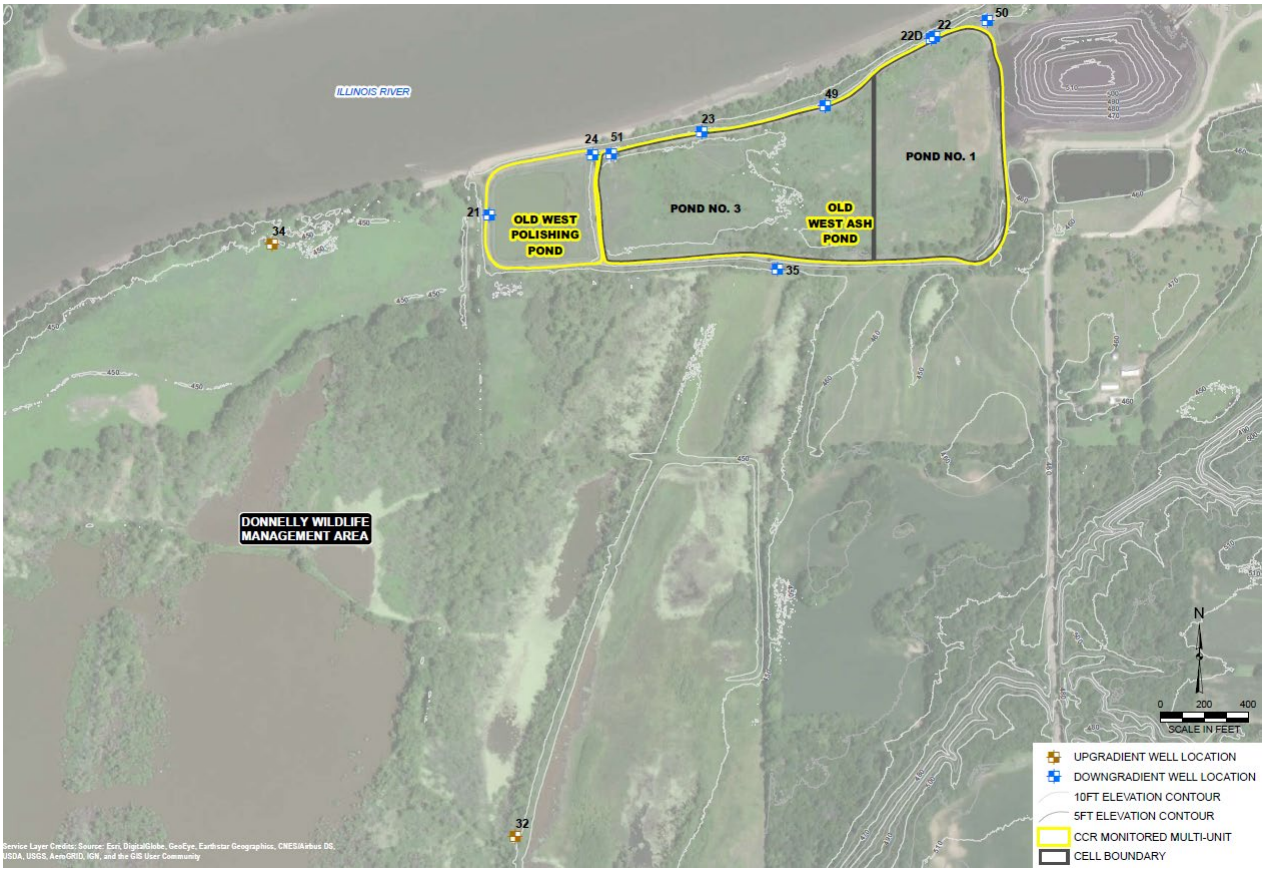

Figure 2.2 West Ash Pond Monitoring Well Locations. Source: OBG (2019). Well 51 was added from Ramboll (2023).

Table 2.1 Groundwater Monitoring Wells Related to Hennepin West Ash Pond[a]

Well ID	Date Constructed	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Well Depth from Ground Surface (ft BGS)	Hydrogeologic Unit
21 (W-1)	Dec-1982	49.0	59.0	59.6	UAU
21R	Feb-2020	37.6	47.6	47.9	UAU
22 (W-2)	Dec-1982	24.4	34.4	34.6	UAU
22D	Aug-2019	49.7	59.7	59.7	UAU
23 (W-3)	Dec-1982	34.0	44.0	45.2	UAU
24 (W-4)	Dec-1982	56.4	66.4	64.5	UAU
27	Sep-1995	30.0	35.0	36.3	UAU
32	Aug-1996	7.0	17.0	17.3	UAU
34	Aug-1996	30.0	35.0	35.0	UAU
35	Sep-1999	8.0	18.0	17.6	UAU
49	Jul-2015	35.0	45.0	45.0	UAU
50	Aug-2019	19.6	29.6	29.6	UAU
51	Feb-2020	56	66	66.3	UAU

Notes:
BGS = Below Ground Surface; UAU = Uppermost Aquifer Unit.
(a) Table lists the wells with data from 2018-2023 that were used in this risk assessment.
Source: NRT (2017); Geosyntec (2020); Ramboll (2019).

Table 2.2 Groundwater Data Summary (2018-2023)

Parameter	Samples with Constituent Detected	Samples Analyzed	Minimum Detect	Maximum Detect	Maximum Detection Limit
Total Metals (mg/L)					
Antimony	7	231	0.00060	0.0012	0.0013
Arsenic	118	243	0.00028	0.038	0.0087
Barium	231	231	0.013	0.40	0.001
Beryllium	1	229	0.00030	0.00030	0.001
Boron	243	243	0.075	18	0.037
Cadmium	75	231	0.00020	0.0096	0.001
Chromium	39	231	0.00070	0.0078	0.0028
Cobalt	165	231	0.00020	0.0099	0.001
Iron	36	37	0.037	11	0.047
Lead	60	231	0.00020	0.0066	0.004
Lithium	241	243	0.0028	0.076	0.005
Manganese	37	37	0.012	1.3	0.0025
Mercury	1	220	0.00059	0.00059	0.0002
Molybdenum	219	243	0.00070	0.21	0.0037
Selenium	26	231	0.00070	0.032	0.001
Thallium	1	231	0.0036	0.0036	0.002
Dissolved Metals (mg/L)					
Antimony	0	3	ND	ND	0.001
Arsenic	8	15	0.0010	0.016	0.001
Barium	3	3	0.035	0.11	7E-07
Beryllium	0	3	ND	ND	0.001
Boron	129	129	0.069	17	0.015
Cadmium	1	3	0.0057	0.0057	0.001
Chromium	0	3	ND	ND	0.0015
Cobalt	1	3	0.0027	0.0027	0.001
Iron	28	44	0.028	6.8	0.047
Lead	0	3	ND	ND	0.001
Lithium	4	4	0.0047	0.058	0.0005
Manganese	44	44	0.0044	1.3	0.0025
Molybdenum	16	16	0.0058	0.14	0.0006
Selenium	1	3	0.021	0.021	0.001
Thallium	0	3	ND	ND	0.002
Other (mg/L or SU)					
Chloride	250	250	23	115	25
Fluoride	220	228	0.090	0.24	1
pH (field)	243	243	6.2	7.8	NA
Sulfate	250	250	37	1,190	307
Total Dissolved Solids	250	250	338	1,940	40
Radionuclides (pCi/L)					
Radium 226 + Radium 228	103	158	ND	3.1	1.8

Source: Ramboll (2024).
Note: NA = Not Applicable; ND = Not Detected.

2.5 Surface Water Monitoring

Surface water samples were collected at 15 locations in September 2020 and one location in February 2021 in the Illinois River adjacent to the HPP. The 2020 samples were collected along five transects, with three samples per transect collected from the two edges and the center of the river (Figure 2.3). Sample set IR-01 was collected approximately one mile upstream of the HPP. Sample sets IR-02, IR-03, and IR-04 and IR-05 were located upstream of the WAPS, and set IR-05 was located downstream of the WAPS. Sample SG02 (February 2021) was located adjacent to the plant (Figure 2.3). It should be noted that many constituents occur naturally in the environment and/or could be associated with industrial activities unrelated to the WAPS. The use of surface water data in this risk assessment does not imply that any constituents are associated with the WAPS. A summary of the surface water data used in this risk evaluation is presented in Table 2.3.

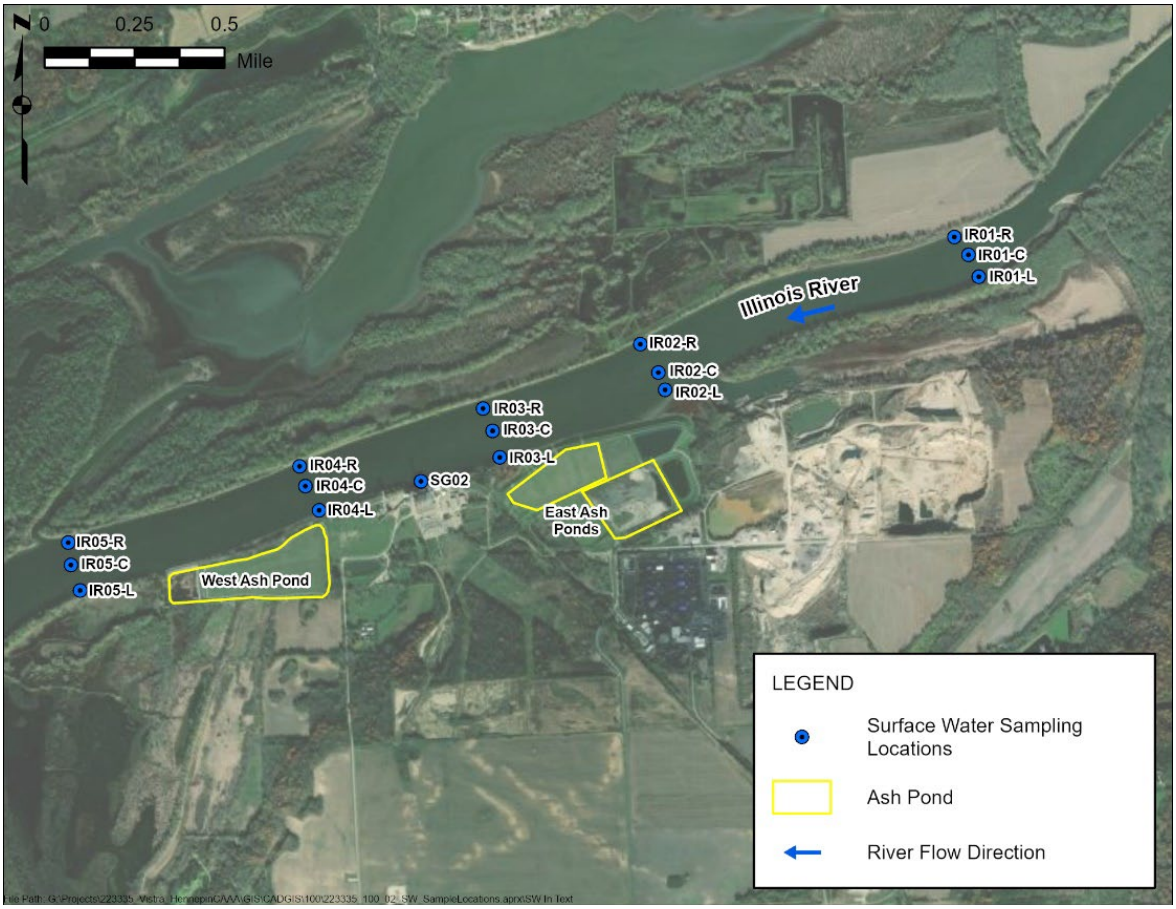

Figure 2.3 Surface Water Sampling Locations. Source: Modified from Geosyntec (2021).

Table 2.3 Surface Water Data Summary

Parameter	Samples with Constituent Detected	Samples Analyzed	Minimum Detect (mg/L)	Maximum Detect (mg/L)	Maximum Detection Limit (mg/L)
Total Metals					
Antimony	0	1	ND	ND	0.001
Arsenic	1	1	0.0012	0.0012	4E-07
Barium	1	1	0.052	0.052	7E-07
Beryllium	0	1	ND	ND	0.001
Boron	1	1	0.22	0.22	--
Cadmium	0	1	ND	ND	0.001
Calcium	1	1	88	88	--
Chromium	0	1	ND	ND	0.0015
Cobalt	0	1	ND	ND	0.001
Iron	1	1	0.24	0.24	1E-05
Lead	0	1	ND	ND	0.001
Lithium	1	1	0.0080	0.0080	--
Magnesium	1	1	35	35	--
Manganese	1	1	0.060	0.060	--
Molybdenum	1	1	0.0061	0.0061	6E-07
Potassium	1	1	6.6	6.6	8E-05
Selenium	0	1	ND	ND	0.001
Sodium	1	1	227	227	--
Thallium	0	1	ND	ND	0.002
Dissolved Metals					
Aluminum	1	15	0.64	0.64	0.025
Antimony	0	16	ND	ND	0.001
Arsenic	16	16	0.0011	0.0034	4E-07
Barium	16	16	0.035	0.049	7E-07
Beryllium	0	16	ND	ND	0.001
Boron	16	16	0.13	0.21	9E-06
Cadmium	0	16	ND	ND	0.001
Calcium	16	16	46	85	--
Chromium	1	16	0.015	0.015	0.015
Cobalt	0	16	ND	ND	0.001
Copper	15	15	0.0016	0.0035	–
Iron	1	16	1.1	1.1	0.025
Lead	1	16	0.0020	0.0020	0.001
Lithium	16	16	0.0071	0.0083	2E-06
Magnesium	16	16	24	30	2E-05
Manganese	3	16	0.010	0.083	0.002
Molybdenum	16	16	0.0048	0.0063	6E-07
Nickel	15	15	0.0026	0.0045	–
Potassium	1	1	6.3	6.3	8E-05
Selenium	0	16	ND	ND	0.001
Silver	0	15	ND	ND	0.001
Sodium	16	16	61	222	--
Strontium	15	15	0.23	0.26	–

Parameter	Samples with Constituent Detected	Samples Analyzed	Minimum Detect (mg/L)	Maximum Detect (mg/L)	Maximum Detection Limit (mg/L)
Thallium	0	16	ND	ND	0.002
Vanadium	0	15	ND	ND	0.005
Zinc	0	15	ND	ND	0.015
Other					
Chloride	16	16	97	282	5
pH	16	16	8.6	8.6	--
Sulfate	16	16	73	94	25
Total Dissolved Solids	11	11	368	878	16

Notes:
– = Not Available; ND = Not Detected.
Data collected 9/2/20 and 2/25/21.

3 Risk Evaluation

3.1 Risk Evaluation Process

A risk evaluation was conducted to determine whether constituents present in groundwater underlying and downgradient of the WAPS have the potential to pose adverse health effects to human and ecological receptors. The risk evaluation is consistent with the principles of risk assessment established by US EPA and has considered evaluation criteria detailed in Illinois guidance documents (*e.g.*, IEPA, 2013, 2019a).

The general risk evaluation approach is summarized in Figure 3.1 and discussed below.

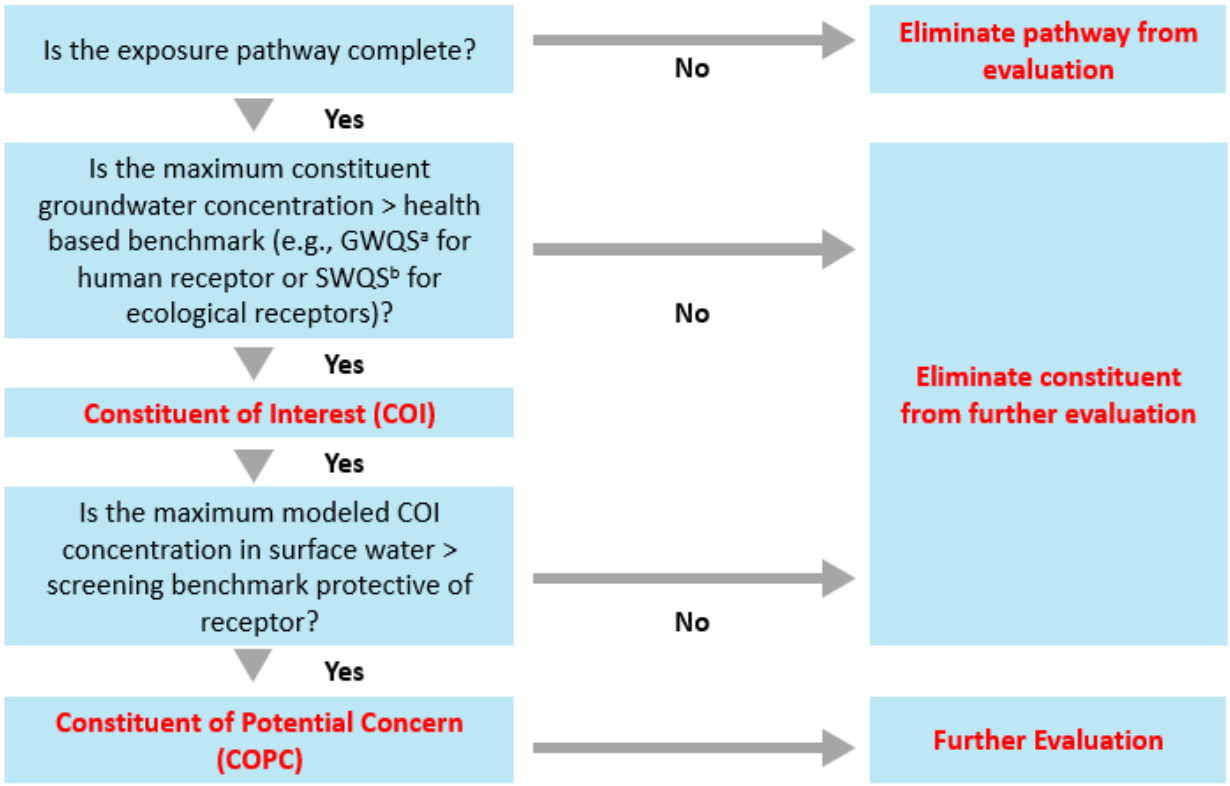

Figure 3.1 Overview of Risk Evaluation Methodology. Notes: IEPA = Illinois Environmental Protection Agency; GWQS = IEPA Groundwater Quality Standards; SWQS = IEPA Surface Water Quality Standards; US EPA = United States Environmental Protection Agency.
(a) The IEPA Part 845 groundwater protection standards were used to identify COIs.
(b) IEPA SWQS protective of chronic exposures to aquatic organisms were used to identify ecological COIs. In the absence of an SWQS, US EPA Region IV ecological screening values were used.

The first step in the risk evaluation was to develop the CEMs and identify complete exposure pathways. All potential receptors and exposure pathways based on groundwater use and surface water use in the

vicinity of the Site were considered. Exposure pathways that are incomplete were excluded from the evaluation.

Groundwater data were used to identify COIs. COIs were identified as constituents with maximum concentrations in groundwater in excess of groundwater quality standards (GWQS)[2] for human receptors and surface water quality standards (SWQS) for ecological receptors. Based on the CSM (Section 2.2), groundwater underlying the WAPS flows from south to north toward the Illinois River. Therefore, any potential WAPS-related constituents in groundwater would flow toward and into surface water.

Surface water samples have been collected from the Illinois River adjacent to the Site; however, sediment samples have not been collected from the river. Gradient modeled the potential migration of COIs from groundwater to surface water and sediment to evaluate potential risks to receptors (see Section 3.3.3). Gradient modeled the COI concentrations in surface water and sediment based on the groundwater data from the WAPS-related groundwater monitoring wells. The measured and modeled COI concentrations in surface water and the modeled sediment concentrations were compared to conservative, generic risk-based screening benchmarks for human health and ecological receptors. These generic screening benchmarks rely on default assumptions with limited consideration of site-specific characteristics. Human health benchmarks are receptor-specific values calculated for each pathway and environmental medium that are designed to be protective of human health. Ecological benchmarks are medium-specific values designed to be protective of all potential ecological receptors exposed to surface water. Ecological and human health screening benchmarks are inherently conservative because they are intended to screen out chemicals that are of no concern with a high level of confidence. Therefore, a measured or modeled COI concentration exceeding a screening benchmark does not indicate an unacceptable risk, but only that further risk evaluation is warranted. COIs with maximum concentrations exceeding a conservative screening benchmark are identified as COPCs requiring further evaluation.

As described in more detail below, this evaluation relied on the screening assessment to demonstrate that constituents present in groundwater underlying the WAPS do not pose an unacceptable human health or ecological risk. That is, after the screening step, no COPCs were identified and further assessment was not warranted.

3.2 Human and Ecological Conceptual Exposure Models

A CEM provides an overview of the receptors and exposure pathways requiring risk evaluation. The CEM describes the source of the contamination, the mechanism that may lead to a release of contamination, the environmental media to which a receptor may be exposed, the route of exposure (exposure pathway), and the types of receptors that may be exposed to these environmental media.

3.2.1 Human Conceptual Exposure Model

The human CEM for the Site depicts the relationships between the off-Site environmental media potentially impacted by constituents in groundwater and human receptors that could be exposed to these media. Figure 3.2 presents a human CEM for the Site. It considers a human receptor who could be exposed to COIs hypothetically released from the WAPS into groundwater, surface water, sediment, and fish. The following human receptors and exposure pathways were evaluated for inclusion in the Site-specific CEM.

[2] As discussed further in Section 3.3.2, GWQS are protective of human health and not necessarily of ecological receptors. While ecological receptors are not exposed to groundwater, groundwater can potentially enter into the adjacent surface water and impact ecological receptors. Therefore, two sets of COIs were identified: one for humans and another for ecological receptors.

- Residents – exposure to groundwater/surface water as drinking water;
- Residents – exposure to groundwater/surface water used for irrigation;
- Recreators in the river near the Site:
  - Boaters – exposure to surface water and sediment while boating;
  - Swimmers – exposure to surface water and sediment while swimming;
  - Anglers – exposure to surface water and sediment and consumption of locally caught fish.

All of these exposure pathways were considered complete except for residential exposure to groundwater or surface water used for drinking water or irrigation. Section 3.2.1.1 explains why the residential drinking water and irrigation pathways are incomplete, and Section 3.2.1.2 provides additional description of the recreational exposures.

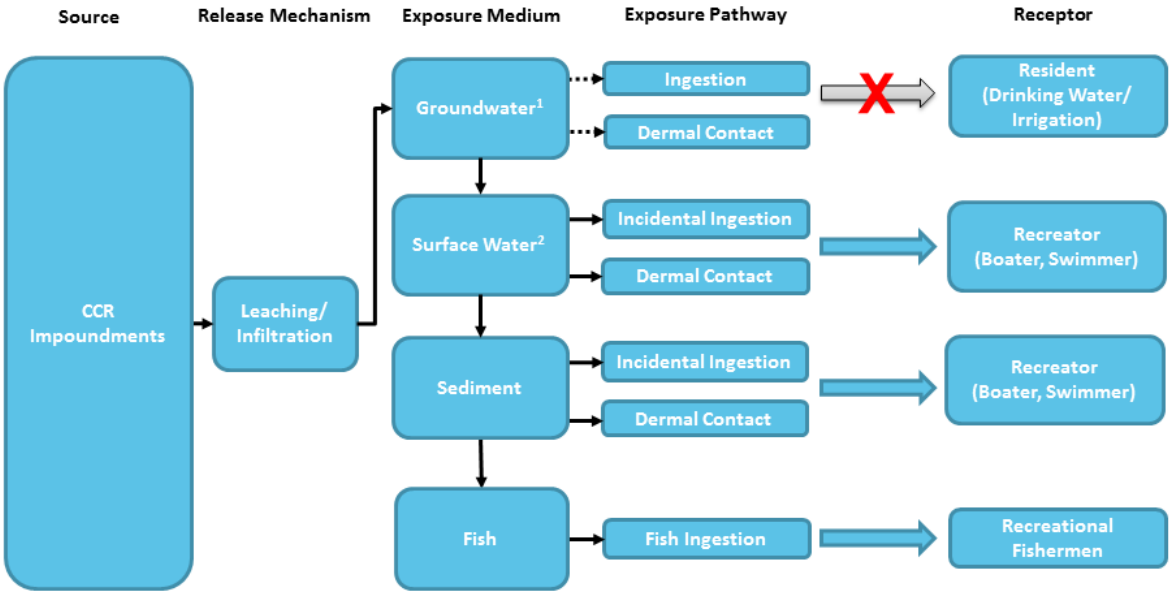

Figure 3.2 Human Conceptual Exposure Model. Notes: CCR = Coal Combustion Residual. Dashed line/Red X indicates incomplete or insignificant exposure pathway.
(1) Groundwater in the vicinity of the Site is not used as a drinking water or irrigation source.
(2) Surface water is not used as a drinking water source.

3.2.1.1 Groundwater or Surface Water as a Drinking Water/Irrigation Source

Groundwater as a source of drinking water and/or irrigation water is not a complete exposure pathway for CCR-related constituents originating from the WAPS. Specifically, shallow groundwater from the UAU in the vicinity of the WAPS is not used as a source of drinking water, and no public groundwater systems are downgradient of the site. Further, the downward migration of groundwater from the UAU is restricted due to the presence of a thick shale bedrock (NRT, 2017). A summary of the evidence supporting the conclusion that there are no residential uses of the shallow groundwater and Illinois River surface water as a source of drinking water is presented below:

- **No potential groundwater receptors are in the vicinity of the WAPS**. The public water systems (PWS) in the Putnam and Bureau Counties in the vicinity of the Hennepin WAPS rely on groundwater as a source of potable water. A review of existing drinking water intakes within the US EPA Safe Drinking Water Information System (SDWIS) (US EPA, 2024), IEPA Illinois Drinking Water Watch (IEPA, 2024a), and IEPA Map Server (IEPA, 2024b) databases yielded no PWS wells within 1,000 meters of the Site, as described below.
    - A total of 10 wells were identified within a 1,000-meter radius of the WAPS during a comprehensive search of the Illinois State Geological Survey (ISGS) Illinois Water and Related Wells (ILWATER) Map (ISGS, 2024b) (Figure 3.3). Under normal groundwater flow conditions, 2 out of the 10 wells are located downgradient from the WAPS (Well IDs 121552089500, and 121552089600), and the remaining 8 wells are located upgradient and/or side-gradient (Well IDs 121550009400, 121550009500, 121550012800, 121552043500, 121552059800, 121552059900, 121552070200, and 121552091200).
    - All 10 wells located within a 1,000-meter radius of the WAPS are listed as being owned by either "Power Plant", Illinois Power Company, Hennepin Power Station, or Dynegy Midwest-Hennepin Power (ISGS, 2024b). The wells include three monitoring wells; one irrigation well,[3] one industrial well, four wells with non-specific use, and one non-community public water well (ISGS, 2024b). The non-community public water well (121552043500) was installed in 1993 and is 120 feet deep; it is screened in sand and gravel from 90 to 115 feet bgs. However, this well is side-gradient to the WAPS (Figure 3.3).
    - A 2009 water well survey conducted in the area by Kelron/Natural Resource Technology concluded that CCR-impacted groundwater at the HPP is not likely to impact any existing potable or non-potable off-Site water wells that are located within 2,500 ft of the property boundary (Ramboll, 2018-2020; NRT, 2017).
    - In a letter to IEPA (Morris, 2021), DMG noted that 16 private wells were identified near the Site, with 1 well located potentially downgradient of the Site. However, DMG noted that this well is unlikely to be in use, based on the installation date (1884) and its remote floodplain location. DMG noted that three non-community water supply wells (CWS) were identified but that they are unlikely to be at risk because they are either inactive and/or not-located hydraulically downgradient of the WAPS.
- **There is no off-Site migration of WAPS-related constituents to nearby wells because all shallow groundwater flows into the Illinois River**. The Illinois River is the regional discharge point for groundwater in the UAU. Groundwater in the UAU flows to north/northwest into the Illinois River under normal conditions (OBG, 2019). Because the Illinois River is a large regional hydraulic boundary (*i.e.*, serves as a sink for groundwater discharges in the area), any potential constituents present in groundwater underlying the WAPS are not likely to migrate under or beyond the river.
- **The Illinois River adjacent to the Site is not used as a public water supply.** IEPA classified the Illinois River as a "General Use Water." IEPA fully supports the use of the Illinois River for aquatic life and primary contact recreation, but it is not designated for public and food processing water supplies. The segment of the Illinois River adjacent to the Site (Section D-16) is listed on the 2018 Illinois Section 303(d) List as being impaired for fish consumption, due to mercury and polychlorinated biphenyls (IEPA, 2016, IEPA, 2018 , IEPA, 2019b). Therefore, surface water adjacent to the Site is not used as a source of drinking water, and this exposure pathway was not evaluated further.

[3] The irrigation well is "used exclusively for irrigation of the coal pile." (NRT, 2017).

- **The WAPS has a limited hydraulic connection to underlying bedrock groundwater resources**. The bedrock aquitard is composed of a 300-400 ft thick shale unit of the Carbondale Formation (NRT, 2017). This thick, continuous shale bedrock forms a hydraulic barrier between the WAPS and deeper groundwater resources. Very low hydraulic conductivities of the shale bedrock and the lack of a downward gradient restrict any downward migration of shallow groundwater originating from the WAPS to the underlying aquifers (NRT, 2017).

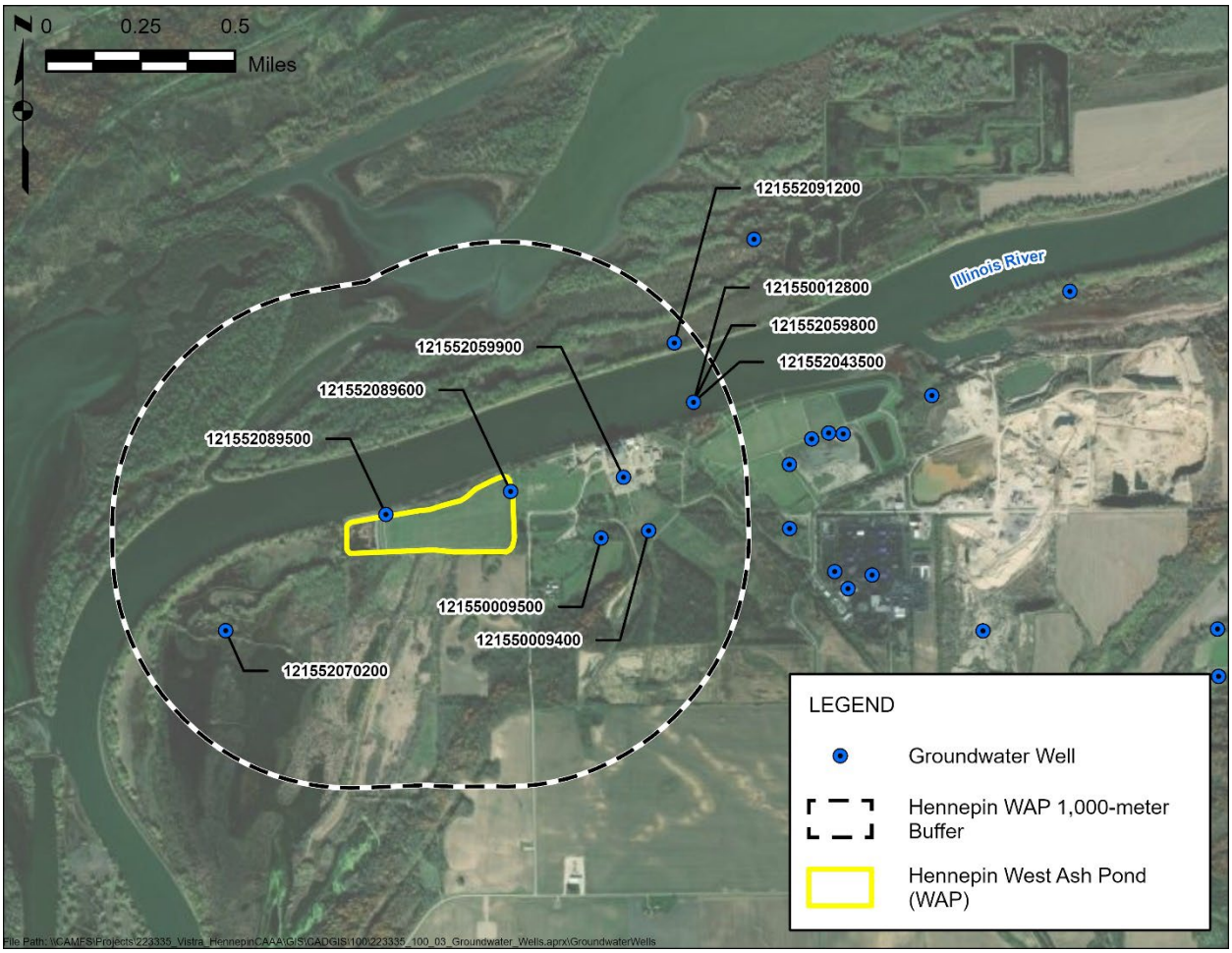

Figure 3.3 Water Wells Within 1,000 Meters of the West Ash Pond. Sources: Google LLC, 2024; ISGS, 2024b.

3.2.1.2 Recreational Exposures

The Illinois River flows east to west past the Site. Recreational exposure to surface water and sediment may occur during activities such as swimming or boating in the river. Exposure estimates for swimmers provide a health-protective means to evaluate exposure during other recreational activities. Recreational anglers may also consume locally caught fish from the Illinois River.

3.2.2 Ecological Conceptual Exposure Model

The ecological CEM for the Site depicts the relationships between off-Site environmental media (surface water and sediment) potentially impacted by COIs in groundwater and ecological receptors that may be

exposed to these media. The ecological risk evaluation considered both direct toxicity as well as secondary toxicity *via* bioaccumulation. Figure 3.4 presents the ecological CEM for the Site. The following ecological receptor groups and exposure pathways were considered:

- **Ecological Receptors Exposed to Surface Water:**
  - Aquatic plants, amphibians, reptiles, and fish.
- **Ecological Receptors Exposed to Sediment:**
  - Benthic invertebrates (*e.g.*, insects, crayfish, mussels).
- **Ecological Receptors Exposed to Bioaccumulative COIs:**
  - Higher trophic-level wildlife (avian and mammalian) *via* direct exposures (surface water and sediment exposure) and secondary exposures through the consumption of prey (*e.g.*, plants, invertebrates, small mammals, fish).

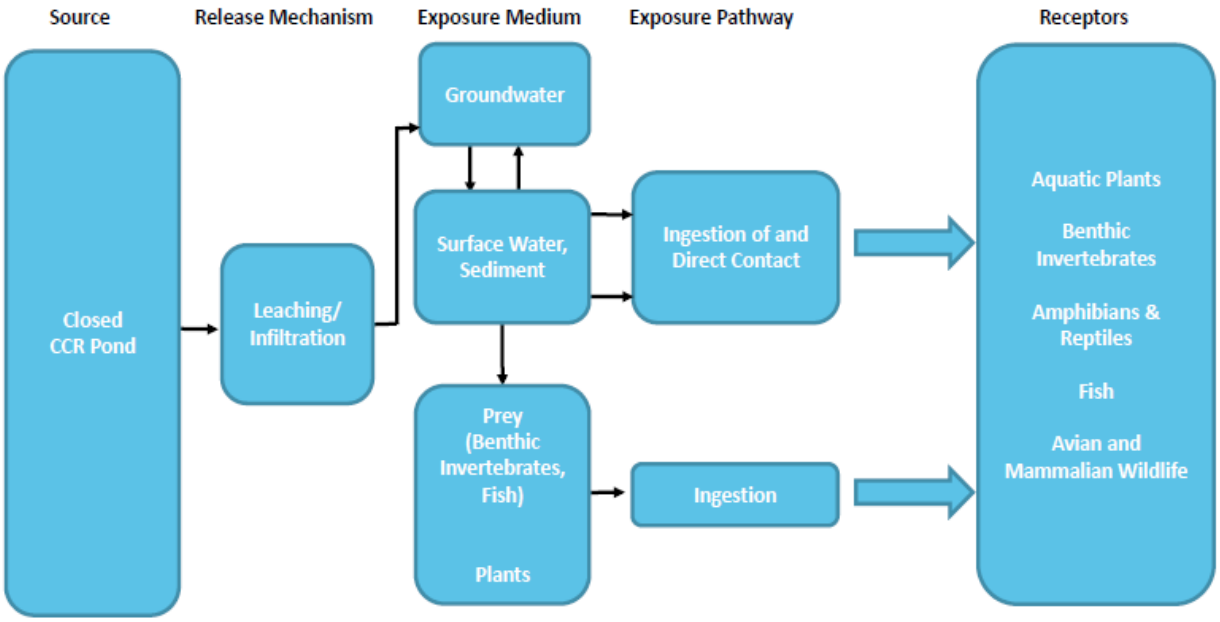

Figure 3.4 Ecological Conceptual Exposure Model. Notes: CCR = Coal Combustion Residual.

3.3 Identification of Constituents of Interest

Risks were evaluated for COIs. A constituent was considered a COI if the maximum detected constituent concentration in groundwater exceeded a health-based benchmark. According to US EPA risk assessment guidance (US EPA, 1989), this screening step is designed to reduce the number of constituents carried through the risk evaluation that are anticipated to have a minimal contribution to the overall risk. Identified COIs are the constituents that are most likely to pose a risk concern in the surface water adjacent to the Site.

3.3.1 Human Health Constituents of Interest

For the human health risk evaluation, COIs were conservatively identified as constituents with maximum concentrations in groundwater above the GWPSs listed in the Illinois CCR Rule Part 845.600 (IEPA, 2021). The use of groundwater data in this risk evaluation does not imply that detected constituents are associated

with the WAPS or that they have been identified as potential groundwater exceedances. Using this approach, the COIs identified for the human health risk evaluation *via* a surface water pathway include arsenic, boron, cadmium, cobalt, iron, lithium, manganese, molybdenum, and thallium (Table 3.1).

The water quality parameters that exceeded the GWPS included sulfate and total dissolved solids (TDS); however, these constituents were not included in the risk evaluation because the GWPS are likely based on aesthetic quality. US EPA set secondary maximum contaminant levels (MCLs) for sulfate and TDS based on aesthetic quality. The sulfate (250 mg/L) MCL is based on salty taste. The secondary MCL for TDS (500 mg/L) is based on hardness, colored water, staining, and salty taste (US EPA, 2021). Given that these parameters are not likely to pose a human health risk concern in the event of exposure, they were not identified as COIs.

Table 3.1 Human Health Constituents of Interest

Analyte[a]	Maximum Groundwater Concentration[b]	GWPS[c]	Human Health COI[d]
Total Metals (mg/L)			
Antimony	0.0012	0.006	No
Arsenic	0.038	0.01	Yes
Barium	0.398	2	No
Beryllium	0.0003	0.004	No
Boron	18.1	2	Yes
Cadmium	0.0096	0.005	Yes
Chromium	0.0078	0.1	No
Cobalt	0.0099	0.006	Yes
Iron	11	5	Yes
Lead	0.0066	0.0075	No
Lithium	0.0764	0.04	Yes
Manganese	1.3	0.15	Yes
Mercury	0.00059	0.002	No
Molybdenum	0.206	0.1	Yes
Selenium	0.0322	0.05	No
Thallium	0.0036	0.002	Yes
Dissolved Metals (mg/L)			
Antimony	ND	0.006	No
Arsenic	0.0156	0.01	Yes
Barium	0.106	2	No
Beryllium	ND	0.004	No
Boron	16.5	2	Yes
Cadmium	0.0057	0.005	Yes
Chromium	ND	0.1	No
Cobalt	0.0027	0.006	No
Iron	6.8	5	Yes
Lead	ND	0.0075	No
Lithium	0.0583	0.04	Yes
Manganese	1.3	0.15	Yes
Molybdenum	0.14	0.1	Yes
Selenium	0.0212	0.05	No
Thallium	ND	0.002	No

Analyte[a]	Maximum Groundwater Concentration[b]	GWPS[c]	Human Health COI[d]
Other (mg/L)			
Chloride	115	200	No
Fluoride	0.24	4	No
pH (field) (SU)	7.8	9	No
Sulfate	1,190	400	No[e]
Total Dissolved Solids	1,940	1,200	No[e]
Radionuclides (pCi/L)			
Radium 226 + Radium 228	3.09	5	No

Notes:
COI = Constituent of Interest; GWPS = Groundwater Protection Standard; ND = Not Detected; SU = Standard Units
Shaded cell indicates a compound identified as a COI.
(a) The constituents are those listed in the IL Part 845.600 GWPS (IEPA, 2021).
(b) The maximum detected groundwater concentration was used to identify COIs.
(c) The IL Part 845.600 GWPS (IEPA, 2021) were used to identify COIs.
(d) COIs are constituents for which the maximum concentration exceeds the groundwater standard.
(e) Sulfate and TDS exceed the GWPS but are not considered to be COIs because the GWPS are likely based on aesthetic quality (see text above).

3.3.2 Ecological Constituents of Interest

The Illinois GWPS, as defined in IEPA's guidance, were developed to protect human health but not necessarily ecological receptors. While ecological receptors are not exposed to groundwater, groundwater can potentially migrate into the adjacent surface water and impact ecological receptors. Therefore, to identify ecological COIs, the maximum concentrations of analytes detected in groundwater were compared to ecological surface water benchmarks protective of aquatic life.

The surface water screening benchmarks for freshwater organisms were obtained from the following hierarchy of sources:

- IEPA (2019a) SWQS. IEPA SWQS are health-protective benchmarks for aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). The SWQS for several metals are hardness dependent (cadmium, chromium, copper, fluoride, lead, manganese, nickel, and zinc). Screening benchmarks for these constituents were calculated assuming US EPA's (2019a) default hardness of 100 mg/L.[4]
- US EPA Region IV (2018) surface water Ecological Screening Values (ESVs) for hazardous waste sites.

For radium, benchmarks from the United States Department of Energy's (US DOE) guidance document, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019), were used. US DOE presents benchmarks for radium-226 and radium-228 separately (4 and 3 pCi/L, respectively). Given that radium concentrations are expressed as total radium (radium-226+228, *i.e.*, the

[4] While hardness data are not available for the Illinois River adjacent to the Site, a US Geological Survey station (05556200) located at Hennepin, Illinois, approximately five miles downstream from the Site, measured hardness concentrations ranging from 200 to 370 mg/L, with a mean hardness of 288 mg/L, from 106 samples collected between 1980 and 1997 (USGS, 2021b). These are older data and may not reflect current conditions; therefore, US EPA's default hardness of 100 mg/L was used. However, use of a higher hardness value (288 mg/L) would result in less stringent screening values, and thus, use of the US EPA default hardness is conservative.

sum of radium-226 and radium-228), Gradient used the lower of the two benchmarks (3 pCi/L for radium-228) to evaluate total radium concentrations.

Consistent with the human health risk evaluation, Gradient used the maximum detected concentrations from groundwater samples collected from the WAPS-associated wells without considering spatial or temporal representativeness for ecological receptor exposures. The use of the maximum constituent concentrations in this evaluation is designed to conservatively identify COIs that warrant further investigation. Boron, cadmium, and iron were identified as COIs for ecological receptors (Table 3.2).

It should be noted that although cadmium and cobalt were screened in as ecological COIs based on the maximum groundwater concentration, neither constituent was detected in surface water (out of 17 samples) (Table 2.3). In addition, no constituent was detected in surface water at a concentration exceeding its ecological benchmark (Table 3.3). The maximum detection limit (0.001 mg/L) for cadmium and cobalt was just slightly above the ecological benchmark for cadmium, but below the ecological benchmark for cobalt (Table 3.3). A total of 158 groundwater samples were analyzed for radium-226+228; of these, only two samples had radium slightly above the ecological benchmark of 3 pCi/L (3.09 and 3.06 pCi/L). Based on a Rosner test for outliers (run in ProUCL 5.1), both samples were considered outliers at the 1% significance level. Thus, radium-226+228 was not considered an ecological COI.

Table 3.2 Ecological Constituents of Interest

Analyte[a]	Maximum Groundwater Concentration[b]	Ecological Benchmark	Basis	ECO COI[c]
Total Metals (mg/L)				
Antimony	0.0012	0.19	EPA R4 ESV	No
Arsenic	0.038	0.19	IEPA SWQC	No
Barium	0.398	5.0	IEPA SWQC	No
Beryllium	0.0003	0.064	EPA R4 ESV	No
Boron	18.1	7.6	IEPA SWQC	Yes
Cadmium	0.0096	0.0011	IEPA SWQC	Yes
Chromium	0.0078	0.21	IEPA SWQC	No
Cobalt	0.0099	0.019	EPA R4 ESV	No
Iron	11	1.0	EPA R4 ESV	Yes
Lead	0.0066	0.020	IEPA SWQC	No
Lithium	0.0764	0.44	EPA R4 ESV	No
Manganese	1.3	1.8	IEPA SWQC	No
Mercury	0.00059	0.0011	IEPA SWQC	No
Molybdenum	0.206	7.2	EPA R4 ESV	No
Selenium	0.0322	1.0	IEPA SWQC	No
Thallium	0.0036	0.0060	EPA R4 ESV	No
Dissolved Metals (mg/L)				
Antimony	ND	0.19	EPA R4 ESV	No
Arsenic	0.0156	0.19	IEPA SWQC	No
Barium	0.106	5.0	IEPA SWQC	No
Beryllium	ND	0.064	EPA R4 ESV	No
Boron	16.5	7.6	IEPA SWQC	Yes
Cadmium	0.0057	0.00093	IEPA SWQC	Yes
Chromium	ND	0.18	IEPA SWQC	No
Cobalt	0.0027	0.019	EPA R4 ESV	No

Analyte[a]	Maximum Groundwater Concentration[b]	Ecological Benchmark	Basis	ECO COI[c]
Iron	6.8	1.0	EPA R4 ESV	Yes
Lead	ND	0.016	IEPA SWQC	No
Lithium	0.0583	0.44	EPA R4 ESV	No
Manganese	1.3	1.8	IEPA SWQC	No
Molybdenum	0.14	0.80	EPA R4 ESV	No
Selenium	0.0212	1.0	IEPA SWQC	No
Thallium	ND	0.0060	EPA R4 ESV	No
Other (mg/L)				
Chloride	115	500	IEPA SWQC	No
Fluoride	0.24	4.0	IEPA SWQC	No
pH (field) (SU)	7.8	NA	NA	No
Sulfate	1,190	NA	NA	No
Total Dissolved Solids	1,940	NA	NA	No
Radionuclides (pCi/L)				
Radium 226 + Radium 228	3.09	3	US DOE	No[d]

Notes:
COI = Constituent of Interest; DOE = Department of Energy; EPA R4 ESV = US Environmental Protection Agency Region IV Ecological Screening Value; GWPS = Groundwater Protection Standards; IEPA SWQS = Illinois Environmental Protection Agency Surface Water Quality Standard; NA = Not Available; SU = Standard Unit.
A gray-shaded cell indicates a compound identified as a COI.
(a) The constituents are those listed in the IL Part 845.600 GWPS (IEPA, 2021) that were detected in at least one groundwater sample from the wells related to the Hennepin WAPS.
(b) Ecological benchmarks are from the hierarchy of sources discussed in Section 3.3.2: IEPA SWQS (IEPA, 2019a); US EPA Region IV, "Ecological Risk Assessment Supplemental Guidance" (US EPA Region IV, 2018); US DOE's guidance document, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019).
(c) Analytes with maximum detected groundwater concentrations exceeding a benchmark protective of surface water exposure are considered ecological COIs.
(d) Of the 158 groundwater samples analyzed for radium-226+228, the two samples that were slightly above the ecological benchmark were considered outliers at the 1% significance level; therefore, radium-226+228 was not considered an ecological COI.

Table 3.3 Measured Surface Water Data Summary

Constituent	Maximum Detect (mg/L)	Maximum Detection Limit (mg/L)	Ecological Benchmark (mg/L)
Total Metals			
Antimony	ND	0.001	0.19
Arsenic	0.0012	4E-07	0.19
Barium	0.052	7E-07	5.0
Beryllium	ND	0.001	0.064
Boron	0.22	0.001	7.6
Cadmium	ND	0.001	0.0011
Chromium	ND	0.0015	0.21
Cobalt	ND	0.001	0.019
Iron	0.24	1E-05	1.0
Lead	ND	0.001	0.020
Lithium	0.0080	0.001	0.44
Manganese	0.060	0.001	1.8
Molybdenum	0.0061	6E-07	7.2
Selenium	ND	0.001	1.0
Thallium	ND	0.002	0.0060
Dissolved Metals			
Aluminum	0.64	0.025	–
Antimony	ND	0.001	0.19
Arsenic	0.0034	4E-07	0.19
Barium	0.049	7E-07	5.0
Beryllium	ND	0.001	0.064
Boron	0.21	9E-06	7.6
Cadmium	ND	0.001	0.00093
Chromium	0.015	0.015	0.18
Cobalt	ND	0.001	0.019
Iron	1.11	0.025	1.0
Lead	0.0020	0.001	0.016
Lithium	0.0083	2E-06	0.44
Manganese	0.083	0.002	1.8
Molybdenum	0.0063	6E-07	0.80
Selenium	ND	0.001	1.0
Thallium	ND	0.002	0.0060
Other			
Chloride	282	5	500
pH	8.6	NA	–
Sulfate	94	25	–
Total Dissolved Solids	878	16	–

Notes:
– = Not Available; NA = Not Applicable; ND = Not Detected.
Surface water data collected 9/2/20 and 2/25/21.

3.3.3 Surface Water and Sediment Modeling

Surface water sampling has been conducted in the Illinois River adjacent to the Site. To estimate the potential contribution to surface water (and sediment) from groundwater specifically associated with the WAPS, Gradient modeled concentrations in the Illinois River surface water and sediment from groundwater discharge to the Illinois River for the detected COIs. This is because the constituents detected in groundwater above a health-based benchmark are most likely to pose a risk concern in the adjacent surface water. Gradient modeled human health and ecological COI concentrations in the surface water and sediment using a mass balance calculation based on the surface water and groundwater mixing. The model assumes a well-mixed groundwater-surface water location.

The maximum detected concentrations in groundwater (regardless of well location) from 2018 to 2023 were conservatively used to model COI concentrations in surface water and sediment. For COIs that were measured as both total and dissolved fractions, we used the maximum of the total and dissolved COI concentrations for the modeling. In this case, the maximum concentration was from the total fraction for all COIs. Use of the total metal concentration for these COIs may overestimate surface water concentrations because dissolved concentrations, which are lower than total concentrations, represent the mobile fractions of constituents that could likely flow into and mix with surface water.

The modeling approach does not account for geochemical transformations that may occur during groundwater mixing with surface water. Gradient assumed that predicted surface water concentrations were influenced only by the physical mixing of groundwater as it enters the surface water and were not further influenced by the geochemical reactions in the water and sediment, such as precipitation. In addition, the model only predicts surface water and sediment concentrations as a result of the potential migration of COI concentrations in WAPS-related groundwater and does not account for background concentrations in surface water or sediment.

For this evaluation we adapted a simplified and conservative form of US EPA's indirect exposure assessment methodology (US EPA, 1998) that was used in US EPA's coal combustion waste risk assessment (US EPA, 2014). The original model is a mass balance calculation based on surface water and groundwater mixing and the concept that the dissolved and sorbed concentrations can be related through an equilibrium partitioning coefficient (K_d). The model assumes a well-mixed groundwater-surface water location, with partitioning among total suspended solids, dissolved water column, sediment porewater, and solid sediments.

Sorption to soil and sediment is highly dependent on the surrounding geochemical conditions. To be conservative, we ignored the natural attenuation capacity of soil and sediment and estimated the surface water concentration based only on the physical mixing of groundwater and surface water (*i.e.*, dilution) at the point of discharge of groundwater to the surface water.

The aquifer and surface water properties used to estimate the volume of groundwater flowing into the Illinois River and surface water concentrations are presented in Table 3.4. The COI concentrations in sediment were modeled using the COI-specific sediment-to-water partition coefficients and the sediment properties presented in Table 3.5. In the absence of Site-specific information for the Illinois River, we used default assumptions (*e.g.*, depth of the upper benthic layer and bed sediment porosity) to model sediment concentrations. The modeled surface water and sediment concentrations are presented in Table 3.6. These modeled concentrations reflect conservative contributions from groundwater flowing into the Illinois River. A description of the modeling and the detailed results are presented in Appendix A.

Table 3.4 Groundwater and Surface Water Properties Used in Modeling

Parameter	Unit	Values	Notes/Source
Groundwater			
COI Concentration	mg/L	Constituent-specific	Maximum detected concentration in groundwater
Cross Sectional Area for the UAU	m^2	11,613	Average thickness of the UAU (*i.e.*, 50 ft, or 15.2 m) multiplied by the length of WAPS adjacent to the Illinois River (2500 ft, or 762 m) (NRT, 2017)
Hydraulic Gradient	m/m	0.005	Horizontal hydraulic gradient from WAPS to off-site areas during normal river stage (NRT, 2017)
Hydraulic Conductivity of the UAU	cm/s	0.017	Geometric mean horizontal hydraulic conductivity measured for wells finished in gravel only (NRT, 2017)
Surface Water			
Surface Water Flow Rate	L/yr	4.56×10^{12}	Representative low flow (10^{th} percentile) discharge rate for the Illinois River (5,100 cfs), as derived from USGS station at Henry (USGS 05558300) (USGS, 2021a)
Total Suspended Solids (TSS)	mg/L	40	Median TSS measured in Illinois River at Hennepin (Tetra Tech, 2012)
Depth of the Water Column	m	4	Maximum "water depth at the 75% exceedance discharge condition" is 4-5 m (USGS, 2024)
Suspended Sediment to Water Partition Coefficient	mg/L	Constituent-specific	Values based on US EPA (2014)

Notes:
cfs = Cubic Feet per Second; COI = Constituent of Interest; US EPA = United States Environmental Protection Agency.

Table 3.5 Sediment Properties Used in Modeling

Parameter	Unit	Value	Notes/Source
Sediment			
Depth of Upper Benthic Layer	m	0.03	Default (US EPA, 2014)
Depth of Water Body	m	4.03	Depth of water column (4 m) plus depth of upper benthic layer (0.03 m) (US EPA, 2014)
Bed Sediment Particle Concentration	g/cm^3	1	Default (US EPA, 2014)
Bed Sediment Porosity	-	0.6	Default (US EPA, 2014)
TSS Mass per Unit Area	kg/m^2	0.16	Depth of water column × TSS × conversion factors (10^6 kg/mg and 1,000 L/m^3)
Sediment Mass per Unit Area	kg/m^2	30	Depth of upper benthic layer × bed sediment particulate concentration × conversion factors (0.001 kg/g, 10^6 cm^3/m^3)
Sediment to Water Partition Coefficients	mg/L	Constituent specific	Values based on US EPA (2014)

Notes:
TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

Table 3.6 Surface Water and Sediment Modeling Results

COI	Maximum Measured Groundwater Concentration (mg/L)	Mass Discharge Rate (mg/year)	Modeled Surface Water Concentration (mg/L)	Modeled Sediment Concentration (mg/kg)
Arsenic	3.8E-02	1.2E+07	2.6E-06	5.0E-04
Boron	1.8E+01	5.6E+09	1.2E-03	6.0E-03
Cadmium	9.6E-03	3.0E+06	6.6E-07	3.2E-04
Cobalt	9.9E-03	3.1E+06	6.8E-07	2.4E-04
Iron	1.1E+01	3.4E+09	7.6E-04	1.9E-02
Lithium	7.6E-02	2.4E+07	5.3E-06	NA[a]
Manganese	1.3E+00	4.0E+08	9.0E-05	1.2E+00
Molybdenum	2.1E-01	6.4E+07	1.4E-05	2.2E-03
Thallium	3.6E-03	1.1E+06	2.5E-07	3.3E-06

Notes:
COI = Constituent of Interest; NA = Not Applicable.
(a) Lithium sorbed to sediment was not calculated because lithium lacks a K_d value.

3.4 Human Health Risk Evaluation

The section below presents the results of the human health risk evaluation for recreators (swimmers and anglers) along the Illinois River adjacent to the Site. Risks were assessed using the maximum measured and modeled COIs in surface water.

3.4.1 Recreators Exposed to Surface Water

Screening Exposures: Recreators could be exposed to surface water *via* incidental ingestion and dermal contact while swimming. In addition, anglers could consume fish caught in the Illinois River. The maximum measured or modeled COI concentrations in surface water were used as conservative upper-end estimates of the COI concentrations to which a recreator might be exposed directly (incidental ingestion of COIs in surface water while swimming) and indirectly (consumption of locally caught fish exposed to COIs in surface water).

Screening Benchmarks: Illinois surface water criteria (IEPA, 2019a), known as human threshold criteria (HTC), are based on incidental exposure through contact or ingestion of small volumes of water while swimming or during other recreational activities, as well as the consumption of fish. The HTC values were calculated from the following equation (IEPA, 2019a):

$$\mathrm{HTC} = \frac{\mathrm{ADI}}{\mathrm{W} + (\mathrm{F} \times \mathrm{BCF})}$$

where:

HTC = Human health protection criterion in milligrams per liter (mg/L)
ADI = Acceptable daily intake (mg/day)
W = Water consumption rate (L/day)
F = Fish consumption rate (kg/day)
BCF = Bioconcentration factor (L/kg)

Illinois defines the acceptable daily intake (ADI) as the "maximum amount of a substance which, if ingested daily for a lifetime, results in no adverse effects to humans" (IEPA, 2019a). US EPA defines its chronic reference dose (RfD) as an "estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure for a chronic duration (up to a lifetime) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (US EPA, 2011a). Illinois lists methods to derive an ADI from the primary literature (IEPA, 2019a). In accordance with Illinois guidance, we derived an ADI by multiplying the MCL by the default water ingestion rate of 2 L/day (IEPA, 2019a). In the absence of an MCL, we used the RfD used by US EPA to derive its Regional Screening Levels (RSLs) (US EPA, 2023) as a conservative estimate of the ADI. The RfDs are given in mg/kg-day, while the ADIs are given in mg/day; thus, we multiplied the RfD by a standard body weight of 70 kg to obtain the ADI in mg/day. The calculation of the HTC values is shown in Appendix Table B.1.

We used bioconcentration factors (BCFs) from a hierarchy of sources. The primary BCFs were those that US EPA used to calculate the national recommended water quality criteria (NRWQC) for human health (US EPA, 2002, 2016). Other sources included BCFs used in the US EPA coal combustion ash risk assessment (US EPA, 2014) and BCFs reported by Oak Ridge National Laboratory's Risk Assessment Information System (ORNL RAIS).[5] Lithium did not have a BCF value available from any authoritative source. Therefore, the water quality criterion for lithium was calculated assuming a BCF of 1. This is a conservative assumption as lithium does not readily bioaccumulate in the aquatic environment (ECHA, 2020a,b; ATSDR, 2010).

Illinois recommends a fish consumption rate of 0.020 kg/day (20 g/day) for an adult weighing 70 kg (IEPA, 2019a). Illinois recommends a water consumption rate of 0.01 L/day for "incidental exposure through contact or ingestion of small volumes of water while swimming or during other recreational activities" (IEPA, 2019a). Appendix Table B.1 presents the calculated HTC for fish and water, and for fish consumption only.

Screening Risk Evaluation: The maximum modeled and measured COI concentrations in surface water were compared to the calculated Illinois HTC values (Table 3.7). All surface water concentrations were below their respective benchmarks. The HTC values are protective of recreational exposure *via* water and/or fish ingestion and do not account for dermal exposures to COIs in surface water while swimming. However, given that the modeled COI surface water concentrations are orders of magnitude below HTC protective of water and/or fish ingestion, dermal exposures to COIs are not expected to be a risk concern. Moreover, the dermal uptake of metals is considered to be minimal and only a small proportion of ingestion exposures. Thus, none of the COIs evaluated would be expected to pose an unacceptable risk to recreators exposed to surface water while swimming and anglers consuming fish caught in the Illinois River.

[5] Although recommended by US EPA (2015c), US EPA EpiSuite 4.1 (US EPA, 2019b) was not used as a source of BCFs because inorganic compounds are outside the estimation domain of the program.

Table 3.7 Risk Evaluation for Recreators Exposed to Surface Water

COI	Maximum Surface Water Concentration (modeled) (mg/L)	Maximum Surface Water Concentration (measured) (mg/L)	HTC for Water and Fish (mg/L)	HTC for Water Only (mg/L)	HTC for Fish Only (mg/L)	COPC based on modeled	COPC based on measured
Arsenic	2.6E-06	1.2E-03	2.2E-02	2.0E+00	2.3E-02	No	No
Boron	1.2E-03	2.2E-01	4.7E+02	1.4E+03	7.0E+02	No	No
Cadmium	6.6E-07	ND	1.8E-03	1.0E+00	1.9E-03	No	No
Cobalt	6.8E-07	ND	3.5E-03	2.1E+00	3.5E-03	No	No
Iron	7.6E-04	2.4E-01	1.3E+02	4.9E+03	1.3E+02	No	No
Lithium	5.3E-06	8.0E-03	4.7E+00	1.4E+01	7.0E+00	No	No
Manganese	9.0E-05	6.0E-02	9.3E+01	1.7E+02	2.1E+02	No	No
Molybdenum	1.4E-05	6.1E-03	3.9E+00	3.5E+01	4.4E+00	No	No
Thallium	2.5E-07	ND	1.7E-03	4.0E-01	1.7E-03	No	No

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; HTC = Human Threshold Criteria; ND = Not Detected; SW = Surface Water; WAPS = West Ash Pond System.
(a) Measured surface water concentrations may be different from modeled concentrations because measured data include the effects of background and other industrial sources. Modeled concentrations only represent the potential effect on surface water quality resulting from the measured groundwater concentrations.

3.4.2 Recreators Exposed to Sediment

Recreational exposure to sediment may occur during boating and swimming activity along the Illinois River; exposure to sediment may occur through incidental ingestion and dermal contact.

Screening Exposures: COIs in impacted groundwater flowing into the river can sorb to sediments. In the absence of sediment data, sediment concentrations were modeled using maximum detected groundwater concentrations.

Screening Benchmarks: There are no established recreator RSLs that are protective of recreational exposures to sediment (US EPA, 2019c). Therefore, benchmarks that are protective of recreational exposures to sediment *via* incidental ingestion and dermal contact were calculated using US EPA's RSL guidance (US EPA, 2019c). These benchmarks were calculated using the recommended assumptions (*i.e.*, oral bioavailability, body weights, averaging time) and toxicity reference values (*i.e.*, RfD and cancer slope factor [CSF]), with the following changes: Recreators were assumed to be exposed to sediment while recreating 60 days a year (or 2 weekend days per week for 30 weeks a year, from April to October). The exposure duration was assumed for a child 6 years of age and an adult 20 years of age, per US EPA guidance (Stalcup, 2014). The daily recommended residential soil ingestion rates of 200 mg/day for a child and 100 mg/day for an adult are based on an all-day exposure to residential soils (Stalcup, 2014; US EPA, 2011b). Since recreational exposures to sediment are assumed to occur for less than 3 hours per day, one-third of the daily residential soil ingestion (67 mg/day for a child and 33 mg/day for an adult) was used as a conservative assumption.

For dermal exposures, recreators were assumed to be exposed to sediment on their lower legs and feet (1,026 cm^2 for the child and 3,026 cm^2 for the adult, based on the age-weighted surface areas reported in US EPA, 2011b). While other body parts may be exposed to sediment, the contact time will likely be very short, as the sediment would wash off in the surface water. We used US EPA's recommended adherence factor of 0.2 mg/cm^2 based on child exposure to wet soil (US EPA, 2004; Stalcup, 2014), which was used in the US EPA RSL User's Guide for a child recreator exposed to soil or sediment (US EPA, 2019c). The

sediment screening benchmarks for cadmium and cobalt were calculated based on a target hazard quotient of 1. Appendix Table B.2 presents the calculation of RSLs protective of recreational exposures to sediment.

Screening Risk Evaluation: The modeled sediment concentrations were well below the recreational sediment RSLs (Table 3.8). Therefore, exposure to sediment is not expected to pose an unacceptable risk to recreators while swimming or boating.

Table 3.8 Risk Evaluation for Recreators Exposed to Sediment

COI	Modeled Sediment Concentration (mg/kg)	Recreator RSL (mg/kg)	COPC
Arsenic	5.0E-04	6.8E+01	No
Boron	6.0E-03	2.7E+05	No
Cadmium	3.2E-04	1.2E+02	No
Cobalt	2.4E-04	4.1E+02	No
Iron	1.9E-02	9.6E+05	No
Lithium	NA[a]	2.7E+03	No
Manganese	1.2E+00	3.3E+04	No
Molybdenum	2.2E-03	6.8E+03	No
Thallium	3.3E-06	1.4E+01	No

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; NA = Not Available; RSL = Regional Screening Level.
(a) Lithium could not be modeled in sediment because it lacks a K_d value.

3.5 Ecological Risk Evaluation

Based on the ecological CEM (Figure 3.4), ecological receptors could be exposed to surface water and dietary items (*i.e.*, prey and plants) potentially impacted by identified COIs (cadmium and cobalt).

3.5.1 Ecological Receptors Exposed to Surface Water

Screening Exposures: The ecological evaluation considered aquatic communities in the Illinois River potentially impacted by identified ecological COIs. Measured and modeled surface water concentrations were compared to risk-based ecological screening benchmarks.

Screening Benchmarks: Surface water screening benchmarks protective of aquatic life were obtained from the following hierarchy of sources:

- IEPA SWQS (IEPA, 2019a), regulatory standards that are intended to protect aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). For cadmium, the surface water benchmark is hardness dependent and calculated using a default hardness of 100 mg/L[6];
- NRWQC – Aquatic Life Criteria Table (US EPA, 2019a); and
- US EPA Region IV (2018) surface water ESVs for hazardous waste sites.

[6] While USGS hardness data are available, US EPA's (2019a) default hardness of 100 mg/L was conservatively used. Conservatisms associated with using a default hardness value are discussed in Section 3.4.

Risk Evaluation: The maximum modeled COI concentrations in surface water were compared to the benchmarks protective of aquatic life (Table 3.9). The measured and modeled surface water concentrations were below their respective benchmarks. Thus, none of the COIs evaluated are expected to pose an unacceptable risk to aquatic life in the Illinois River.

Table 3.9 Risk Evaluation of Ecological Receptors Exposed to Surface Water

COI	Maximum Surface Water Concentration, Modeled (mg/L)	Maximum Detected SW Conc (mg/L)	Ecological Freshwater Benchmark (mg/L)	Basis	COPC Based on Modeled Values	COPC Based on Measured Values
Boron	1.2E-03	2.2E-01	7.6E+00	IEPA (2019a)	No	No
Cadmium	6.6E-07	ND	1.1E-03	IEPA (2019a)	No	No
Iron	7.6E-04	2.4E-01	1.0E+00	US EPA Region IV (2018)	No	No

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; IEPA = Illinois Environmental Protection Agency; N = No; ND = Not Detected; SW = Surface Water; US EPA R4 = United States Environmental Protection Agency Region IV.
(a) Modeled COI concentrations reflect the potential maximum COI surface water concentrations from groundwater mixing with surface water.
(b) A default hardness value of 100 mg/L was used to calculate this hardness-dependent benchmark.

3.5.2 Ecological Receptors Exposed to Sediment

Screening Exposures: COIs in impacted groundwater discharging into the Illinois River can sorb to sediments *via* chemical partitioning. In the absence of sediment data, sediment concentrations were modeled using maximum detected groundwater concentrations. Therefore, the modeled COI sediment concentrations reflect the potential maximum Site-related sediment concentration from groundwater discharge.

Screening Benchmarks: Sediment screening benchmarks were obtained from US EPA Region IV (2018). The majority of the sediment ESVs are based on threshold effect concentrations (TECs) from MacDonald *et al.* (2000), which provide consensus values that identify concentrations below which harmful effects on sediment-dwelling organisms are unlikely to be observed. The benchmarks used in this evaluation are listed in Table 3.10.

Screening Risk Results: The maximum modeled COI sediment concentrations were below their respective sediment screening benchmarks (Table 3.10). The modeled sediment concentrations attributed to potential contributions from Site groundwater for all COIs were less than 1% of the sediment screening benchmark. Therefore, the modeled sediment concentrations attributed to potential contributions from Site groundwater are not expected to significantly contribute to ecological exposures in the Illinois River adjacent to the Site.

Table 3.10 Risk Evaluation of Ecological Receptors Exposed to Sediment

COI	Modeled Sediment Concentration (mg/kg)	ESV[a] (mg/kg)	COPC	% of Benchmark
Boron	5.97E-03	38[c]	No	0.02%
Cadmium	3.16E-04	0.99	No	0.03%
Iron	1.90E-02	20,000	No	0.0001%

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; ESV = Ecological Screening Value; NOEC = No Observed Effect Concentration; US EPA = United States Environmental Protection Agency.
(a) ESV from US EPA Region IV (2018).
(c) Boron NOEC of 38 mg/kg was used as a conservative benchmark for boron in the absence of an ESV (ECHA, 2019 219-6670).

3.5.3 Ecological Receptors Exposed to Bioaccumulative Constituents of Interest

Screening Exposures: COIs with bioaccumulative properties can impact higher-trophic-level wildlife exposed to these COIs *via* direct exposures (surface water and sediment exposure) and secondary exposures through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, and fish).

Screening Benchmark: US EPA Region IV (2018) guidance and IEPA's SWQS (IEPA, 2019a) guidance were used to identify analytes with potential bioaccumulative effects.

Risk Evaluation: The ecological COIs (boron, cadmium and iron)[7] were not identified as having potential bioaccumulative effects. Therefore, these COIs are not considered to pose an ecological risk *via* bioaccumulation.

3.6 Uncertainties and Conservatisms

A number of uncertainties and their potential impact on the risk evaluation are discussed below. Wherever possible, conservative assumptions were used in an effort to minimize uncertainties and overestimate rather than underestimate risks.

Exposure Estimates:

- The risk evaluation included the IL Part 845.600 constituents detected in groundwater samples collected from wells downgradient of the WAPS. However, it is possible that not all of the detected constituents are related specifically to the WAPS, since there are several sources in this area.
- The human health and ecological risk characterizations were based on the maximum modeled COI concentrations, rather than on averages. Thus, the variability in exposure concentrations was not considered. Given that receptors are mobile and concentrations change over time, assuming continuous exposure to the maximum concentration overestimates human and ecological exposures. For example, US EPA guidance states that risks should be estimated using average exposure concentrations as represented by the 95% upper confidence limit on the mean (US EPA, 1992). Given that exposure estimates based on the maximum concentrations did not exceed risk benchmarks, we have greater confidence that there is no risk concern.

[7] US EPA Region IV (2018) identifies only mercury (including methyl mercury) and selenium as having potential bioaccumulative effects. IEPA (2019a) identifies mercury as the only metal with bioaccumulative properties. Mercury and selenium were detected in groundwater but were not considered ecological COIs.

- Only analytes detected in groundwater were used to identify COIs and model COI concentrations in surface water and sediment. For the constituents that were not detected in WAPS groundwater, the detection limits were below the IL Part 845 GWPS and thus do not require further evaluation.
- COI concentrations in surface water were modeled using the maximum detected total or dissolved COI concentrations. In this case, maximum detected concentrations for cadmium, cobalt, and lithium are based on total concentrations. Modeling surface water concentrations using total metal concentrations for these COIs may overestimate surface water concentrations because dissolved concentrations, which are lower than total concentrations, represent the mobile fractions of constituents that could likely flow into and mix with surface water.
- The COIs identified in this evaluation also occur naturally in the environment. Contributions to exposure from natural or other non-WAPS-related sources were not considered in the evaluation of modeled concentrations; only exposure contributions potentially attributable to Site groundwater mixing with surface water were evaluated. While not quantified, exposures from potential WAPS-related groundwater contributions are likely to represent only a small fraction of the overall human and ecological exposure to COIs that also have natural or non-WAPS-related sources.
- Screening benchmarks for human health were developed using exposure inputs based on US EPA's recommended values for reasonable maximum exposure (RME) assessments (Stalcup, 2014). RME is defined as "the highest exposure that is reasonably expected to occur at a site but that is still within the range of possible exposures" (US EPA, 2004). US EPA states the "intent of the RME is to estimate a conservative exposure case (*i.e.*, well above the average case) that is still within the range of possible exposures" (US EPA, 1989). US EPA also notes that this high-end exposure "is the highest dose estimated to be experienced by some individuals, commonly stated as approximately equal to the 90th percentile exposure category for individuals" (US EPA, 2015b). Thus, most individuals will have lower exposures than those presented in this risk assessment.
- Although the maximum radium-226+228 concentration in groundwater exceeded the ecological screening benchmark, radium-226+228 was not considered an ecological COI because the two highest results, detected slightly above the benchmark, were considered outliers at the 1% significance level. While risks to ecological receptors exposed to radium-226+228 in surface water, sediment, and diet were not evaluated, the risks are expected to be *de minimis*.[8]

Toxicity Benchmarks:

- Screening-level ecological benchmarks were compiled from IEPA and US EPA guidance and designed to be protective of the majority of Site conditions, leaving the option for Site-specific refinement. In some cases, these benchmarks may not be representative of the Site-specific conditions or receptors found at the Site, or may not accurately reflect concentration-response relationships encountered at the Site. For example, the ecological benchmark for cadmium is hardness dependent. While a US Geological Survey [USGS] station had available hardness data, we relied on US EPA's default hardness of 100 mg/L due to the limitations of the USGS data. USGS data from Hennepin, Illinois (five miles downstream of the Site) reported hardness ranging from 200 to 370 mg/L, with a mean hardness of 288 mg/L, based on samples collected in 1980-

[8] Radium was not analyzed in surface water. However, the surface water and sediment modeling for other ecological COIs demonstrate that the modeled concentrations are orders of magnitude lower than the measured COI concentration in surface water and sediment. Given that the maximum groundwater concentration slightly exceeds the surface water benchmark, the modeled surface water and sediment concentrations will be below their respective benchmarks. Furthermore, radium is not described in US EPA Region IV guidance, but it is identified as bioaccumulative by other entities (*e.g.*, ATSDR, 1990). However, the benchmark used to identify ecological COIs already considers bioaccumulative exposures. Given that the modeled concentrations are anticipated to be below benchmarks, which account for bioaccumulative exposures, radium-226+228 is not expected to pose a risk concern to ecological receptors based on its bioaccumulative properties.

1997 (USGS, 2021b). Increasing the hardness from 100 to 288 mg/L would increase the cadmium SWQS because benchmarks become less stringent with higher levels of hardness. Regardless of the hardness, the maximum modeled cadmium concentration is orders of magnitude below the SWQS.

- In addition, for the ecological evaluation, we conservatively assumed all constituents to be 100% bioavailable. Modeled COI concentrations in surface water are considered total COI concentrations. US EPA recommends using dissolved metals as a measure of exposure to ecological receptors because it represents the bioavailable fraction of metal in water (US EPA, 1993). Therefore, the modeled surface water COI concentrations may be an overestimation of exposure concentrations to ecological receptors.
- In general, it is important to appreciate that the human health toxicity factors used in this risk evaluation are developed to account for uncertainties, such that safe exposure levels used as benchmarks are often many times lower (even orders of magnitude lower) than the levels that cause effects that have been observed in human or animal studies. For example, toxicity factors incorporate a 10-fold safety factor to protect sensitive subpopulations. This means that a risk exceedance does not necessarily equate to actual harm.

4 Summary and Conclusions

A screening-level risk evaluation was performed for Site-related constituents in groundwater at the Hennepin Power Plant in Hennepin, Illinois. The CSM developed for the Site indicates that groundwater beneath the WAPS flows into the Illinois River adjacent to the Site and may potentially impact surface water and sediment.

CEMs were developed for human and ecological receptors. The complete exposure pathways for humans include recreators in the Illinois River who are exposed to surface water and sediment (boaters and swimmers) and anglers who consume locally caught fish. Based on the local hydrogeology, residential exposure to groundwater used for drinking water or irrigation is not a complete pathway and was not evaluated. The complete exposure pathways for ecological receptors include aquatic life (including aquatic and marsh plants, amphibians, reptiles, and fish) exposed to surface water; benthic invertebrates exposed to sediment; and avian and mammalian wildlife exposed to bioaccumulative COIs in surface water, sediment, and dietary items.

Surface water data collected in 2020 and 2021, and groundwater data collected from 2018 to 2023, were used to estimate exposures. The maximum detected concentrations in surface water were used for human and ecological receptors exposed to surface water. For analytes detected in groundwater, surface water concentrations were also modeled using the maximum detected groundwater concentration. In the absence of sediment data, modeled sediment concentrations based on the maximum detected groundwater concentrations were used as the exposure estimate for human and ecological receptors. Surface water and sediment exposure estimates were screened against benchmarks protective of human health and ecological receptors for this risk evaluation.

For recreators (boaters and swimmers) exposed to surface water, all COIs were below the conservative risk-based screening benchmarks. Therefore, none of the COIs evaluated in surface water are expected to pose an unacceptable risk to recreators swimming or boating in the Illinois River adjacent to the Site.

For recreators exposed to sediment *via* incidental ingestion and dermal contact, the modeled sediment concentrations for all COIs were below the health protective sediment benchmarks. Therefore, the modeled concentrations in sediment are not expected to pose an unacceptable risk to recreators exposed to sediment in the Illinois River adjacent to the Site.

For anglers consuming locally caught fish, the maximum measured and modeled concentrations of all COIs in surface water were below conservative benchmarks protective of fish consumption. Therefore, none of the COIs evaluated are expected to pose an unacceptable risk to recreators consuming fish caught in the Illinois River.

Ecological receptors exposed to surface water include aquatic and marsh plants, amphibians, reptiles, and fish. The risk evaluation showed that none of the modeled or measured COIs in surface water exceeded protective screening benchmarks. Ecological receptors exposed to sediment include benthic invertebrates. The modeled sediment COIs did not exceed the conservative screening benchmarks; therefore, none of the COIs evaluated in sediment are expected to pose an unacceptable risk to ecological receptors. Ecological receptors were also evaluated for exposure to bioaccumulative COIs. This evaluation considered higher-trophic-level wildlife with direct exposure to surface water and sediment and secondary exposure through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, fish). The ecological COIs

were not identified as having potential bioaccumulative effects. Therefore, these COIs are not considered to pose an ecological risk *via* bioaccumulation. Overall, this evaluation demonstrated that none of the COIs evaluated are expected to pose an unacceptable risk to ecological receptors.

It should be noted that this evaluation incorporates a number of conservative assumptions that tend to overestimate exposure and risk. The risk evaluation was based on the maximum detected COI concentration; however, US EPA guidance states that risks should be based on a representative average concentration such as the 95% upper confidence limit on the mean; thus, using the maximum concentration tends to overestimate exposure. Although the COIs identified in this evaluation also occur naturally in the environment, the contributions to exposure from natural background sources and nearby industry were not considered; thus, CCR-related exposures were likely overestimated. Exposure estimates assumed 100% metal bioavailability, which likely results in overestimates of exposure and risks. Exposure estimates were based on inputs to evaluate the RME; thus, most individuals will have lower exposures than those estimated in this risk assessment.

Finally, it should be noted that because current conditions do not present a risk to human health or the environment, there will also be no unacceptable risk to human health or the environment for future conditions when the WAPS is closed. For all future closure scenarios, potential releases of CCR-related constituents will decline over time and, consequently, potential exposures to CCR-related constituents in the environment will also decline.

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Appendix A

Surface Water and Sediment Modeling

Gradient modeled concentrations in river surface water and sediment based on available groundwater data. First, we estimated the flow rate of constituents of interest (COIs) flowing to the Illinois River *via* groundwater. Then, we adapted United States Environmental Protection Agency's (US EPA's) indirect exposure assessment methodology (US EPA, 1998) in order to model surface water and sediment water concentrations in the Illinois River.

Model Overview

The groundwater flow into the river is represented by a one-dimensional steady-state model. In this model, the groundwater plume migrates horizontally in the uppermost aquifer, from south to north, in the direction of the Illinois River. The groundwater flow entering the river is the flow going through a cross-sectional area that has a length equal to the length of the river adjacent to the West Ash Pond System (WAPS) with potential coal combustion residual (CCR)-related impacts and a height equal to the saturated thickness of the uppermost aquifer (Table 3.4). It was assumed that all the groundwater flowing through the uppermost aquifer flows into the Illinois River. The length of the river adjacent to the WAPS was estimated using Google Earth Pro.

The groundwater flow into the river mixes with the surface water in the Illinois River. The COIs entering the river *via* groundwater can dissolve into the water column, sorb to suspended sediments, or sorb to benthic sediments. Using US EPA's indirect exposure assessment methodology (US EPA, 1998), the model evaluates the surface water and sediment concentrations at a location downstream of the groundwater discharge, assuming a well-mixed water column.

Groundwater Discharge Rate

We used conservative assumptions to evaluate the groundwater discharge rate of the COIs. We conservatively assumed that the groundwater concentrations were uniformly equal to the maximum detected concentration for each individual COI. We ignored adsorption by subsurface soil and assumed that all the groundwater flowing through the uppermost aquifer flows into the river.

For each groundwater unit, the groundwater flow rate into the river was derived using Darcy's Law:

$$Q = KiA$$

where:

Q = Groundwater flow rate (m^3/s)
K = Hydraulic conductivity (m/s)
i = Hydraulic gradient (m/m)
A = Cross-sectional area (m^2)

For each COI, the mass discharge rate into the river was then calculated by:

$$m_c = C_c \times Q \times CF$$

where:

m_c = Mass discharge rate of the COI (mg/year)
C_c = Maximum groundwater concentration of the COI (mg/L)
CF = Conversion factors needed for unit conversion: 1,000 L/m^3; 31,557,600 s/year

The values of the aquifer parameters used for these calculations are provided in Table A.1. The calculated mass discharge rates were then used as inputs for the surface water and sediment partitioning model.

Surface Water and Sediment Concentration

Groundwater flowing into the river gets diluted in the surface water flow. Constituents transported by groundwater into the surface water migrate into the water column and the bed sediments. The surface water model we used to estimate the surface water and sediment concentrations is a steady-state model described in US EPA's indirect exposure assessment methodology (US EPA, 1998) and also used in US EPA's "Human and Ecological Risk Assessment of Coal Combustion Residuals" (US EPA, 2014). This model describes the partitioning of constituents between surface water, suspended sediments, and benthic sediments based on equilibrium partition coefficients. It estimates the concentrations of constituents in surface water, suspended sediments, and benthic sediments at steady-state equilibrium at a theoretical location downstream of the discharge point after complete mixing of the water column. In our analysis, we used the partitioning coefficients given in Table J-1 of the US EPA CCR Risk Assessment for all COIs (US EPA, 2014). These coefficients are presented in Table A.2.

To be conservative, we assumed that the constituents were not affected by dissipation or degradation once they entered the water body. The total water body concentration of the COI was calculated as (US EPA, 1998):

$$C_{wtot} = \frac{m_c}{V_f \times f_{water}}$$

where:

C_{wtot} = Total water body concentration of the constituent (mg/L)
V_f = Water body annual flow (L/year)
f_{water} = Fraction of COI in the water column (unitless)
m_c = Mass discharge rate of the COI (mg/year)

For the Illinois River annual flow rate, we conservatively used the low flow (10th percentile) discharge rate of about 5,100 cubic feet per second (cfs) based on the daily mean discharge rates measured at Henry (USGS station #05558300)[9] between 1981 and 2021 (USGS, 2021).

The fraction of COIs in the water column was calculated for each COI using the sediment/water and suspended solids/water partition coefficients (US EPA, 2014). The fraction of COIs in the water column is defined as (US EPA, 2014):

$$f_{water} = \frac{(1 + [K_{dsw} \times TSS \times 0.000001]) \times \frac{d_w}{d_z}}{\left([1 + (K_{dsw} \times TSS \times 0.000001)] \times \frac{d_w}{d_z}\right) + ([bsp + K_{dbs} \times bsc] \times \frac{d_b}{d_z})}$$

where:

K_{dsw} = Suspended sediment-water partition coefficient (mL/g)
K_{dbs} = Sediment-water partition coefficient (mL/g)

[9] The USGS station at Henry, located approximately 18 miles downstream of the Hennepin plant, is the closest USGS gauging station with surface water flow data.

TSS	=	Total suspended solids in the surface water body (mg/L), set equal to the median river concentration of 40 mg/L (TetraTech, 2012)
0.000001	=	Units conversion factor
d_w	=	Depth of the water column (m)
d_b	=	Depth of the upper benthic layer (m), set equal to 0.03 m (US EPA, 2014)
$d_z = d_w + d_b$	=	Depth of the water body (m)
bsp	=	Bed sediment porosity (unitless), set equal to 0.6 (US EPA, 2014)
bsc	=	Bed sediment particle concentration (g/cm^3), set equal to 1.0 g/cm^3 (US EPA, 2014)

The fraction of COIs dissolved in the water column (f_d) is calculated as (US EPA 2014):

$$f_d = \frac{1}{1 + K_{dsw} \times TSS \times 0.000001}$$

The values of the fraction of COIs in the water column and other calculated parameters are presented in Table A.3. Other water body parameters are presented in Table A.4.

The total water column concentration (C_{wcTot}) of the COIs, comprising both the dissolved and suspended sediment phases, is then calculated as (US EPA, 2014):

$$C_{wcTot} = C_{wtot} \times f_{water} \times \frac{d_z}{d_w}$$

Finally, the dissolved water column concentration (C_{dw}) for the COIs is calculated as (US EPA, 2014):

$$C_{dw} = f_d \times C_{wcTot}$$

The dissolved water column concentration was then used to calculate the concentration of COIs sorbed to suspended solids in the water column (US EPA, 1998):

$$C_{sw} = C_{dw} \times K_{dsw}$$

where:

C_{sw}	=	Concentration sorbed to suspended solids (mg/kg)
C_{dw}	=	Concentration dissolved in the water column (mg/L)
K_{dsw}	=	Suspended solids/water partition coefficient (mL/g)

In the same way, using the total water body concentration and the fraction of COIs in the benthic sediments, the model derives the total concentration in benthic sediments (US EPA, 2014):

$$C_{bstot} = f_{benth} \times C_{wtot} \times \frac{d_z}{d_b}$$

where:

C_{bstot}	=	Total concentration in bed sediment (mg/L or g/m^3)

C_{wtot} = Total water body concentration of the constituent (mg/L)
f_{benth} = Fraction of contaminant in benthic sediments (unitless)
d_b = Depth of the upper benthic layer (m)
$d_z = d_w + d_b$ = Depth of the water body (m)

This value can be used to calculate dry weight sediment concentration as follows:

$$C_{sed-dw} = \frac{C_{bstot}}{bsc}$$

where:

C_{sed-dw} = Dry weight sediment concentration (mg/kg)
C_{bstot} = Total sediment concentration (mg/L)
bsc = Bed sediment bulk density (used the default value of 1 g/cm^3 from US EPA, 2014)

The total sediment concentration is composed of the concentration dissolved in the bed sediment pore water (equal to the concentration dissolved in the water column) and the concentration sorbed to benthic sediments (US EPA, 1998).

The concentration sorbed to benthic sediments was calculated from (US EPA, 1998):

$$C_{sb} = C_{dbs} \times K_{dbs}$$

where:

C_{sb} = Concentration sorbed to bottom sediments (mg/kg)
C_{dbs} = Concentration dissolved in the sediment pore water (mg/L)
K_{dbs} = Sediments/water partition coefficient (mL/kg)

For each COI, the modeled total water column concentration, the modeled dry weight sediment concentration, and the modeled concentration sorbed to sediment are presented in Table A.5.

Table A.1 Parameters Used to Estimate Groundwater Discharge to Surface Water

GW Unit	Parameter	Full Name	Value	Unit
Uppermost Aquifer	A	Cross-Sectional Area	11,613	m^2
Uppermost Aquifer	i	Hydraulic Gradient	0.005	m/m
Uppermost Aquifer	K	Hydraulic Conductivity	0.017	cm/s

Notes:
GW = Groundwater, UA = Uppermost Aquifer.
Average thickness of the UA (*i.e.*, 50 ft or 15.2 m) multiplied by the length of the WAP-intersecting Illinois River (2,500 ft, or 762 m).
Source: NRT (2017).

Table A.2 Partition Coefficients

Constituent	Sediment-Water, Mean, K_{dbs}		Suspended Sediment-Water, Mean, K_{dsw}	
	Value (log_{10}) (mL/g)	Value (mL/g)	Value (log_{10}) (mL/g)	Value (mL/g)
Arsenic (III)	2.4	2.51E+02	3.9	7.94E+03
Boron	0.8	6.31E+00	3.9	7.94E+03
Cadmium	3.3	2.00E+03	4.9	7.94E+04
Cobalt	3.1	1.26E+03	4.8	6.31E+04
Iron	1.4	2.51E+01	1.4	2.51E+01
Lithium	Not Available	Not Available	Not Available	Not Available
Manganese	4.4	2.80E+04	4.4	2.80E+04
Molybdenum	2.5	3.16E+02	4.4	2.51E+04
Thallium	1.3	2.00E+01	4.1	1.26E+04

Notes:
Lithium was not modeled because it lacks a K_d value in US EPA (2014).
Source: US EPA (2014).

Table A.3 Calculated Parameters

Constituent	Fraction of Constituent in the Water Column f_{water}	Fraction of Constituent in the Benthic Sediments $f_{benthic}$	Fraction of Constituent Dissolved in the Water Column $f_{dissolved}$
Arsenic (III)	0.4110	0.5890	0.7589
Boron	0.9622	0.0378	0.7589
Cadmium	0.2182	0.7818	0.2394
Cobalt	0.2717	0.7283	0.2838
Iron	0.8384	0.1616	0.9990
Lithium	0.9955	0.0045	1.0
Manganese	0.00999	0.9900	0.4717
Molybdenum	0.4576	0.5424	0.4988
Thallium	0.9070	0.0930	0.6651

Table A.4 Surface Water Parameters

Parameter	Full Name	Value	Unit
TSS	Total Suspended Solids	40	mg/L
V_{fx}	Surface Water Flow Rate	4.56E+12	L/yr
db	Depth of Upper Benthic Layer (default: 0.03)	0.03	m
dw	Depth of Water Column	4	m
dz	Depth of Water Body	4.03	m
bsc	Bed Sediment Particle Concentration (default)	1	g/cm^3
bsp	Bed Sediment Porosity (default: 0.6)	0.6	-
M_{TSS}	TSS Mass per Unit Area	0.16	kg/m^2
M_S	Sediment Mass per Unit Area	30	kg/m^2

Notes:
Source of input values: Flow rate value from USGS (2021), total suspended solids value from Tetra Tech (2012), and depth of water column value from USGS (2016). Remaining values from US EPA (2014).

Table A.5 Input Groundwater Concentrations and Output Surface Water and Sediment Concentrations

Constituent	Groundwater Concentration (mg/L)	Mass Discharge Rate to Surface Water (mg/year)	Total Water Column Concentration (mg/L)	Concentration Sorbed to Bottom Sediments (mg/kg)
Arsenic (III)	3.8E-02	1.2E+07	2.6E-06	5.0E-04
Boron	1.8E+01	5.6E+09	1.2E-03	6.0E-03
Cadmium	9.6E-03	3.0E+06	6.6E-07	3.2E-04
Cobalt	9.9E-03	3.1E+06	6.8E-07	2.4E-04
Iron	1.1E+01	3.4E+09	7.6E-04	1.9E-02
Lithium	7.6E-02	2.4E+07	5.3E-06	NA[a]
Manganese	1.3E+00	4.0E+08	9.0E-05	1.2E+00
Molybdenum	2.1E-01	6.4E+07	1.4E-05	2.2E-03
Thallium	3.6E-03	1.1E+06	2.5E-07	3.3E-06

Note:
(a) Lithium was not modeled in sediment due to a lack of K_d value in US EPA (2014).

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US Geological Survey (USGS). 2016. "Upper Mississippi River System - Systemic Spatial Data Viewer." Accessed at https://umesc.usgs.gov/management/dss/umrs_land_cover_viewer.html.

US Geological Survey (USGS). 2021. "Discharge data for Illinois River at Henry, IL (1981-2021) [USGS 05558300]."

Appendix B

Screening Benchmarks

Table B.1 Calculated Water Quality Standards Protective of Incidental Ingestion and Fish Consumption

Analytes	Bioconcentration Factor (BCF)		Average Daily Intake (ADI)			Human Threshold Criteria (HTC)		
	BCF[a] (L/kg-tissue)	Basis	MCL (mg/L)	RfD (mg/kg-d)	ADI[b] (mg/day)	Water & Fish (mg/L)	Water Only (mg/L)	Fish Only (mg/L)
Arsenic	44	NRWQC, 2002	0.010	0.00030	0.020	0.022	2.0	0.023
Boron	1	(d)	NC	0.20	14	467	1400	700
Cadmium	270	US EPA, 2014	0.0050	0.00050	0.010	0.0018	1.0	0.0019
Cobalt	300	ORNL RAIS	NC	0.00030	0.021	0.0035	2.1	0.0035
Iron	19	US EPA, 2014	NC	0.70	49	126	4900	129
Lithium	1	(d)	NC	0.002	0.14	4.7	14	7.0
Manganese	0.4	US EPA, 2014	NC	0.024	1.7	93	168	210
Molybdenum	4	US EPA, 2014	NC	0.00500	0.3500	3.9	35	4.4
Thallium	116	NRWQC, 2002	0.0020	0.000010	0.0040	0.0017	0.40	0.0017

Notes:

ADI = Average Daily Intake; BCF = Bioconcentration Factor; F = Fish Consumption Rate; HTC = Human Threshold Criteria; IEPA = Illinois Environmental Protection Agency; MCL = Maximum Contaminant Level; NA = BCF Not Available and Therefore, WQC for Fish Only Not Calculated; NC = No Criterion Available; NRWQC = National Recommended Water Quality Criteria; ORNL RAIS = Oak Ridge National Laboratory Risk Assessment Information System; RfD = Reference Dose; W = Water Consumption Rate; WQC = Water Quality Criteria; SWQC = Surface Water Quality Criteria; US EPA = United States Environmental Protection Agency.

(a) BCFs from the following hierarchy of sources:

NRWQC (US EPA, 2016). National Recommended Water Quality Criteria.

NRWQC (US EPA, 2002). National Recommended Water Quality Criteria: 2002. Human Health Criteria Calculation Matrix.

US EPA (2014). Human and Ecological Risk Assessment of Coal Combustion Residuals.

ORNL RAIS (ORNL, 2023). Risk Assessment Information System (RAIS) Chemical Toxicity Values.

(b) ADI based on the MCL is calculated as the MCL (mg/L) multiplied by a water ingestion rate of 2 L/day. In the absence of an MCL, the ADI was calculated as the RfD (mg/kg-d) multiplied by the body weight (70 kg).

(c) SWQC based on US EPA's action level.

(d) BCF of 1 was used as a conservative assumption, due to lack of published BCF.

Equations from IEPA (2019a):

Consumption of Water and Fish

$$HTC = \frac{ADI}{W + (F \times BCF)}$$

Incidental Consumption of Water only

$$HTC = \frac{ADI}{W}$$

Consumption of Fish only

$$HTC = \frac{ADI}{F \times BCF}$$

Where

Average Daily Intake (ADI)	=	Chem. Specific	mg/day
Fish Consumption Rate (F)	=	0.02	kg/day
Bioconcentration Factor (BCF)	=	Chem. Specific	L/kg-tissue
Water Consumption Rate (W)	=	0.01	L/day

Table B.2 Recreator Exposure to Sediment

COI	Relative Bioavailability B (unitless)	Dermal Absorption Fraction ABS (unitless)	Cancer				Cancer SL (mg/kg)	Non-Cancer								Recreator RSL Sediment (mg/kg)	Basis
			TRV		Child + Adult			TRV		Child		Adult		Child	Adult		
			CSF $(mg/kg\text{-}d)^{-1}$	Derm. CSF $(mg/kg\text{-}d)^{-1}$	Incidental Ingestion SL_{ing} (mg/kg)	Dermal Contact SL_{derm} (mg/kg)		RfD (mg/kg-d)	Derm. RfD (mg/kg-d)	Incidental Ingestion SL_{ing} (mg/kg)	Dermal Contact SL_{derm} (mg/kg)	Incidental Ingestion SL_{ing} (mg/kg)	Dermal Contact SL_{derm} (mg/kg)	Non-Cancer SL (mg/kg)			
Arsenic	1	0.03	1.5E+00	1.5E+00	8.1E+01	4.1E+02	6.8E+01	3.0E-04	3.0E-04	4.1E+02	4.4E+03	4.4E+03	8.0E+03	3.8E+02	2.8E+03	6.8E+01	c
Boron	1	NA	NC	NC	NC	NC	NC	2.0E-01	2.0E-01	2.7E+05	NA	2.9E+06	NA	2.7E+05	2.9E+06	2.7E+05	nc
Cadmium	1	0.001	NC	NC	NC	NC	NC	1.0E-04	2.5E-06	1.4E+02	1.1E+03	1.5E+03	2.0E+03	1.2E+02	8.5E+02	1.2E+02	nc
Cobalt	1	NA	NC	NC	NC	NC	NC	3.0E-04	3.0E-04	4.1E+02	NA	4.4E+03	NA	4.1E+02	4.4E+03	4.1E+02	nc
Iron	1	NA	NC	NC	NC	NC	NC	7.0E-01	7.0E-01	9.6E+05	NA	1.0E+07	NA	9.6E+05	1.0E+07	9.6E+05	nc
Lithium	1	NA	NC	NC	NC	NC	NC	2.0E-03	2.0E-03	2.7E+03	NA	2.9E+04	NA	2.7E+03	2.9E+04	2.7E+03	nc
Manganese	1	NA	NC	NC	NC	NC	NC	2.4E-02	9.6E-04	3.3E+04	NA	3.5E+05	NA	3.3E+04	3.5E+05	3.3E+04	nc
Molybdenum	1	NA	NC	NC	NC	NC	NC	5.0E-03	5.0E-03	6.8E+03	NA	7.3E+04	NA	6.8E+03	7.3E+04	6.8E+03	nc
Thallium	1	NA	NC	NC	NC	NC	NC	1.0E-05	1.0E-05	1.4E+01	NA	1.5E+02	NA	1.4E+01	1.5E+02	1.4E+01	nc

Notes:

AL = EPA Action Level; COI = Constituent of Interest; CSF = Cancer Slope Factor; derm = Dermal Contact; ing = Ingestion; NC = No Criterion Available; RfD = Reference Dose; SL = Screening Level; TRV = Toxicity Reference Value.

Health Benchmark defined as the lower of the screening levels for cancer and non-cancer. The basis of the Health Benchmark is presented as c = based on cancer endpoint, or nc = based on non-cancer endpoint.

$$\text{Screening Benchmark} = \frac{1}{\frac{1}{SL_{ing}} + \frac{1}{SL_{derm}}}$$

$$\text{Non-cancer } SL_{ing} = \frac{THQ * RfD}{Intake} \qquad \text{Cancer } SL_{ing} = \frac{TR}{Intake * CSF}$$

$$\text{Non-cancer } SL_{derm} = \frac{THQ * RfD}{Intake * ABS} \qquad \text{Cancer } SL_{derm} = \frac{TR}{Intake * ABS * CSF}$$

Target Cancer Risk (TR) = 1E-05

Target Hazard Quotient (THQ) = 1

Sediment – Ingestion (Chemical)

Intake Factor (IF) = $\frac{IR \times EF \times ED \times CF}{BW \times AT}$ =			Non-Cancer		Cancer		Basis
			7.3E-07 Child	6.8E-08 Adult	6.3E-08 Child	2.0E-08 Adult	
	IR	Ingestion Rate (mg/day)	67	33	67	33	One-third of US EPA residential soil ingestion rate (Prof. Judgment)
	EF	Sediment Exposure Frequency (days/year)	60	60	60	60	2 days/week between April and Oct when air temp. > 70°F (Prof. Judgment)
	ED	Exposure Duration (years)	6	20	6	20	Default value for Resident (US EPA, 2023)
	CF	Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	
	BW	Body Weight (kg)	15	80	15	80	Default value for Resident (US EPA, 2023)
	AT	Averaging Time (d)	2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2023)

Sediment – Dermal Contact (Chemical)

Intake Factor (IF) = $\frac{SA \times AF \times EF \times ED \times CF}{BW \times AT}$ =			Non-Cancer		Cancer		Basis
			2.2E-06 Child	1.2E-06 Adult	1.9E-07 Child	3.6E-07 Adult	
	SA	Surface Area Exposed to Sediment (cm^2/day)	1,026	3,026	1,026	3,026	Age weighted SA for lower legs and feet (US EPA, 2011b)
	AF	Sediment Skin Adherence Factor (mg/cm^2)	0.2	0.2	0.2	0.2	Age weighted AF for children exposed to sediment (US EPA, 2011b)
	EF	Sediment Exposure Frequency (days/year)	60	60	60	60	2 days/week between April and Oct when air temp. > 70°F (Prof. Judgment)
	ED	Exposure Duration (years)	6	20	6	20	Default value for Resident (US EPA, 2023)
	CF	Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	
	BW	Body Weight (kg)	15	80	15	80	Default value for Resident (US EPA, 2023)
	AT	Averaging Time (d)	2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2023)

Appendix B

Corrective Action Alternatives Analysis – Supporting Information Report

Intended for
Dynegy Midwest Generation, LLC
13498 E 800th St
Hennepin, Illinois 61327

Date
May 6, 2025

Project No.
1940103584-005

CORRECTIVE ACTION ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT

HENNEPIN POWER STATION, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

RAMBOLL Bright ideas. Sustainable change.

CORRECTIVE ACTION ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT HENNEPIN POWER STATION, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

Project name	**Hennepin West Ash Pond System**
Project no.	**1940103584-005**
Recipient	**Dynegy Midwest Generation, LLC**
Document type	**Supporting Information Report**
Revision	**FINAL**
Date	**May 6, 2025**
Prepared by	**Elizabeth (Richter) Rotstein, PE**
Checked by	**Lucas Carr, PE**
Approved by	**Brian G. Hennings, PG**
Description	**Corrective Action Alternatives Analysis Supporting Information Report**

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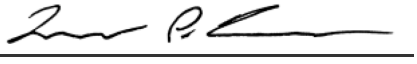

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Appendix B2	Groundwater Model Report
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ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
2020 closure	WAPS source control by consolidate-and-cap approach completed in 2020
bgs	below ground surface
BMP	best management practices
CAAA	Corrective Action Alternatives Analysis
CAAA-SIR	Corrective Action Alternatives Analysis Supporting Information Report
CAP	Corrective Action Plan
CCR	coal combustion residuals
CCR Rule	40 C.F.R. § 257 Subpart D
CIP	closure-in-place
cm/s	centimeters per second
CMA	Corrective Measures Assessment
COC	constituent of concern
CSM	conceptual site model
DMG	Dynegy Midwest Generation, LLC
gpm	gallons per minute
Gradient	Gradient Corporation
GWPS	groundwater protection standard(s)
HEN	Hennepin Power Station
HPP	Hennepin Power Plant
ID	identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ISS	in-situ solidification/stabilization
Kd	soil adsorption coefficient
mL/g	milliliters per gram
NAVD88	North American Vertical Datum of 1988
No.	number
NPDES	National Pollutant Discharge Elimination System
O&M	operation & maintenance
OWAP	Old West Ash Pond
OWPP	Old West Polishing Pond
PRB	Permeable Reactive Barrier
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RS Means	RS Means Heavy Construction Cost Data
SI	surface impoundment
TDS	total dissolved solids
UA	uppermost aquifer
USEPA	United States Environmental Protection Agency
WAPS	West Ash Pond System

1. INTRODUCTION AND BACKGROUND

1.1 Plant and Site Information

Dynegy Midwest Generation, LLC (DMG) is the owner of the inactive coal-fired Hennepin Power Plant (HPP), also referred to as the Hennepin Power Station (HEN), in Hennepin, Putnam County, Illinois. DMG intends to complete groundwater corrective action at the coal combustion residuals (CCR) surface impoundment (SI) West Ash Pond System (WAPS), which is identified by Illinois Environmental Protection Agency (IEPA) identification (ID) numbers (No.) W1550100002-01 and W1550100002-03, CCR Unit ID 804, and National Inventory of Dams Number IL50698. The WAPS is comprised of the Old West Ash Pond (OWAP) and the Old West Polishing Pond (OWPP). WAPS was constructed as a single unit with a single perimeter dike and subsequently internally divided into the OWAP and OWPP as part of operational practices. Source control (*e.g.*, closure) was completed in 2020; this included leaving CCR in place within the OWAP, removing all CCR from the OWPP, placing it within the OWAP, and installing a geomembrane final cover system over the consolidated OWAP [1, 2]. This document and all past engineering and hydrogeological studies consider the WAPS as a single CCR unit. Groundwater corrective action for the HEN WAPS will be performed under the requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments [3] and the requirements of Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257, herein referred to as the Federal CCR Rule [4].

1.2 CAAA-SIR Background and Scope

35 I.A.C. § 845 requires a Corrective Action Alternatives Analysis (CAAA) to be completed as part of remedy selection, pursuant to the requirements of 35 I.A.C. § 845.670(e). The CAAA for the HEN WAPS will be prepared by Gradient Corporation (Gradient). Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Corrective Action Alternatives Analysis Supporting Information Report (CAAA-SIR) to provide information requested by Gradient to support the CAAA for the HEN WAPS.

This CAAA-SIR is a feasibility-level assessment utilized to evaluate multiple groundwater corrective action alternatives. The remedy that is selected within the CAAA, to which this CAAA-SIR is attached, is then further developed into a permit-level remedy within the Corrective Action Plan (CAP), to which the CAAA is attached. Therefore, there may be minor differences in information presented for the selected remedy between this CAAA-SIR and the CAP. Information that may be different includes, but is not limited to, groundwater quality data, groundwater modeling inputs and results, implementation schedules, time to reach GWPSs, physical dimensions and scope of the remedy, and engineering design parameters. These differences are due to the further remedy refinement that is inherent with advancing the selected alternative into the permit-level remedy that is included within the CAP.

1.2.1 Identified Corrective Action Alternatives

Corrective action remedies selected for evaluation within this CAAA-SIR include:

- Alternative 1: Source control with groundwater polishing (GWP); and
- Alternative 2: Source control with continuous containment system.

Multiple remedies were evaluated in the Corrective Measures Assessment (CMA), prepared by Ramboll and attached to the CAAA prepared by Gradient, including source control with GWP, source control with cutoff wall, source control with *in-situ* stabilization (ISS), source control with permeable reactive barrier (PRB), source control with in-situ chemical treatment, and source control with groundwater extraction.

Out of these remedies, source control with GWP, source control with cutoff wall, and source control with ISS were identified for further assessment, while the remaining remedies were determined to be infeasible. As part of further assessment performed during this CAAA-SIR modeling and development, the following adjustments were made to the remedies identified by the CMA:

- Following groundwater modeling, the source control with ISS remedy was determined to be infeasible and omitted for inclusion in this CAAA-SIR, for the reasons described below:
  - ISS would require the temporary removal of approximately 15 acres of the 30-acre completed WAPS final cover system. Removal of the final cover system could allow for significant stormwater infiltration into CCR within the WAPS, potentially leading to temporary reductions in the effectiveness of the completed source control.
  - ISS would require handling of tens of thousands of cubic yards of CCR and CCR-impacted ISS cuttings on the surface of the WAPS. These activities could lead to an elevated risk of releasing CCR-impacted stormwater and sediments during construction activities, which could result in negative impacts to adjacent environmentally sensitive areas.
- The source control with cutoff wall remedy was expanded into the source control with continuous containment system remedy. The remedy includes a deep cutoff wall that is integrated with the existing cover system to provide lateral and surface isolation of the CCR from the surrounding environment and keyed into the competent shale bedrock which will provide isolation below the WAPS. Additional information on the expanded remedy is provided in Section 3.

1.2.2 Scope of CAAA-SIR

Ramboll completed the following tasks and documented the tasks within this CAAA-SIR, for each of the corrective action alternative remedies listed in **Section 1.2.1**:

- Feasibility-level design drawings (**Appendix A**) were developed to show the approximate extents and typical details of the Alternative 2 remedy (source control with continuous containment system). Drawings were not prepared for the Alternative 1 remedy as it does not involve construction at the site.
- Narratives describing the implementation of each remedy were developed, including the pre-design, design, construction, and closeout phases.
- Feasibility-level schedules providing the estimated time to implement the remedy were developed, including design, permitting, and construction.
- Information required to evaluate specific portions of 35 I.A.C. § 845.670(e) requirements were prepared, as requested by Gradient, including 35 I.A.C. § 845.670(e)(1)(H) and 35 I.A.C. § 845.670(e)(3).

- Estimates of implementation-based equipment mileage, vehicle delivery mileage, labor hour, and labor commuting mileage, were developed for each remedy alternative where physical construction activities are expected to occur.

All remedies presented in this CAAA-SIR are in conjunction with source control for the WAPS, which was completed in 2020 ("2020 closure") in accordance with the closure plan and supporting groundwater modeling that was submitted to and approved by IEPA in 2018 [5, 6, 1, 2]. Source control was the primary corrective action completed for the WAPS and utilized a consolidate-and-cap approach. The consolidate-and-cap approach included excavating all CCR from the OWPP portion of the WAPS, constructing a sheet pile wall and compacted clay buttress to separate the closure-by-removal and closure-in-place (CIP) portions of the WAPS, placing the CCR excavated from the OWPP in the OWAP portion of the WAPS, and then capping the CIP area with a geosynthetic and soil final cover system ("completed WAPS final closure"). The design of the source control was supported by groundwater modeling included in the IEPA-approved 2017 closure plan (**Appendix B2**).

1.2.3 Criterion for Estimating Time to Achieve GWPS

Times to achieve GWPS for each of the remedial alternative remedies were estimated for the wells within the existing WAPS compliance monitoring system, using updated groundwater modeling that incorporated the 2020 closure, as provided in **Appendix B1**. This approach was utilized to provide a consistent comparison of the estimated time to reach GWPS for each remedy, as required by 35 I.A.C. § 845.670(e)(f).

Closure for the WAPS serves as the primary corrective action for the unit and was completed in 2020, as discussed in **Section 1.2.2**. Supplemental remedial alternatives for the WAPS will need to be integrated with the completed closure. This affects the time to reach GWPS for each remedy, as the timeframe for each remedial alternative to become functional varies based on the required level of remedy permitting, design, and construction, or lack thereof. To provide a simplified comparative framework for the remedial alternatives, the groundwater modeling provided in **Appendix B1** assumed that Corrective Action Plans would be approved in 2026 and that construction for the source control with continuous containment system remedy would be completed in 2028.

1.3 Report Contents

The following information is included within this report:

- **Section 1** includes the introduction and background;
- **Section 2** includes information for the Alternative 1 remedy: source control with GWP;
- **Section 3** includes information for the Alternative 2 remedy: source control with continuous containment system;
- **Section 4** includes a brief summary of times to reach GWPS for Alternatives 1 through 3;
- **Section 5** includes information used to develop estimates of material quantities, labor hours, and mileage; and
- **Section 6** includes reference documents used in the development of this CAAA-SIR.

2. ALTERNATIVE 1 REMEDY: SOURCE CONTROL WITH GROUNDWATER POLISHING

The Alternative 1 remedy, source control with GWP, includes the already completed consolidate-and-cap approach for source control, after which GWP would be implemented via a formalized process. GWP is a remedial alternative that relies on natural geochemical processes and may be appropriate as recognized by the United States Environmental Protection Agency (USEPA) in a final policy directive for groundwater remediation [7]. GWP has been naturally occurring at the WAPS since source control was completed in 2020. For the purposes of this CAAA-SIR, the Alternative 1 remedy would involve formalizing the ongoing natural GWP processes as the corrective action remedy for the WAPS.

2.1 Supporting Groundwater Modeling and Time to Reach GWPS

The COCs exceeding[1] the GWPS at compliance groundwater monitoring wells as of the 2024 Annual Report [8] include arsenic, boron, lithium, sulfate, and TDS. Boron was selected for modeling the source control presented in the Final Closure Plan and was identified as a surrogate for other exceedances of the GWPS (**Appendix B2**). For modeling purposes, it was assumed that boron would not significantly sorb or chemically react with aquifer solids (soil adsorption coefficient [Kd] was set to 0 milliliters per gram [mL/g]) which is a conservative estimate for predicting contaminant transport times in the model. Boron transport is likely to be affected by both chemical and physical attenuation mechanisms (*i.e.,* adsorption and/or precipitation reactions as well as dilution and dispersion). Physical attenuation (dilution and dispersion) of contaminants in groundwater is simulated in the groundwater computer models. Chemical attenuation mechanisms and their effect on modeled times for exceedances to reach the GWPS are discussed in the Groundwater Polishing Evaluation Report [9] which is attached to the CAAA and discussed herein.

Groundwater modeling was performed to support the closure plan for the WAPS in 2017 (**Appendix B2**). This groundwater modeling identified that removing CCR from the OWPP portions of the WAPS was necessary to reduce times to reach GWPS. This was incorporated into the closure plan, and closure in accordance with the IEPA-approved closure plan was implemented in 2020 [1, 2]. More than three years of post-closure groundwater monitoring has subsequently been collected. The calibration associated with the 2017 groundwater model was updated to include that data as part of this CAAA-SIR, as discussed in the Groundwater Modeling Technical Memorandum included in **Appendix B1** [10]. The updated groundwater model estimated, for an assumed start of remedial action in 2026, that GWPS would be met for all wells in the monitoring system in 2055. This is 29 years after the assumed start of corrective action for all wells and 6 years on average (mean) for wells in the current monitoring system.

2.2 Remedy Implementation

Implementation of the source control portion of this remedy was completed in 2020 [1, 2]. Although a formal GWP remedy has not yet been initiated and approved by IEPA, GWP processes

[1] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or GWPSs as described in the proposed groundwater monitoring program, which was submitted to the IEPA on October 25, 2021 as part of DMG's operating permit application for the HPP WAPS. That operating permit application, including the proposed groundwater monitoring program, remains under review by the IEPA and, therefore, DMG has not identified any actual exceedances.

have been ongoing since the closure was completed. Implementation of GWP would include formalizing the GWP remedy. This would include performing corrective action groundwater monitoring, enacting an adaptive management strategy, and, after GWPS have been met, performing corrective action closure and completion activities. Information associated with each of these activities is described below.

- Corrective Action Groundwater Monitoring
  - Regular corrective action groundwater monitoring would be conducted utilizing a corrective action groundwater monitoring system designed in accordance with 35 I.A.C. § 845.680(c), which specifies that wells must be installed in the plume of contamination that lies beyond the waste boundary.
    - Samples would be collected for major ions for evaluating groundwater chemistry and COCs. Samples would be collected on a quarterly basis initially and potentially reduced to a semiannual basis once five years of monitoring have occurred, in accordance with 35 I.A.C. § 845.650(b)(4).
    - Monitoring results would be submitted to IEPA for each monitoring event, in addition to an annual groundwater monitoring and corrective action report, in accordance with 35 I.A.C. § 845.610(e).
    - Routine maintenance of the monitoring well system would occur during the monitoring period. This would include inspecting the wells, making repairs to the wells (as and if needed), and rehabilitating and/or replacing wells to improve performance (as and if needed).
- Adaptive Management during Monitoring
  - Groundwater monitoring results would be evaluated and documented in the monitoring reports submitted to IEPA, in accordance with 35 I.A.C. § 845.610(e).
  - If remedy progress does not correspond with expectations, additional methods or techniques to achieve compliance with GWPS would be evaluated and, if feasible, implemented in accordance with 35 I.A.C. § 845.680(b).
- Corrective Action Confirmation Monitoring and Completion
  - After GWPS have been met for all corrective action monitoring wells, corrective action confirmation groundwater monitoring would be implemented. This would include monitoring each well for three additional years to confirm that GWPS have been achieved, in accordance 35 I.A.C. § 845.680(c).
    - It should be noted that this could occur prior to or after completion of the 30-year post-closure care groundwater monitoring requirement associated with 35 I.A.C. § 845.780(c).
  - After completion of the corrective action confirmation monitoring period, a Corrective Action Completion Report and Certification would be prepared and submitted to IEPA, in accordance with 35 I.A.C. § 845.680(e).

2.2.1 Remedy Implementation Schedule

A feasibility-level implementation schedule for the Alternative 1 source control with GWP remedy is provided in **Table A** below.

Table A. Feasibility-Level Implementation Schedule – Alternative 1 Source Control with GWP

Implementation Phase	Implementation Task	Timeframe (Preliminary Estimates)
Corrective Action Monitoring and Closeout	Corrective Action Monitoring (Time to Meet GWPS)	348 months (29 years)
	Corrective Action Groundwater Confirmation Monitoring	36 months
	Corrective Action Completion	6 months
	Timeframe to Complete Corrective Action Implementation	390 months
Total Timeline to Complete Corrective Action (after approval of Corrective Action Plan)		390 months (33 years)

2.2.2 Management of Extracted Groundwater

No groundwater extraction would occur under this remedy.

2.2.3 35 I.A.C. § 845.670(e)(1)(H) and 35 I.A.C. § 845.670(e)(3) Information

As requested by Gradient, the following information required by 35 I.A.C. § 845.670(e)(1)(H) and 35 I.A.C. § 845.670(e)(3) has been developed for the remedy. The information was developed based on preliminary-level information contained within the CMA for the HEN WAPS and then refined based on additional feasibility-level design activities performed as part of the development of this CAAA-SIR.

- Potential Need for Replacement of the Remedy – 35 I.A.C. § 845.670(e)(1)(H)
  - No replacement of the remedy would be required for source control with GWP, as a physical remedy would not be constructed.
- Degree of Difficulty Associated with Constructing the Remedy – 35 I.A.C. § 845.670(e)(3)(A)
  - No construction would be required with the source control with GWP remedy; therefore, there is no difficulty in constructing the remedy.
- Expected Operational Reliability of the Remedy - 35 I.A.C. § 845.670(e)(3)(B)
  - A report detailing the GWP process [9] has been developed and evaluates the reliability and the potential for reversibility of the chemical attenuation mechanisms. This report is attached to the Gradient CAAA.
- Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies - 35 I.A.C. § 845.670(e)(3)(C)
  - No permits are needed outside of approval of the eventual CAP.

- Availability of Necessary Equipment and Specialists - 35 I.A.C. § 845.670(e)(3)(D)
  - Equipment and specialists for field data collection and groundwater sampling are required for the GWP alternative. Laboratory equipment and specialists would also be required to assess groundwater concentrations of site constituents. Groundwater professionals (*i.e.*, geologists, hydrogeologists, statisticians, geochemists) would be required to perform statistical analysis and other assessments to confirm that GWP is functioning as intended and prepare corrective action-related groundwater monitoring and progress reports.
  - The equipment and specialists required for site groundwater monitoring and analysis are currently performing this work as part of the routine groundwater monitoring program in accordance with 35 I.A.C. § 845.220(c)(4). Therefore, no new equipment or specialists are required for groundwater monitoring for this alternative.
- Available Capacity and Location of Needed Treatment, Storage, and Disposal Services – 35 I.A.C. § 845.670(e)(3)(E)
  - No treatment, storage, or disposal services would be required with the source control with GWP remedy, as GWP would not generate any appreciable volume of waste or wastewater.

3. ALTERNATIVE 2 REMEDY: SOURCE CONTROL WITH CONTINUOUS CONTAINMENT SYSTEM

The Alternative 2 remedy, source control with continuous containment system, includes the completed source control supplemented by the construction of a cutoff wall that would extend from the top of the WAPS perimeter dikes (approximate elevation of 462-465 feet[2]) completely through the highly pervious uppermost aquifer (UA) and penetrate (*i.e.*, anchor) into shale bedrock at an approximate elevation of 375 feet (*i.e.*, a deep cutoff wall). The deep cutoff wall would encircle the perimeter of the CIP portions of the WAPS, with a total length of approximately 5,200 feet and a typical depth of 90 feet below ground surface (bgs). The existing final cover system would be extended over the top of and tied into the deep cutoff wall. This would result in CCR within the WAPS being contained within a continuous system of low-permeability materials and isolated from the surrounding environment on all sides, which includes the highly pervious UA, through:

- The deep cutoff wall, providing lateral containment on all sides of the CCR,
- The existing low-permeability geomembrane final cover system, providing surface containment on the top of the CCR,
- Low-permeability competent shale bedrock, providing base containment below the CCR.

This continuous containment system would provide a physical barrier between the CCR and the surrounding environment. Modeling indicates the continuous containment system is unlikely to result in the buildup of liquids within the contained CCR mass, and therefore supplemental groundwater extraction and/or active gradient control within the WAPS to remove accumulated liquids is not expected to be necessary. Therefore, the continuous containment system would control the source of releases of constituents.

The deep cutoff wall portion of the system would be constructed using either a mixture of soil and bentonite or cement and bentonite and would have a typical thickness of 2 to 3 feet. The cutoff wall would have a typical hydraulic conductivity value of approximately 1×10^{-7} centimeters per second (cm/s) or lower.

A feasibility-level design drawing of the Alternative 2 source control with continuous containment system remedy is provided as **Figure 2** in **Appendix A.**

3.1 Remedy Scoping and Groundwater Modeling Results

The location of the deep cutoff wall portion of the continuous containment system remedy was selected by reviewing physical constraints around the WAPS and designating locations on the DMG property where the wall could feasibly be constructed. The objective of selecting the wall location was to limit impacts to existing site infrastructure and sensitive areas such as wetlands, regulatory floodplains, or areas with documented decurrent false aster plants[3] while also limiting adverse impacts or conflicts with the 2020 WAPS final closure. This assessment resulted in the selection of a wall alignment along and outside of the existing site access road around the crest

[2] All elevations in this report are in the North American Vertical Datum of 1988 (NAVD88), unless otherwise noted.

[3] The decurrent false aster (*Boltonia decurrents*), a threatened species in Illinois, has been identified along the southern boundary of the OWAP [12, 13, 14]

of the WAPS perimeter dikes, which is not within regulatory floodplains or known wetlands, avoids known decurrent false asters, and provides generally level alignment for the wall. The location also allows the cutoff wall to act as a lateral barrier between the CCR contained within the OWAP and the surrounding environment and reduces, but does not eliminate, conflicts with the 2020 WAP closure. The location of the wall would allow the final cover to be extended over the top of the wall as surface containment, while also allowing the wall to completely encircle CCR within the WAPS.

Other locations were considered and determined to be infeasible for construction of the deep cutoff wall portion of the continuous containment system remedy. One location was outside the OWAP perimeter dikes, such as at the toe of the OWAP dikes or within adjacent portions of the OWAP that were closed by removal of CCR (*i.e.,* the OWPP). This is because these areas are within the 100-year floodplain of the Illinois River and are often flooded by seasonal high-water events, located near or beyond DMG property boundaries, in areas that are considered regulatory wetlands, or home to rare and endangered species (*e.g.*, decurrent false aster known to be present along the southern boundary of OWAP [11]). Therefore, both permitting and constructing the cutoff wall portion of the remedy in these areas was determined to be impracticable due to a high likelihood for flood-related impacts during wall construction, multiple floodplain and wetland-related permits required for the construction, the potential need to purchase or obtain access easements from adjacent landowners, the potential for a release of impacted stormwater and/or sediments to the wetlands or river during construction, and the potential adverse impacts to rare and/or endangered species previously discussed. Adjacent wetlands, floodplains, and rare plant locations are shown on the drawings provided in **Appendix A**.

Groundwater modeling estimated that, for an assumed start of remedial action in 2028, GWPS would be met for all wells in the monitoring network in 2061. This is 33 years after the start of corrective action that was assumed in the groundwater model. The attached Groundwater Modeling Technical Memorandum, which provides additional information on the updated groundwater modeling used to support the feasibility-level design of this remedy, is provided in **Appendix B1**.

3.2 Remedy Implementation

Implementation of the Alternative 2 source control with continuous containment system remedy is expected to include multiple tasks spread out over three phases, including pre-construction activities (Phase 1), corrective action construction (Phase 2), and corrective action operations, maintenance, and closeout (Phase 3). Information for each phase is described in this section.

3.2.1 Phase 1: Pre-Construction Activities

Pre-construction activities would include further pre-design investigation, obtaining permits from other agencies, completing the final design of the remedy, and selecting a remedy implementation contractor via a bidding process. Information associated with each of these activities is described below.

- Completing pre-design investigation, final design, and bid activities, including:
  - Completion of final pre-design subsurface investigations, laboratory soil testing, engineering calculations, bench-scale testing of proposed wall construction materials, design drawings, specifications, and a construction quality assurance plan.

  - Bidding and selection of a cutoff wall construction contractor.

- Obtaining permits from other agencies including:
  - A general stormwater permit for construction site activities through IEPA, including construction of stormwater controls and other best management practices (BMPs) such as silt fences.
  - An Illinois Department of Natural Resources (IDNR) Office of Water Resources, Dam Safety modification permit would be likely be required for modification of the WAPS embankment.
  - A National Pollutant Discharge Elimination System (NPDES) permit modification to allow CCR-contact stormwater generated during construction to be collected and transmitted to the existing on-site treatment pond for discharge to the Illinois River via Outfall 003.

3.2.2 Phase 2: Corrective Action Construction

Corrective action construction would be initiated after pre-construction activities are complete. It would include mobilizing construction equipment to the site, preparing the site for construction activities, construction of the cutoff wall (which would include removal and replacement of existing subgrade soils with low-permeability wall materials), and performing post-construction and site restoration activities including integrating the deep cutoff wall with the completed final closure to provide the continuous containment system.

Information associated with each of these activities is described below.

- The contractor would mobilize equipment and materials to the site, install stormwater BMPs around the construction area, construct a staging and laydown area, and construct a level working pad and/or temporary construction access roads along the cutoff wall alignment.
- The cutoff wall alignment would likely conflict with the completed geosynthetic and soil final cover system for the WAPS. To allow for cutoff wall construction, the final cover system would be temporarily removed in these areas.
  - This would include stripping topsoil and cover soil from the geomembrane, stockpiling the materials in the former Hennepin Coal Yard for future final cover restoration, removing the geosynthetics, and disposing of them in an off-site landfill.
  - Any conflicting site infrastructure (i.e., access roads, piezometers, monitoring wells, stormwater channels, stormwater letdown structures, pressure relief vents) would also be removed as part of the activities.
- A level, approximately 60-feet wide working pad and temporary construction access road would be constructed along the cutoff wall alignment to allow construction equipment (*i.e.*, cranes, haul trucks, light vehicles) access and traffic.
  - Due to the expected high ground pressures of the construction equipment, there is a high potential for damage to final cover system geosynthetics beneath access roads and working pads, even in areas outside of the cutoff wall alignment itself. For this reason, the final cover system soils and geosynthetics would also be removed beneath the footprint of the working pad and access road, in the same manner as final cover system removal completed directly beneath the cutoff wall alignment.

- A temporary contact water stormwater management system would be constructed to collect CCR-impacted stormwater generated during construction. This is expected to include temporary drainage sumps, pumps, and piping required to collect contact stormwater and pump it to the existing on-site treatment pond for discharge via NPDES Outfall 003.
- A temporary on-site batch plant and/or material handling system would be established for the purpose of generating low permeability backfill for the cutoff wall. This would include either mixing bentonite with the subgrade soils or producing a cement-bentonite slurry to place into the wall.
- A geotechnical monitoring system would be installed to monitor the WAPS perimeter dikes for movement when the dike is loaded with heavy construction equipment with the potential to destabilize the slurry construction. The monitoring system may consist of survey monuments, survey prisms, inclinometers, piezometers, and/or other appropriate monitoring devices.
- The wall would likely be constructed utilizing either crane-mounted conventional construction equipment (*i.e.,* clamshell, slurry cutter, and/or hydromill); however, other innovative methods could be utilized if determined to be appropriate based on site-specific subsurface conditions and constructability considerations.
- Installation of the cutoff wall would occur concurrently with the removal of some of the subsurface soils (soil-bentonite walls) or all of the subsurface soils (cement-bentonite wall).
- The wall would likely require installation in discontinuous panels (*i.e.,* primary panels) with secondary panels installed for connection after the primary panels have sufficiently cured/hardened, in order to support the stability of the sides of the wall during construction and reduce the destabilizing effects of slurry within the perimeter embankments.
- Excavated soils (*e.g.,* spoils) would be placed into off-road dump trucks and hauled to the former Hennepin Coal Yard for temporary stockpiling.
- After the cutoff wall construction is complete, CCR-impacted cutoff wall spoils and/or work pad materials would be managed either off-site or beneficially used within the Hennepin East Ash Pond as compacted contouring fill beneath the final cover system.
  - Cutoff wall spoils that are not CCR-impacted would be disposed of on-site at the HPP.
- The final cover system would then be restored. This would include placing new geosynthetics and tying them into the existing, un-damaged geosynthetics, extending the final cover system across the deep cutoff wall to provide the continuous containment system, and replacing the cover soil and topsoil with the previously removed and stockpiled final cover system soils.
- The temporary contact water management system would be decommissioned as part of final cover system replacement.
- Piezometers, monitoring wells, pressure relief vents, stormwater channels, stormwater letdown structures, and access roads damaged or removed during construction would also be replaced, and the final cover system would be revegetated via seeding.
- Temporary BMPs would also be installed during the site restoration period, if required in accordance with site land disturbance permits. The BMPs would be removed once vegetation is established.

3.2.3 Phase 3: Corrective Action Operations, Maintenance, and Closeout

Corrective action operations, maintenance, and closure would be initiated after corrective action construction is completed. Phase 3 would include performing corrective action groundwater monitoring, and, after GWPS have been met, performing corrective action closeout and completion activities. Information associated with each of these activities is described below.

- Corrective Action O&M
  - No corrective action O&M is required for the deep cutoff wall or shale bedrock portions of the continuous containment system remedy, as these features are passive, below-grade structure without maintenance or operational needs.
  - Maintenance of the WAPS final cover system portion of the continuous containment system remedy would continue in accordance with current post-closure care O&M practices.
- Corrective Action Groundwater Monitoring
  - Regular corrective action groundwater monitoring would be conducted utilizing a corrective action groundwater monitoring system designed in accordance with 35 I.A.C. § 845.680(c), which specifies that wells must be installed within the plume of contamination that lies beyond the waste boundary.
    - Samples would be collected for COCs required by 35 I.A.C. § 845.600(a)(1). Samples would be collected on a quarterly basis initially and potentially reduced to a semiannual basis once five years of monitoring have occurred, in accordance with 35 I.A.C. § 845.650(b)(4).
    - Monitoring results would be submitted to IEPA after each monitoring event, in addition to an annual groundwater monitoring and corrective action report, in accordance with 35 I.A.C. § 845.640(e). The annual corrective action report would include an evaluation of the actual performance of the remedy relative to the remedy's expected performance.
    - Routine maintenance of the monitoring well system would be conducted during the monitoring period. This would include inspection of the wells, making repairs to the wells (as and if needed), and rehabilitation and/or replacing the wells to improve performance (as and if needed).
  - If the remedy does not achieve its expected performance, additional methods or techniques to achieve compliance with GWPS would be evaluated and, if feasible, implemented in accordance with 35 I.A.C. § 845.680(b).
- Adaptive Management during Monitoring
  - Groundwater monitoring results would be evaluated and documented in the monitoring reports submitted to IEPA, in accordance with 35 I.A.C. § 845.610(e).
  - Remedy progress evaluation as part of adaptive site management may include additional investigation to inform updates to the conceptual site model (CSM), groundwater, and geochemical models.
  - If remedy progress does not correspond with expectations, additional methods or techniques to achieve compliance with GWPS would be evaluated and, if feasible, implemented in accordance with 35 I.A.C. § 845.680(b).

- Corrective Action Completion
  - After GWPS have been met for all compliance wells for a period of three years, corrective action would be considered complete, per 35 I.A.C. § 845.680(c).
    - It should be noted that this could occur prior to or after completion of the 30-year post-closure care groundwater monitoring requirement associated with 35 I.A.C. § 845.780(c).
  - After completion of the corrective action confirmation monitoring period, a Corrective Action Completion Report and Certification would then be submitted to IEPA, in accordance with 35 I.A.C. § 845.680(e).

3.2.4 Remedy Implementation Schedule

A feasibility-level implementation schedule for the Alternative 2 source control with continuous containment system remedy is provided in **Table B** below.

Table B. Feasibility-Level Implementation Schedule – Alternative 2 Source Control with Continuous Containment System

Implementation Phase	Implementation Task	Timeframe (Preliminary Estimates)
1: Pre-Construction Activities	Agency Coordination, Approvals, and Permitting	18 to 24 months
	Final Design and Bid Process	24 to 36 months
	Timeframe to Complete Corrective Pre-Construction Activities	42 to 60 months after CAP Approval
2: Corrective Action Construction	Corrective Action Construction	18 to 24 months
	Timeframe to Complete Corrective Action Construction	18 to 24 months
3: Corrective Action Monitoring and Closeout	Corrective Action Monitoring (Time to Meet GWPS)	396 months (33 years)
	Corrective Action Groundwater Confirmation Monitoring	36 months
	Corrective Action Completion	6 months
	Timeframe to Complete Corrective Action O&M and Closeout	438 months
Total Timeline to Complete Corrective Action (after approval of Corrective Action Plan)		498 to 522 months (42 to 44 years)

3.2.5 Management of Extracted Groundwater

No groundwater extraction would occur under this remedy.

3.2.6 35 I.A.C. § 845.670(e)(1)(H) and 35 I.A.C. § 845.670(e)(3) Information

As requested by Gradient, the following information required by 35 I.A.C. § 845.670(e)(1)(H) and 35 I.A.C. § 845.670(e)(3) has been developed for the remedy. The information was developed based on preliminary-level information contained within the CMA for the HEN WAPS and then refined based on additional feasibility-level design activities performed as part of the development of this CAAA-SIR.

- Potential Need for Replacement of the Remedy – 35 I.A.C. § 845.670(e)(1)(H)
  - The deep cutoff wall and underlying shale bedrock remedy would be unlikely to require replacement, as the cutoff wall would be a robust, engineered, and maintenance-free subsurface structure.
  - The final cover system portion of the remedy will require continual maintenance in accordance with existing post-closure care plans, but is an engineered and passive structure that is unlikely to require replacement.
- Degree of Difficulty Associated with Constructing the Remedy – 35 I.A.C. § 845.670(e)(3)(A)
  - The remedy would require mobilizing specialty equipment to the site (*i.e.,* large cranes, clamshells, or slurry cutters) to construct the deep cutoff wall in addition to other supporting equipment (*i.e.,* batch plants, excavation, and grading equipment).
  - While cutoff walls are routinely constructed to similar depths in similar geologic environments, they often encounter difficulties during construction. The difficulties could include encountering especially pervious layers and resulting slurry loss or encountering obstructions that require specialized techniques and/or equipment to advance past, or instability or caving in the sidewalls prior to hardening of the slurry backfill. These difficulties can be problematic at the WAPS due to the known presence of boulders and cobbles within the subsurface soils. While these challenges can be addressed during cutoff wall construction, they may result in schedule delays.
  - The cutoff wall would be installed through an existing CCR surface impoundment embankment that is also a dam regulated by IDNR. This would require placing heavy construction equipment (*i.e.*, cranes) at the crest of the embankment as well as placing a slurry fluid within the embankment that may cause temporary destabilization of the embankments until curing occurs. While these challenges are common to constructing cutoff walls in embankments, additional engineering assessments and monitoring systems/programs would be required to monitor the embankment for signs of distress (*i.e.*, deformation, cracking) during cutoff wall construction and take appropriate means to stabilize the embankment if signs of potential instability are noted.
    - Furthermore, the act of placing the crane at the top of the embankment and placing slurry within the embankment may result in temporary destabilization of the embankment relative to current conditions. This would be addressed by performing detailed engineering assessments to evaluate the stability of the WAPS embankments during cutoff wall construction.
  - CCR-contact stormwater management is an obligatory part of construction that is necessary in order to comply with site-specific land disturbance permits and reduce the potential for the release of contact stormwater into the adjacent wetlands or Illinois River. This would require the installation and operation of a contact stormwater management system to pump contact stormwater approximately 1.3 miles to the existing on-site treatment pond for discharge via NPDES Outfall 003. Additional management of outfall water quality may also be required during construction.
  - The performance of the cutoff wall portion of the remedy would be dependent on the construction techniques of the wall, in order to avoid gaps, voids, or other discontinuous features or defects in the wall. Continuous quality control monitoring would be required

during construction as part of construction quality control and quality assurance activities in order to avoid these features. The wall may also require post-construction quality assurance activities (*i.e.,* coring and testing) to verify the quality of the constructed barrier.

  - The performance of the deep cutoff wall portion of the remedy would also be dependent on the actual hydraulic conductivity of the wall. This would require continual monitoring, quality control testing, and quality assurance testing of slurry mixing and placement or soil-bentonite mixing to verify that the as-designed mix is utilized.

- Expected Operational Reliability of the Remedy - 35 I.A.C. § 845.670(e)(3)(B)
  - The continuous containment system wall is expected to have high operational reliability if the deep cutoff wall is constructed in accordance with standard design specifications for barrier walls and the final cover system is maintained in accordance with the existing post-closure care plan. This is because the remedy provides continuous surface, lateral, and lower containment of the CCR using both engineered and natural inert, low-permeability groundwater flow barriers (*i.e.*, the existing cover, the deep cutoff wall, and competent shale bedrock).
  - Temporarily removing portions of the completed WAPS final cover is required to allow for installation of the cutoff wall portion of the remedy. The final cover system will be restored around one year later. This process may allow additional stormwater to percolate into the CCR while the final cover system is removed and potentially cause a temporary reversal of some of the positive effects of the completed final cover system (*e.g.*, source control).
    - However, these effects would be expected to diminish after the final cover system is repaired, as the continuous containment system will then be present.
- Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies - 35 I.A.C. § 845.670(e)(3)(C)
  - Agency permits would need to be obtained from IEPA for construction stormwater controls and BMPs, in addition to a joint water pollution control construction and operating permit and IDNR Dam Safety modification permit to allow for modifications of the WAPS embankment.
  - A modification to the site's NPDES permit would also be required to allow for the discharge of CCR-contact stormwater generated during construction. These permits typically take 18 to 24 months to obtain.
- Availability of Necessary Equipment and Specialists - 35 I.A.C. § 845.670(e)(3)(D)
  - Construction of the deep cutoff wall portion of the remedy would require a specialized contractor experienced with construction of similar types of walls in similar geologic environments (*i.e.,* the Illinois, Mississippi, and/or Ohio River Valleys), particularly in environments with a prevalence of boulders and cobbles in the subsurface. The contractor would likely need specialized equipment, such as large cranes, clamshell buckets, slurry cutters, hydromills, batch plants, or other types of specialized equipment.
  - Specialists in cutoff wall design and construction would also need to be utilized during the design and construction phase of the cutoff wall. The specialists would include design

engineers, construction managers, and contractor staff experienced with cutoff wall construction and equipment operation.

- Monitoring of the WAPS embankments during cutoff wall construction would require specialists in geotechnical instrumentation (*i.e.,* inclinometers, survey prisms, vibrating wire piezometers) and visual observation of embankments for signs of distress. Additionally, a specialized drilling and instrumentation installation contractor would be needed to construct the geotechnical instrumentation system. Surveyors or other specialists may also be needed to collect routine readings from the system.
- These types of equipment and specialists have been utilized in the past for other similar types of deep cutoff wall design and construction projects. However, there may be shortages associated with the equipment and specialists, due to high existing backlog for specialty ground improvement contractors and design specialists who are supporting similar types of projects in the electric utility, dam/levee, and other market sectors.
- Specialists, with the necessary equipment, experienced with geosynthetics design and installation, specifically with seaming new geosynthetics to an existing final cover system, would be required for the final cover system restoration portion of the remedy. These types of equipment and specialists are available; however, they may have a high existing backlog due to ongoing projects in the solid waste management, electric utility, and other market sectors.
- Equipment and specialists for field data collection, groundwater sampling, analysis, and periodic corrective action groundwater monitoring and reporting would be required for the remedy. As described in **Section 2.2.3,** the equipment and specialists required to support these activities are currently performing routine groundwater monitoring in accordance with 35 I.A.C. § 845.220(c)(4). Therefore, no new equipment or specialists are required for groundwater monitoring in this alternative.
    - The equipment and specialists required for site groundwater monitoring and analysis are currently performing this work in accordance with 35 I.A.C. § 845.220(c)(4). Therefore, no new equipment or specialists are required for groundwater monitoring for this alternative.

- Available Capacity and Location of Needed Treatment, Storage, and Disposal Services - 35 I.A.C. § 845.670(e)(3)(E)
    - Wastes generated during cutoff wall construction would be limited to geosynthetics and other debris from removing the final cover system, cutoff wall spoils, and contact stormwater.
        - Geosynthetics and other debris would be disposed at an off-site landfill. Multiple off-site landfills are located within the region, and all are expected to have sufficient volume to receive the relatively low quantities of geosynthetics and other debris.
        - Cutoff wall spoils containing CCR-impacted material would be temporarily staged on-site during construction and ultimately be managed either off-site or beneficially utilized as compacted contouring fill on-site beneath the Hennepin East Ash Pond final cover system during restoration. This would require coordination with the East Ash Pond closure.

    - Cutoff wall spoils that do not contain CCR-impacted material would be disposed of at an appropriate on-site location at the HPP.
    - Contact stormwater would be pumped to the existing on-site treatment pond for discharge via NPDES Outfall 003. The treatment pond and outfall previously received much higher flow volumes during operation and are therefore expected to have sufficient capacity for contact stormwater management.
- No wastes would be generated during operation of the continuous containment system; therefore, no additional treatment, storage or disposal services would be required with the source control with cutoff wall remedy.

4. MATERIAL QUANTITY, LABOR, AND MILEAGE ESTIMATES

Estimates of material quantities, total labor hours, and mileage were prepared for Alternative 2 source control with continuous containment system remedy, to support Gradient in preparing a CAAA. Estimates were not prepared for Alternative 1 source control with GWP as the alternative does not require remedial construction or operations and maintenance of a physical remedy.

These estimates were prepared utilizing the following approach:

- Major implementation (*e.g.*, construction) components and line items were identified in accordance with the remedy implementation narratives contained within this CAAA-SIR.
- Construction quantities were estimated based on quantity estimates for volumes, areas, and units, as obtained from the feasibility-level engineering drawings and schedules included within this CAAA-SIR.
- RS Means Heavy Construction Cost Data (RS Means) [12] was utilized to estimate the crew size, equipment description, and daily output associated with each line item.
- For line-items where RS Means data was not available, the crew size, equipment description, and daily output were estimated based on Ramboll's experience, information from contractors, and/or information from material suppliers.
- For the Alternative 2 source control with continuous containment system remedy, daily construction and oversight were estimated assuming an average one-way commute of 35 miles for each individual working on-site. The number of working days and hours per week were estimated from the construction schedule developed for each remedy.
- Estimates of material delivery miles were prepared based on Ramboll's experience.

The detailed material quantity, labor, and mileage estimates are provided in **Appendix C** for each alternative.

5. REFERENCES

[1] Dynegy Midwest Generation, LLC, "Hennepin Power Station; Old West Ash Pond, Ash Pond No. 2, Notification of Completion of Closure," Luminant, December 17, 2020.

[2] Dynegy Midwest Generation, LLC, "Hennepin Power Station; Old West Polishing Pond, Notification of Completion of Closure," Luminant, December 17, 2020.

[3] "35 Ill. Admn. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Illinois Environmental Protectoin Agency, Springfield, IL, 2021.

[4] Code of Federal Regulations, "Title 40, Chapter I, Subchapter I, Part 257, Subpart D, Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," April 17, 2015.

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[7] United States Environmental Protection Agency, "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites," OSWER Directive Number 9200.4-17P, April 21, 1999.

[8] Ramboll Americas Engineering Solutions, Inc., "2024 35 I.A.C. § 845 Annual Groundwater Monitoring and Corrective Action Report. West Ash Pond System, Hennepin Power Plant, Hennepin, Illinois.," 2025. January 31.

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[11] SCI Engineering, Inc., "Decurrent False Aster Survey, Hennepin Power Station - Old West Ash Pond," September 27, 2019.

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[15] Geosyntec Consultants, "Construction Certification Report Closure of the Old West Ash Pond and Old West Polishing Pond," 2021.

[16] Ramboll Americas Engineering Solutions, Inc., "River Flood Evaluation Report, Hennepin East Ash Pond No. 2 and No. 4, Closure Plan Addendum 3," 2020.

APPENDIX A
FEASIBILITY-LEVEL DESIGN DRAWINGS FOR ALTERNATIVE 2 REMEDY

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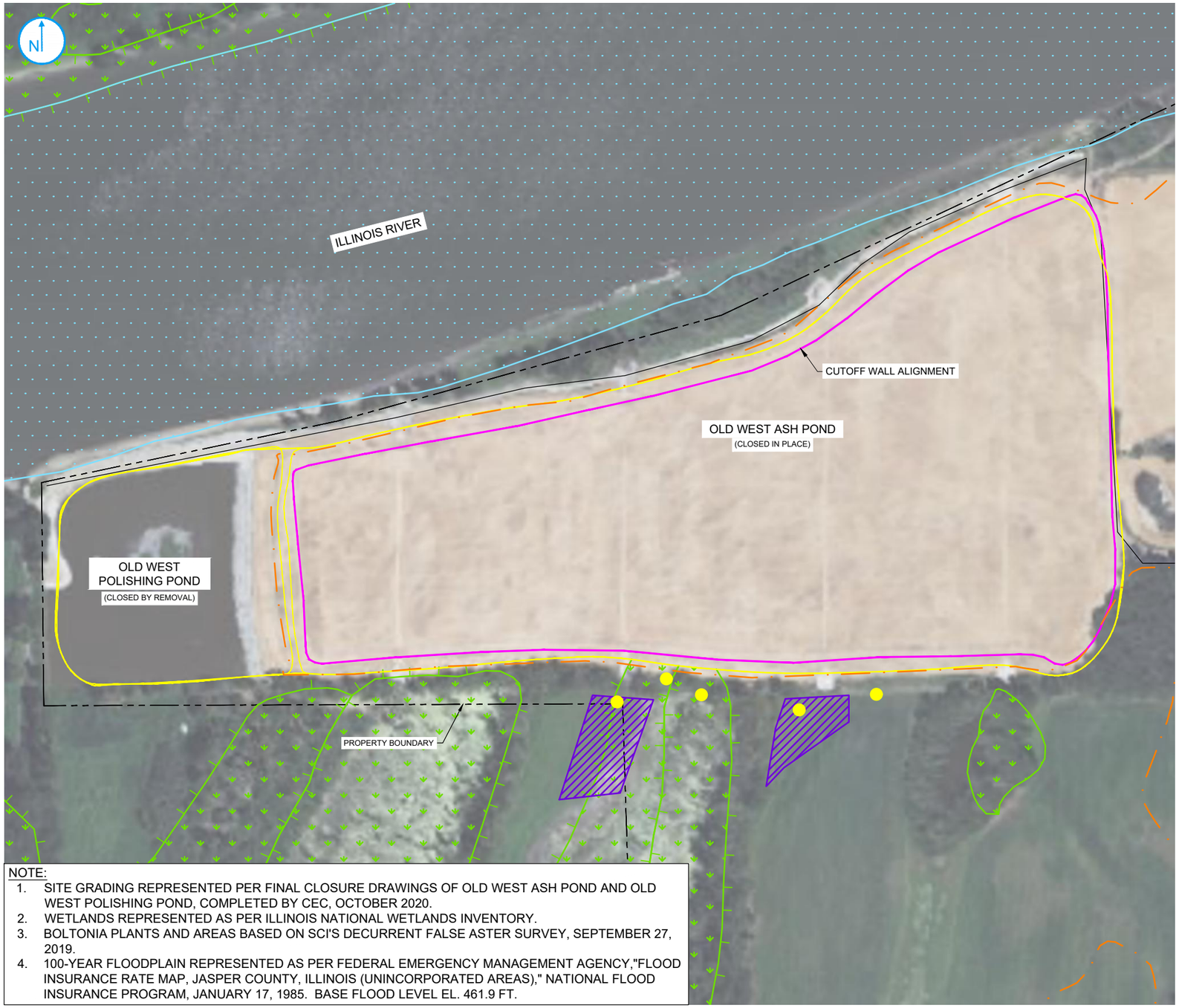
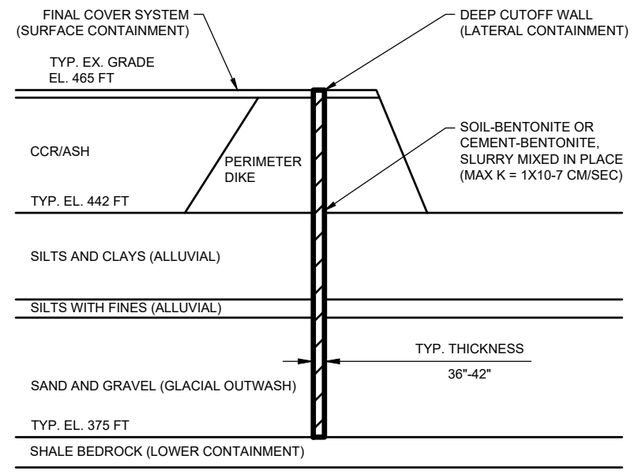
DESIGNER: LEMMONBN
DATED: 2/21/2024
PROJECT: ----



NOTE:
1. SITE GRADING REPRESENTED PER FINAL CLOSURE DRAWINGS OF OLD WEST ASH POND AND OLD WEST POLISHING POND, COMPLETED BY CEC, OCTOBER 2020.
2. WETLANDS REPRESENTED AS PER ILLINOIS NATIONAL WETLANDS INVENTORY.
3. BOLTONIA PLANTS AND AREAS BASED ON SCI'S DECURRENT FALSE ASTER SURVEY, SEPTEMBER 27, 2019.
4. 100-YEAR FLOODPLAIN REPRESENTED AS PER FEDERAL EMERGENCY MANAGEMENT AGENCY,"FLOOD INSURANCE RATE MAP, JASPER COUNTY, ILLINOIS (UNINCORPORATED AREAS)," NATIONAL FLOOD INSURANCE PROGRAM, JANUARY 17, 1985. BASE FLOOD LEVEL EL. 461.9 FT.



CONTINUOUS CONTAINMENT SYSTEM DETAIL

NOT TO SCALE

WETLANDS BOUNDARY (SEE NOTE 2)

BODY OF WATER

BOLTONIA PLANTS (SEE NOTE 3)

BOLTONIA AREAS (SEE NOTE 3)

100-YR FLOODPLAIN (SEE NOTE 4)

PROPOSED CUTOFF WALL LOCATION

0 250 Feet

SOURCE CONTROL WITH CONTINUOUS CONTAINMENT SYSTEM

FEASABILITY-LEVEL DESIGN

Hennepin Power Plant
Hennepin Power Plant 13498 E 800th St Hennepin, IL 61327

FIGURE 1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY
RAMBOLL

APPENDIX B
GROUNDWATER MODELING DOCUMENTS

APPENDIX B1
GROUNDWATER MODELING TECHNICAL MEMORANDUM

Intended for
Dynegy Midwest Generation, LLC

Date
May 6, 2025

Project No.
1940103584-005

GROUNDWATER MODELING TECHNICAL MEMORANDUM

WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS
IEPA ID NO. W1550100002-01 AND W1550100002-03

RAMBOLL Bright ideas. Sustainable change.

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT

Project Name	**Hennepin Power Plant West Ash Pond System**
Project No.	**1940101010-005**
Recipient	**Dynegy Midwest Generation, LLC**
Document Type	**Groundwater Corrective Action Alternatives Modeling Report**
Revision	**FINAL**
Date	**May 6, 2025**
Prepared by	**Katie Moran**
Checked by	**Lucas Carr**
Approved by	**Brian G. Hennings, PG**

Katie Moran
Senior Scientist

Brian G. Hennings, PG
Project Officer, Hydrogeology

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Figure 3-8 Simulated Boron Concentrations at Compliance Monitoring Wells: Alternative 3
Figure 3-9 Simulated Boron Concentrations, 30 and 100 years: Alternative 3

APPENDICES

Appendix A MODFLOW and MT3DMS Modeling Files (Electronic Only)

ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
ASD	Alternative Source Demonstration
CAAA	Corrective Action Alternatives Analysis
CAP	Corrective Action Plan
CBR	closure-by-removal
CCR	coal combustion residuals
CCR Rule	40 C.F.R. § 257 Subpart D
cm/s	centimeters per second
COC	constituent of concern
DMG	Dynegy Midwest Generation, LLC
ft/day	feet per day
ft^2/day	square feet per day
ft/ft	foot per foot
GMR	Groundwater Modeling Report
GPR	Groundwater Polishing Evaluation Report
GWP	groundwater polishing
GWPS	groundwater protection standard(s)
HCR	Hydrogeologic Site Characterization Report
HELP	Hydrologic Evaluation of Landfill Performance
HFB	horizontal flow barrier
HPP	Hennepin Power Plant
ID	identification
IEPA	Illinois Environmental Protection Agency
in/yr	inch per year
ISS	in-situ solidification/stabilization
Kd	soil adsorption coefficient
mg/L	milligrams per liter
mL/g	milliliters per gram
MW	megawatt
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical datum of 1929
No.	number
NRT	Natural Resources Technology, Inc.
OWAP	Old West Ash Pond
OWPP	Old West Polishing Pond
Ramboll	Ramboll Americas Engineering Solutions, Inc.
TDS	total dissolved solids
UA	uppermost aquifer
USEPA	United States Environmental Protection Agency
WAPS	West Ash Pond System

EXECUTIVE SUMMARY

Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Groundwater Modeling Technical Memorandum on behalf of the Hennepin Power Plant (HPP), operated by Dynegy Midwest Generation, LLC (DMG), in accordance with requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments. This document presents the groundwater flow and transport models for the West Ash Pond System (WAPS) and the results of predictive groundwater modeling simulations for proposed corrective action. The coal combustion residuals (CCR) unit is the WAPS, composed of the Old West Polishing Pond (OWPP) and the Old West Ash Pond (OWAP), both closed in 2020 (Vistra identification [ID] number [No.] 804). The WAPS was operated from the 1960s until 1996. The Illinois Environmental Protection Agency (IEPA)-approved closure of the WAPS consisted of excavation of ash material from the OWPP, consolidation of ash from the OWPP into the OWAP, and capping of the OWAP with a geomembrane and soil cover. The closure plan for the WAPS was described in Closure and Post-Closure Care Plan (Geosyntec, 2017) and approved by the IEPA in a letter dated June 19, 2018.

A detailed summary of site conditions was provided in the Hydrogeologic Site Characterization Report (HCR; Natural Resources Technology, Inc. (NRT), 2017a). The principal stratigraphic layers encountered at the WAPS and adjacent areas (from top to bottom) are CCRs consisting primarily of fly ash with lesser amounts of bottom ash and slag, alluvial fine-grained silts and clays classified as Cahokia Alluvium, alluvial fine to medium sands, and sand and gravel with boulders deposited by glacial meltwaters, which are classified as Henry formation. Bedrock is encountered at an approximate elevation of 375 feet[1] and consists of interbedded layers of shales and thin limestone, sandstone, and coal beds.

The overall groundwater flow regime consists of surface recharge to groundwater, with flow directions towards the Illinois River. Flow patterns within the site hydrostratigraphic units are typically horizontal, with components of converging vertical (upward) flow near and below the river. Under typical post-closure conditions, groundwater flow directions at the OWAP are north, towards the river. During the former operation of the impoundments, high local recharge to groundwater from sluicing of ash created radial flow conditions near the impoundment; while groundwater flow was still predominantly towards the river, some of the groundwater beneath the impoundment flowed outwards towards the south and west of the OWAP.

Boron transport in groundwater was evaluated with the groundwater model because it is a primary indicator of coal ash leachate, exceeds the Class I standard, is mobile in groundwater, and is more representative of coal ash leachate than sulfate at this site, which may originate from other anthropogenic or natural sources. Boron enters groundwater via vertical recharge through coal ash, and horizontal groundwater flow through coal ash where it lies below the water table. Solutes are transported in groundwater towards the Illinois River which is the primary receiving body of water adjacent to the WAPS. The conceptual transport model assumes that boron concentration in leachate does not vary as a function of time, although the volume and flux rate of leachate decreases over time as a function of pond dewatering and capping. It is assumed in this model there is no removal of mass from the groundwater system via adsorption or decay.

[1] All elevations and total heads in this report and the subsequent attachments are referenced to North American Vertical Datum of 1988 (NAVD88), unless otherwise noted.

For modeling purposes, it was assumed that boron would not significantly sorb or chemically react with aquifer solids (soil adsorption coefficient [Kd] was set to 0 milliliters per gram [mL/g]) which is a conservative estimate for predicting contaminant transport times in the model.

This Correction Action Plan (CAP) model update is a revision to the model developed for the WAPS in 2014 and updated in 2017 (NRT, 2017b). Generally, the model boundaries, parameters, and calibration (heads, flow directions, and boron distributions) were retained from the 2017 model; however, some small adjustments were made to parameter and boundary conditions to preserve model calibration (flow and transport) following updates to the model resolution and base-of-ash elevations within the OWAP. The objectives of the model update were to refine model specifications to include data collected since 2017 (*i.e.,* the closure conditions of the OWAP) while maintaining the previous quality of calibration, and to generate results consistent with the 2017 model predictions.

Model prediction scenarios were simulated to evaluate potential groundwater corrective action alternatives for boron in groundwater. Prediction models were evaluated from projected remedy completion of 2028 to 200 years in the future (2228). The objective of predictive modeling of the corrective action scenarios listed below is to simulate boron concentrations in groundwater for different corrective actions to evaluate if implementation of these actions will reduce the amount of time to meet the groundwater protection standard (GWPS) of 2 mg/L for boron at the nine compliance monitoring wells; and, within groundwater at the site.

The following corrective action alternatives were simulated:

- Alternative 1, Source Control with Groundwater Polishing (GWP)
- Alternative 2, Source Control with Cutoff Wall
  - 2a, Continuous Containment System with Deep Cutoff Wall
  - 2b, Partial-Depth Cutoff Wall
  - 2c, Shallow Cutoff Wall
- Alternative 3, Source Control with In-situ Solidification/Stabilization (ISS)

Simulation of the corrective action alternatives indicated that concentrations of boron at the nine site compliance wells have decreased as a result of the closure in 2020 and will continue to decrease. Each of the five alternatives results in reduction of boron at the compliance wells within approximately 30 years following corrective action. Small differences in cleanup time were identified for each of the different alternatives. Comparison of predicted concentrations at the compliance wells indicates that the time to reach GWPS is similar across each of the evaluated remedies, with Alternatives 1, 2b, 2c, and 3 reaching GWPS in 2055 (27 years after implementation), and Alternative 2a reaching GWPS by 2061 (33 years after implementation).

1. INTRODUCTION

1.1 Overview

NRT, an OBG Company, documented site-specific MODFLOW and MT3DMS groundwater flow and transport models in a Groundwater Modeling Report (GMR) submitted to IEPA in 2017 (Appendix D of the Closure and Post-Closure Care Plan; Geosyntec, 2017). The groundwater modeling activities documented in the 2017 GMR were performed to support closure of the WAPS at the Hennepin Power Station, Hennepin, Illinois. This document presents the MODFLOW and MT3DMS groundwater flow and transport models developed in 2023 (CAP model update) to meet the Corrective Action requirements of 35 I.A.C. § 845.220(c)(2) and 845.670. These models contain minor refinements to reflect current conditions at the now-closed WAPS and enable improved simulation of future conditions.

Closure of the WAPS consisted of excavation of ash material from the OWPP, consolidation of ash from the OWPP into the OWAP, and capping of the OWAP with a geomembrane and soil cover. The closure plan for the WAPS was described in Closure and Post-Closure Care Plan (Geosyntec, 2017) and approved by the IEPA in a letter dated June 19, 2018. The WAPS closure was completed in 2020 (Dynegy, 2020a; Dynegy, 2020b).

Site hydrogeology and groundwater quality are summarized below , and described in detail in a separate Hydrogeologic Characterization Report (NRT, 2017a) and the Nature and Extent Report (Ramboll, 2024b) The Hydrogeologic Investigation Report was completed to summarize data collected to comply with the requirements of Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257, herein referred to as the Federal CCR Rule, as well as comprehensive data collection and evaluations from prior hydrogeologic investigation reports completed at the site. In addition, Hydrologic Evaluation of Landfill Performance (HELP) modeling was conducted to enable estimation of the time required for hydrostatic equilibrium of groundwater to be achieved beneath the final cover system of the WAPS. The HELP modeling also provided percolation rates for existing conditions and predicted cap scenario that were used as inputs in the groundwater flow and transport model. A description of the HELP model inputs and modeling results are found in the Hydrostatic Modeling Report (NRT, 2017c). Groundwater transport modeling was performed to assess the effects of impoundment closure on groundwater quality. Model development and calibration is documented in **Section 2**. The model prediction results are presented in **Sections 4** and conclusions are summarized in **Section 5**.

1.2 Background

1.2.1 Site History

The Hennepin Power Station has two coal-fired generating units with a total capacity of 280 megawatts (MW). The units were constructed in 1953 and 1959, respectively. DMG operated the WAPS at the Hennepin Power Station from 1952 until late 1996 when the WAPS was removed from service.

The impoundment originally consisted of three ponds: Pond 1 (9.3 acres), at the eastern end of the impoundment, primarily contained bottom ash and slag. Pond 3 (16.4 acres), in the central portion of the impoundment, contained mixed coal ash. A polishing pond (4.7 acres) was located at the western end of the impoundment. The berms, which are 15 feet above grade, were

constructed from locally occurring sandy soils. During operation, service water was used to sluice fly ash, bottom ash, and low-volume wastes to the impoundment.

Closure of the WAPS consisted of excavation of ash material from the OWPP *(*closure-by-removal [CBR]), consolidation of ash from the OWPP into the OWAP, and capping of the OWAP with a geomembrane and soil cover. The WAPS closure was completed in 2020 (Dynegy, 2020a; Dynegy, 2020b).

Site Hydrogeology

In addition to the CCR fill material, the four principal stratigraphic layers (from top to bottom) encountered at the WAPS and adjacent areas are:

- Alluvial fine-grained silts and clays;
- Alluvial fine to medium sands;
- Sand and gravel with boulders, deposited by glacial meltwaters and classified as Henry Formation;
- Bedrock, consisting of interbedded layers of shales and thin limestone, sandstone, and coal beds.

The river-laid deposits are classified as Cahokia Alluvium. The Henry Formation sands and gravels make up the upper and lower terraces, contain frequent boulders, and fill the valley beneath the alluvium. An additional stratigraphic layer, loamy and sandy diamicton (*i.e.*, till) of the Wedron or Glasford Formation, was encountered at one location (Boring 32) approximately 2,560 feet (½ mile) south of the western end of the impoundment; however, this layer is not significant to the hydrogeology at the impoundment.

The uppermost bedrock near the Hennepin Power Station, including the WAPS, is the Pennsylvanian Carbondale Formation, which consists of shale with thin limestone, sandstone, and coal beds. Depth to bedrock in this area varies based upon data available from the Illinois Geological Survey (Chenoweth, et al., 1994) A bedrock investigation conducted in 2025 encountered shale bedrock at a depth of approximately 85 feet beneath the WAPS (Ramboll, 2025).

The WAPS lies over both glacial deposits (Henry Formation) and alluvium (Cahokia Alluvium). Pond 1 lies on top of lower terrace glacial sand and gravel deposits. The eastern portion of Pond 3 overlies alluvial sand, while the western portion of Pond 3 and the Polishing Pond overlay silty clay alluvial channel fill deposits. The Cahokia Alluvium and Henry Formation materials together comprise the uppermost aquifer at the WAPS, which extends from the water table to the top of the bedrock. More details are presented in the HCR (NRT, 2017a).

Groundwater elevation data is available beginning in 1993. The Illinois River is the local and regional receiving body of water for groundwater, and river stage is controlled by dams located upstream and downstream. River stage is usually lowest during the months of August through October. The river basin experiences annual spring flooding during the months of March, April, May, and sometimes June, while lesser flooding occasionally occurs during autumn. River stage during high precipitation and/or flood events seasonally rises above adjacent groundwater elevations and in low lying areas of the floodplain, particularly within the Donnelley WMA at wells 32, 33, and 34. Stage of the Illinois River typically measures 441-442 feet elevation during

baseflow conditions (low stage); the 10-year flood level is 457 feet, and annual floods typically reach elevations of 450 feet or above.

Review of groundwater elevation data for the site, including transducer data collected in 2023, indicates that groundwater levels across the system vary system-wide, with variations in head tied to river stage and/or seasonal recharge. Horizontal hydraulic gradients from the WAPS to off-site areas ranges from 0.001 foot per foot (ft/ft) during Illinois River flood stage to about 0.005 ft/ft during normal river stage, yielding a groundwater velocity ranging from 0.1 to 1.1 ft/day (NRT, 2017a).

1.2.2 Groundwater Quality

35 I.A.C. § 845 groundwater monitoring began in 2023. Exceedances[2] to the GWPS were identified for boron, cadmium, lithium, sulfate, total dissolved solids, and arsenic. An Alternate Source Demonstration (ASD) was approved for cadmium. The remainder of the constituents with groundwater exceedances were discussed in the Groundwater Monitoring Data and Detected Exceedances, Quarter 4, 2023 (Ramboll, 2024a) and the Nature and Extent Report (Ramboll, 2024b).

1.3 Conceptual Model

The WAPS overlays alluvium and outwash deposits in the Illinois River valley. The principal stratigraphic layers encountered at the WAPS and adjacent areas (from top to bottom) are CCRs and fill consisting primarily of fly ash with lesser amounts of bottom ash and slag, alluvial fine grained silts and clays classified as Cahokia Alluvium, alluvial fine to medium sands, and sand and gravel with boulders deposited by glacial meltwaters which are classified as Henry formation.

The overall groundwater flow regime within the unlithified materials is consistent with topographically-controlled flow patterns, where infiltration of surface precipitation recharges groundwater and flows north and west near the Site towards the Illinois River. Flow patterns within the site hydrostratigraphic units are typically horizontal, with components converging vertical (upward) flow near and underneath the river. Under typical post-closure conditions, groundwater flow directions at the WAPS are north, towards the river. During the operation of the impoundments, high local recharge to groundwater from sluicing of ash created radial flow conditions near the impoundment; while groundwater flow was still predominantly towards the river, some of the groundwater beneath the impoundment flowed towards the adjacent wetlands located south and west of the WAPS (NRT, 2017a; Ramboll, 2024b).

The CCR materials are the primary source of constituent loading to the CCR porewater (*i.e.*, CCR source water). Over an extended period (*e.g.*, months to years), the CCR source water (*i.e.*, water contained within the interstitial pore spaces of the CCR that can be sampled by low-flow groundwater sampling methods) reaches equilibrium with the CCR materials. The porewater is therefore representative of the mobile phase constituents capable of migrating into the underlying materials and potentially downgradient in groundwater. The WAPS CCR source water is therefore the primary indicator of constituents available to the groundwater and is considered

[2] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or GWPSs as described in the proposed groundwater monitoring program, which was submitted to the IEPA on October 25, 2021 as part of DMG's operating permit application for the HPP WAPS. That operating permit application, including the proposed groundwater monitoring program, remains under review by the IEPA and, therefore, DMG has not identified any actual exceedances.

the primary source term for environmental investigation and fate and transport modeling (Ramboll, 2024b).

Boron was simulated and considered a surrogate for other 35 I.A.C. § 845.600 constituents because (1) it is commonly present at elevated concentrations in coal ash leachate; (2) it is mobile and typically not very reactive but conservative (*i.e.*, low rates of sorption or degradation) in groundwater; and (3) it is less likely than other constituents to be present at elevated concentrations in background groundwater from natural or other anthropogenic sources. The surrogate selected for groundwater flow and transport modeling is conservative (*i.e.*, aqueous concentrations are predominantly affected by physical processes such as dilution and dispersion rather than by chemical attenuation mechanisms) and therefore represent the maximum plume extent. The use of a conservative parameter to represent plume extent and clean-up times is consistent with United States Environmental Protection Agency (USEPA) modeling examples intended for evaluating relative remedy effectiveness (USEPA, 1994) as well as an independent subject matter expert review validating the modeling approach for evaluating closure alternatives (Gradient, 2024).

Conservative parameters are most acutely affected by closure: once the source is controlled via closure, concentrations of surrogate parameters in the groundwater will respond in timeframes consistent with groundwater flow. Source control will control, minimize, or eliminate, to the maximum extent feasible, infiltration of liquids through the CCR (per 35 I.A.C. § 845.750(a)(1)), mitigating the flux of not only the surrogate parameters but all other parameters potentially leaching from the unit. The time to reach the GWPS determined by modeling surrogate parameters correlates to the effectiveness of the proposed closure as source control. Therefore, the existing model is appropriate for assessing the effect of closure on the flux of all CCR SI porewater constituents.

The conceptual model for transport assumes two boron sources: boron that leaches to recharge water during percolation through ash above the water table; and boron that leaches to water that may infiltrate from the sides or base of the CCR unit below the water table. Therefore, mass is added to groundwater via vertical recharge through coal ash, and horizontal exfiltration of water from coal ash where it lies below the water table. Mass is transported along with groundwater toward the Illinois River, which is the primary receiving body of water adjacent to the WAPS. The conceptual transport model assumes that boron concentration in leachate does not vary as a function of time, although the volume of leachate decreases over time as a function of capping.

For modeling purposes, it was assumed that boron would not significantly sorb or chemically react with aquifer solids (Kd was set to 0 mL/g) which is a conservative estimate for predicting contaminant transport times in the model. Boron transport is likely to be affected by both chemical and physical attenuation mechanisms (*i.e.,* adsorption and/or precipitation reactions as well as dilution and dispersion). Physical attenuation (dilution and dispersion) of contaminants in groundwater is simulated in the groundwater computer models. Chemical attenuation mechanisms and their effect on modeled times for exceedances to reach the GWPS are discussed in the Groundwater Polishing Evaluation Report [GPR, Geosyntec, 2025] and summarized in **Section 3.2**.

1.3.1 Correlation of Boron with Sulfate, Lithium, and Arsenic

Boron is considered a surrogate for other parameters that exceed the GWPS that do not have approved alternative source demonstrations (arsenic, lithium, and sulfate) because it occurs above the GWPS in the greatest number of wells and it is the constituent at the site that will likely require the longest time to achieve the GWPS. In addition, comparisons of observed sulfate and lithium to boron concentrations (**Figures A and B** below) indicate a statistically significant correlation between these parameters in downgradient uppermost aquifer (UA) wells with exceedances. The correlation coefficient (R^2) and p values (indicator of statistical significance) are also provided on **Figures A and B**. Higher R^2 values (*i.e.,* closer to 1) indicate stronger correlation between parameters. A correlation is considered statistically significant when the p value is lower than 0.05. The p values are less than the target of 0.05, indicating correlations are statistically significant. The statistically significant correlations between sulfate and boron and lithium and boron indicate boron is an appropriate surrogate for sulfate and lithium in the groundwater model, and concentrations of these parameters are expected to change consistent with model predicted boron concentrations.

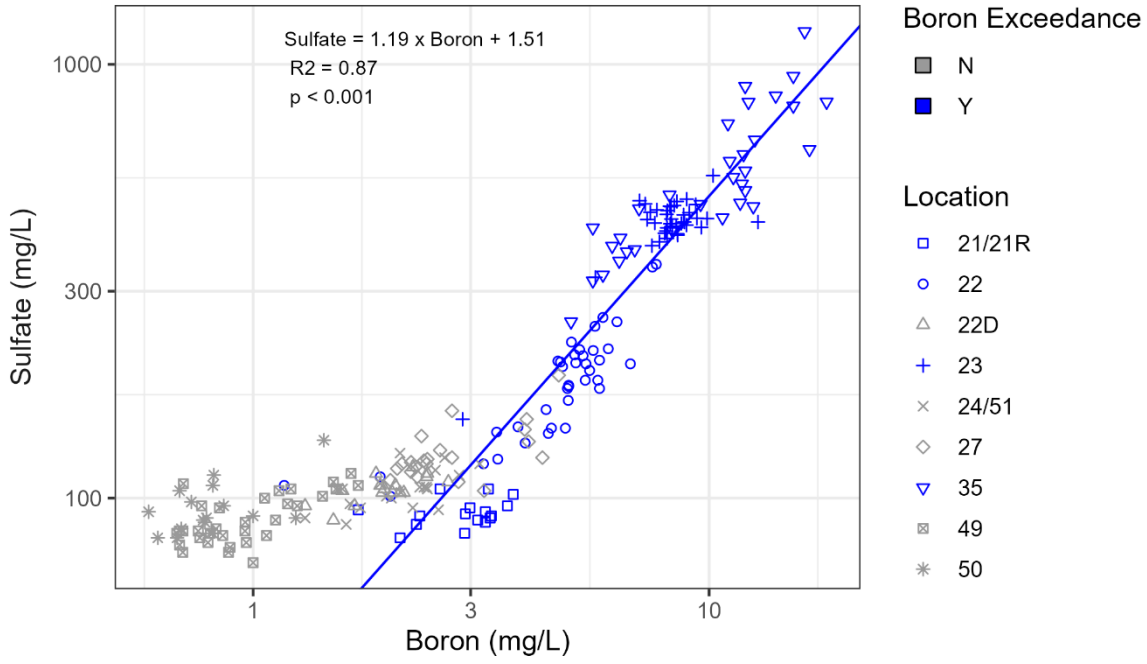

Figure A Correlation of Observed Sulfate and Boron Concentrations in Downgradient Wells (Linear regression for wells with exceedances only)

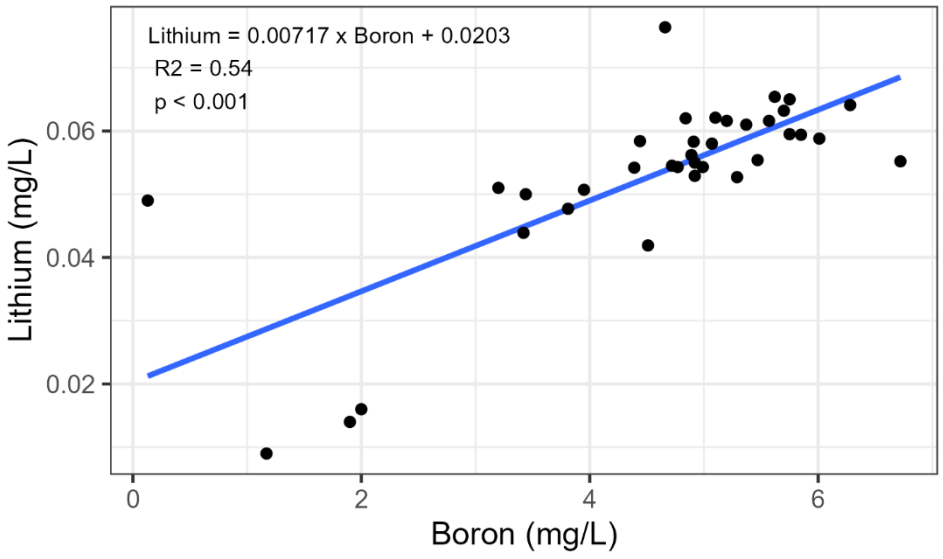

Figure B Correlation of Observed Lithium and Boron Concentrations in Well 22

Boron and arsenic concentrations in downgradient wells with an arsenic (21R and 51) and/or boron exceedance were also evaluated for correlation (**Figure C**). The arsenic data set contains a large number of non-detect values and as a result no statistically significant correlation was found. Arsenic is a reactive CCR constituent, and concentrations within the aquifer will be influenced by geochemical conditions and changes following closure. Localized effects on arsenic geochemistry and expected behavior following closure at these two well locations are further discussed in the Groundwater Polishing Evaluation Report (Geosyntec, 2025) and **Section 3.2**.

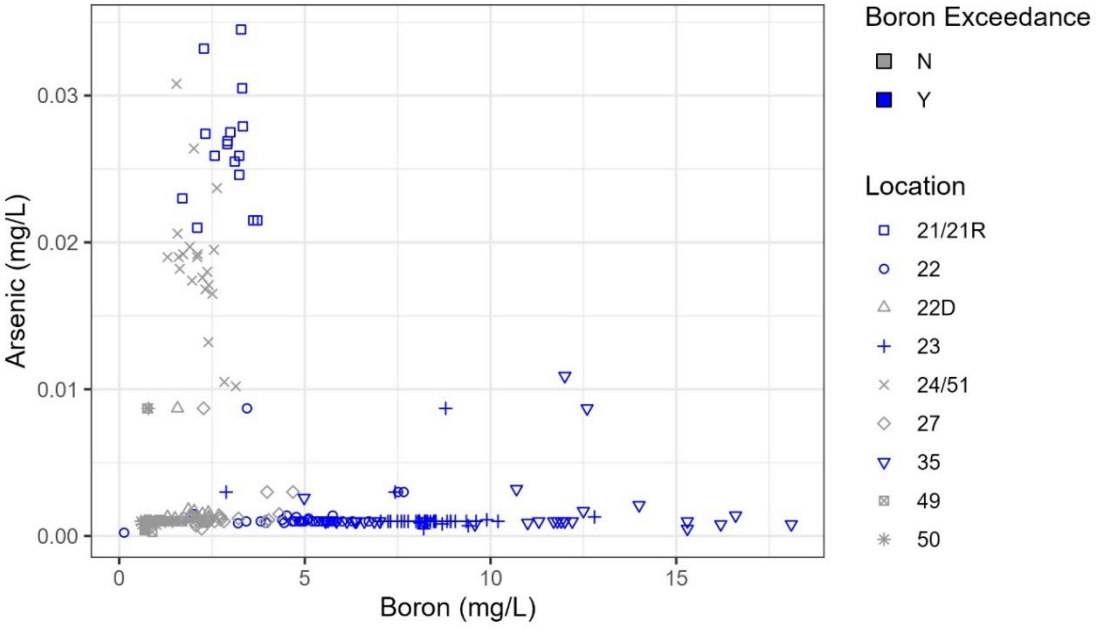

Figure C Correlation of Arsenic and Boron Concentrations in Downgradient Wells

2. GROUNDWATER MODEL DEVELOPMENT AND CALIBRATION

The CAP model update described herein consists of an update to the model developed for the WAPS in 2014 and 2017 (NRT, 2017b). Generally, the model boundaries, parameters, and calibration (heads, flow directions, and boron distributions) were retained from the 2017 model; however, some small adjustments were made to parameter and boundary conditions to preserve model calibration (flow and transport) following updates described in **Section 2.1**. The objectives of the model update were to incorporate information collected since 2017 (including the 2020 closure of the OWAP) while maintaining the previous quality of calibration. Since the model update is predicated on the need to simulate additional corrective action for boron concentrations in groundwater at the site, it was important to retain to the extent practicable the previous model components and calibrations, to ensure that predicted results would be comparable to the 2017 model predictions for WAPS closure.

Specifications and results of the MODFLOW/MT3DMS modeling are presented below. Electronic copies of the model files are provided with this report (**Appendix A**).

2.1 Model Background

Model updates / revisions completed for the CAP model update consist of the following:

- Model Discretization
  - The model extents (domain) and origin were adjusted to correctly align with Illinois state plane coordinates (North American Datum of 1983 [NAD83]).
  - Model resolution was increased, with the horizontal grid spacing decreased from 100 to 25 feet at the WAPS.
  - The bottom of model layer 1 was revised to better match the base of ash elevations within the footprint of the OWAP with the increased resolution of the model. A bottom elevation of 444 feet was assigned to the former OWPP, and model layer 1 bottom elevations were set to 440 feet outside of the WAPS.
  - The bottom of model layer 6 was revised from 390 to 375 feet to better match the estimated bedrock elevation at the WAPS.
- Model Approach and Codes
  - The model time frames were adjusted to simulate current conditions in 2023 and future conditions. The transient calibration model was extended from 2017 to 2023; the previous stress period (2) was extended from 2017 to 2020, and a new stress period (3) was used to simulate closure of the WAPS which was performed in 2020. Stress period 3 was extended to the current time for the calibration model, and until 2028 for the prediction models.
  - The simulation of conditions for unit closure are documented later in **Section 2.4.4**. Simulation specifications for unit closure were consistent with the predictive modeling for capping of the OWAP performed in 2017.
  - New model simulations were performed using MODFLOW 2005, instead of MODFLOW-2000, which was used for the 2017 model simulations. Different versions of MODFLOW are

similar but offer slightly different functionalities that can be useful for various simulated conditions. MT3DMS was retained as the transport model code.

- Boundaries and Parameters
  - Assigned hydraulic conductivity for the glacial outwash material in model layer 6 was decreased to 100 ft/day to retain a consistent transmissivity value after increasing the thickness of the layer.
  - Minor modifications were made to the representation of the Illinois River. The river stage of 441.7 feet National Geodetic Vertical Datum (NGVD29) was retained[3], with the bottom elevation changed to 435 feet to better match river depths. Consequently, the river cells were moved from layer 1 to layer 2 to better match the layer elevations. The river cell conductance values were adjusted in areas away from the WAPS to preserve the calibration and heads from the previous version of the model with the adjustments to the model extent and grid.
  - The conductance values for the river cells used to represent the duck ponds and wetland areas southeast of the impoundments were adjusted to preserve calibration and flow directions with changes to grid cell size.
  - Minor adjustments were made to the alignment of hydraulic conductivity zones to preserve model calibration and flow directions following other minor changes to boundaries and the model grid.
  - Minor adjustments were made to assigned model recharge to preserve model calibration.
  - The no-flow cells in model layer 1 used to represent the areas of the OWAP which were unsaturated under typical conditions were removed to allow model cells to convert from wet to dry during model simulations as warranted by simulated groundwater elevations.
  - Specific yield was decreased from 0.3 to 0.2 to be consistent with porosity (0.2) for each of the transient flow models.
- Transport Model
  - Assignment of a Kd of 1 mL/g for the silt/clay materials was removed to maintain a Kd of 0 mL/g for the entire model domain (no retardation). This is consistent with MT3DMS modeling performed to simulate boron transport at other Luminant/DMG CCR impoundments regulated by 35 I.A.C. § 845.

2.2 Model Approach

Three modeling codes were used to model groundwater flow and contaminant transport: (1) percolation through the cap system was modeled using the HELP model. All details regarding closure configurations and HELP model establishment are presented in a separate Hydrostatic Equilibrium Report (NRT, 2017c); (2) groundwater flow was modeled in three dimensions using MODFLOW 2005; and (3) contaminant transport was modeled in three dimensions using MT3DMS.

[3] All river stages are referenced to NGVD29, which is the USACE gauge datum. The NGVD29 and NAVD88 datums have a difference of around 0.2' in Putnam County, IL. Due to the difference being relatively minor in the context of the model size and accuracy, the river stage elevations were not corrected from the NGVD29 gauge datum to NAVD88.

A three-dimensional groundwater flow and transport model was developed to represent the conceptual flow system described above and then calibrated to match the groundwater monitoring results since 1994. A number of simulations were created to represent different periods of time (below and in **Table A**):

- A steady-state flow model was calibrated to approximate head distributions observed while the impoundment was in service, based on median heads observed from 1994 through 1996 (steady-state flow model)
- The accompanying transport model was calibrated to approximate concentrations observed while the impoundment was in service, based on observations from 1994 through 1996. A 30-year period of impoundment operation was simulated to represent the years 1966 to 1996.
- A transient flow model was created from the steady-state flow model and calibrated to match the decreasing heads measured after the impoundment was removed from service. The model period was December 1996 through December 2016 (transient calibration model stress periods 1 and 2). For this CAP model update, stress period 2 was extended from December 2016 to July 2020.
- The transport model was calibrated to approximate boron concentration trends observed since the impoundment was removed from service. The model period was December 1996 through July 2020 (transient model stress periods 1 and 2).
- New for the CAP model update: A new stress period 3 was added to the transient flow and transport models to simulate closure of the WAPS in 2020. Simulation specifications for the completed closure of the WAPS were consistent with the predictive model for the capping scenario performed in 2017.
- New for the CAP model update: Predictive modeling was performed to evaluate the effects of additional corrective action alternatives on boron concentrations. Flow conditions and concentrations were simulated for a number of scenarios (**Section 3**) from the current time to 2228.

Table A. Model Simulation Stress Periods

Model Stage	Time Period	Model Description
Steady State Flow Model / Transport Model	1966 - 1996	30-year simulation of flow directions and boron transport under operating conditions
	Steady-State Flow Calibration	
	Transient Transport Calibration	
Transient Flow Model and Transport Model	Stress Period 1 (1997 - May 1998)	SP1 – natural dewatering of OWAP after closure
	Stress Period 2 (May 1998 – July 2020)	SP2 – dormant period
	Stress Period 3 (August 2020 - December 2023)	SP3 – post-closure period
Predictive Corrective Action Alternative Simulations (Flow and Transport)	Stress Period 3, extended to 2028	Predictive scenario simulations
	Predictive Scenarios (2028 - 2228)	

2.3 Model Codes

MODFLOW uses a finite difference approximation to solve a three-dimensional head distribution in a transient, multi-layer, heterogeneous, anisotropic, variable-gradient, variable-thickness, confined or unconfined flow system—given user-supplied inputs of hydraulic conductivity, aquifer/layer thickness, recharge, wells and boundary conditions. The program also calculates water balance at wells, rivers and drains.

MODFLOW was developed by the United States Geological Survey (McDonald and Harbaugh, 1988) and has been updated several times since. Major assumptions of the code are: (1) groundwater flow is governed by Darcy's law; (2) the formation behaves as a continuous porous medium; (3) flow is not affected by chemical, temperature, or density gradients; and (4) hydraulic properties are constant within a grid cell. Other assumptions concerning the finite difference equation can be found in McDonald and Harbaugh (1988). MODFLOW 2005 (Harbaugh et al., 2017) was used for this model revision using Groundwater Vistas 8 software for model pre- and post-processing tasks (Rumbaugh, 2020).

MT3DMS (Zheng and Wang, 1998) is an update of MT3D and calculates concentration distribution for a single dissolved solute as a function of time and space. Concentration is distributed over a three-dimensional, non-uniform, transient flow field. Solute mass may be input at discrete points (wells, drains, river nodes, constant head cells), or distributed evenly or unevenly over the land surface (recharge).

MT3DMS accounts for advection, dispersion, diffusion, first-order decay and sorption. Sorption can be calculated using linear, Freundlich, or Langmuir isotherms. First-order decay terms may be differentiated for the adsorbed and dissolved phases.

Major assumptions are: (1) changes in the concentration field do not affect the flow field; (2) changes in the concentration of one solute do not affect the concentration of another solute; (3) chemical and hydraulic properties are constant within a grid cell; and (4) sorption is instantaneous and fully reversible, while decay is not reversible.

2.4 Model Setup

2.4.1 Grid and Boundary Conditions

The discretization of the model consists of six layers, 119 rows, and 178 columns. Variable horizontal grid spacing was used with grid spacing of up to 200 feet at the edges of the model and 25 feet in the area of interest (**Figure 2-1**). Model layers are simulated with uniform top and bottom elevation, with the exception of model layer 1. Variable bottom elevations for model layer 1 were used within the former OWAP to represent the base of ash material (approximately 438-450 feet, 444 feet in the former OWPP, and 440 feet for the remainder of model layer 1).

Flow and transport model domain boundaries were the same for all scenarios. The upgradient (east and south) edge of the model is a no-flow boundary. The downgradient (north) and lateral (west) boundaries are either MODFLOW river (mixed) boundaries (layer 2) or no-flow (layers 1 and 3 to 6). The upper boundary is a time-dependent specified flux (Neumann) boundary, with specified flux rates equal to the recharge rate (from precipitation) or the rate of percolation from the impoundment. The base of the model is a no-flow boundary, at the base of layer 6 (bedrock surface). Additional information on these boundaries is discussed in the subsequent section of this report.

The model included two types of transport boundaries (constant concentration and recharge), both in layer 1. Ash materials within the impoundments were explicitly simulated using both constant concentration cells and recharge. Representation of ash with both boundaries is conservative, in that source concentrations are assigned to active model cells by the constant concentration cells and assigned to inactive or dry cells by recharge concentrations to represent precipitation infiltrating vertically through the ash to the underlying groundwater table. The distribution of these boundaries was adjusted within the ash ponds for the different transport model stress periods to match actual conditions.

2.4.2 Flow Model Input Values

Flow model input values are described below and summarized in **Table 2-1** (Steady-State Flow Model / Transport Model Input Values) and **Table 2-2** (Transient Model Input Values). Sensitivity analysis of input values was performed and documented in the 2017 model update but is not included in this report. Input values were generally retained from the 2017 model, with revisions noted above and in **Table 2-1** and **Table 2-2**.

Layer Bottom

Layer bottoms were set for each of the six layers (**Table B)**. The bottom of model layer 1 was revised from the 2017 model by increasing the grid discretization to better match the base of ash elevations within the footprint of the OWAP. The bottom elevation of model layer 6 was changed from 390 feet to 375 feet to better match the estimated bedrock elevation at the WAPS.

Table B. Model Layer Bottom Elevations

Model Layer	2017 Model	Model Revision
1	440+	437+
2	430	430
3	420	420
4	410	410
5	400	400
6	390	375

Note: Elevations are in feet referenced to NAVD88.

Hydraulic Conductivity

Hydraulic conductivity values were initially derived from field-measured and laboratory tested values and adjusted during calibration. Calibrated values were within observed ranges for the formations present at the site. Vertical anisotropy ratios were set at 2.0 for the sand and gravel and 10 for the silty clay and alluvium. The Kx/Kz ratios represent expected stratification within the formations. **Figures 2-2** through **2-7** present hydraulic conductivity zones and boundary conditions for model layers 1 through 6 for the steady-state and transient calibration models, with a summary of hydraulic conductivity zones in **Table 2-1**. Modifications were made to the boundary conditions and the hydraulic conductivity distribution in model layer 1 at the WAPS to represent closure conditions in stress period 3 (**Figure 2-8**).

Storage

No field data was available defining these terms, so representative values for similar materials were obtained from Smith and Wheatcraft (1993). Sensitivity analysis was not performed on this

parameter. The storage coefficient used in the model was 0.01 and the specific yield was 0.2 (revised from 2017 model). A value of 0.2 was assigned for model porosity for all layers.

Recharge
Recharge rates for the impoundment while in service and during dewatering were assigned during model calibration. Recharge rates for the model domain were adopted from the previous 2017 model and were adjusted during calibration. **Figures 2-9** through **2-12** present the recharge distributions for the steady-state flow model, transient model stress period 1 (1996 to 1997), transient stress period 2 (1998 to 2020), and OWAP closure conditions (stress period 3). A summary of model recharge is provided on **Tables 2-1** and **2-2**.

River Parameters
River boundary cells were used to represent the Illinois River, the waterfowl ponds south and west of the impoundments, and a small creek leading from the waterfowl ponds **(Figures 2-2** and **2-3)**. **Table 2-1** presents stage, river bottom, and conductance for these features used for each of the model simulations. The characteristics of the river boundaries in the model were retained from the 2017 model with a few adjustments to conductance to account for revisions to the model grid and to preserve the previous calibration (head and flow directions). The river was specified in model layer 2 to better match river geometry (depth and stage).

An Illinois River stage of 441.7 feet was retained from the 2017 model, which represents a relatively low stage for typical baseflow conditions. Since groundwater elevations near the OWAP are controlled primarily by river stage, this selection is consistent with simulation of baseflow *(i.e.*, low) groundwater elevations, which is reflected in selected calibration targets for the steady-state flow model.

2.4.3 Transport Model Input Values

Transport model input values are listed in **Tables 2-1** and **2-2** and described below. Sensitivity analysis of transport model inputs was conducted as part of the model development and is documented in the 2017 GMR. Transport calibration was performed during the 2017 model development; minor adjustments to transport parameters were performed to retain calibration of the model with respect to other modifications to grid size and refinements to the base of ash elevations (layer 1 bottom elevations).

Initial Concentration
Initial concentrations for the 1966 to 1996 model were set to zero to represent the background concentration for boron. The final concentrations from the steady-state flow / transient transport calibration model (1966 to 1996) were used as the initial concentrations for the subsequent transient transport model representing the years 1996 and later.

Source Concentration
Boron source concentrations were set during model calibration at values between 7 and 19 milligrams per liter (mg/L), the range observed in monitoring wells near the impoundment. These values were assigned during model calibration conducted in 2017 and retained for the CAP model update.

Ash materials within the impoundments were explicitly simulated using both constant concentration cells and recharge. Representation of ash with both boundaries is conservative, in that source concentrations are assigned active cells by the constant concentration cells and assigned to inactive or dry cells by recharge concentrations to represent precipitation infiltrating

through the ash to the underlying groundwater table. Equivalent concentrations were assigned at each location through recharge (**Tables 2-1** and **2-2**) and using constant concentration cells.

Dispersivity
Dispersivity was set during model calibration, with sensitivity testing performed as part of the 2017 model revision. Transverse and vertical dispersion were estimated according to ratios developed by Gelhar et al. (1985). Calibrated concentrations at some wells distant from the impoundment (wells 26, 30, 31, and 36) were highly sensitive to the longitudinal dispersivity value and to the vertical dispersivity multiplier.

Retardation
Retardation was calculated by the model based on the Kd, which was set during calibration during previous models. The 2017 model assigned a Kd value of 1.0 mL/g to the silty units (channel-fill deposits and alluvium), and a Kd of zero for the sand and gravel units. The simulated Kd was set to zero for the entire model domain (including for the silty units) in the CAP model update to be more consistent with other Luminant/DMG CCR models, and due to low sensitivity of 2017 model results to the Kd for the silty units.

Diffusion
Diffusion was set to 0 square feet per day for the entire model domain.

2.4.4 Simulation of OWAP Closure (Stress Period 3)

Closure of the OWAP was completed in July 2020 in a manner consistent with the specifications simulated in the 2017 predictive modeling, specifically in that the OWPP was removed, and Pond 1 and Pond 3 (the OWAP) were fully capped by a geomembrane cover, comprised of (from top to bottom) a 6-inch vegetative layer, 18-inch protective soil layer, a 0.2-inch geocomposite drainage layer, and a 40-mil geomembrane layer. These conditions were simulated as stress period 3 according to the following model changes:

- All observed ash was excavated from the OWPP and consolidated within the footprint of the OWAP. This was simulated in the flow and transport model by setting the hydraulic conductivity and recharge to the values assigned to the channel fill silts (K of 1.4 ft/day, recharge of 2.2 inch per year (in/yr) and concentration of 0 mg/L), and by removing the constant-concentration cells from the OWPP.
- A structural steel sheet pile wall was installed between the OWAP and the former OWPP. This was represented in the model using the horizontal flow boundary package in MODFLOW. Horizontal flow barriers (HFBs) were assigned to the locations corresponding to the sheet pile installation with an assigned hydraulic conductivity of 1×10^{-6} cm/s (simulated conductance of 2.36×10^{-4} square feet per day [ft^2/day]). This component of the OWAP closure was not simulated in the 2017 model.
- Recharge values in the OWAP were modified to reflect capping of the OWAP with soil and a geomembrane final cover system, consistent with the simulation of this scenario in the 2017 model. Areal recharge was reduced to 0.0024 in/yr across the OWAP, and concentration recharge values of 7 to 19 mg/L were retained to represent concentrations in the limited vertical infiltration through the ash material under the cap (**Table 2-2**).

2.5 Flow and Transport Model Assumptions and Limitations

Simplifying assumptions are necessary when numerically representing the natural environment in a groundwater flow and transport model. Outside of assumptions inherent to the codes used to develop the model, several simplifying assumptions were made, including:

- Recharge instantaneously migrates to groundwater (*e.g.,* rapid vertical infiltration through the unsaturated zone).
- Fluctuations in river stage are short in duration and do not materially affect long-term groundwater flow.
- Source concentrations remain constant over time.
- Boron minimally adsorbs and does not decay, and mixing and dispersion are the primary attenuation mechanisms.
- Cap construction has an instantaneous effect on recharge and percolation because they are constructed over a brief period relative to the length of the model simulation.

The model is limited by the data used for calibration, which adequately define the local groundwater flow system and the source and extent of the plume. These data, collected from 1994 through 2023, are from points near the WAPS. Model predictions of transport distant from the impoundment will not be as reliable as predictions of transport near the impoundment, and the reliability of model predictions decreases with increasing time because changes to the system may occur that the model does not account for.

2.6 Steady-State Flow Model and Transport Model Calibration

Calibration of a groundwater flow or transport model refers to the iterative process of adjusting model parameters and boundary conditions to obtain a reasonable match between observed conditions and simulation results. The primary criterion for evaluating the calibration of a groundwater flow model is the difference between observed and simulated water levels at a set of calibration targets. Calibration targets are a set of field measurements, typically groundwater elevations. For the calibration of a steady-state (time-invariant) model, the goal in selecting calibration targets is to define a set of water level measurements that represent the average elevation of the water table or potentiometric surface at locations throughout the site. The calibration of a groundwater flow model should rely on spatially discrete measurements of groundwater elevation to avoid the potential for interpretive bias that may result from attempting to match a contoured potentiometric surface (Kalikow, 1978; Anderson and Woessner, 1992).

A model residual is defined as the calculated difference between the observed and simulated hydraulic head at a specific location (observed–simulated). Residual statistics are used to quantify and evaluate the relative fit of a model simulation to measured water level targets. The mean of model residuals is a representation of overall model bias; a value near zero is desired. The steady-state flow model and accompanying transport model were developed to represent conditions from 1966 to 1996, during operation of the impoundments. The steady-state flow and transport model targets used in the 2017 modeling were retained for this model revision, with the objective of a similar level of calibration (equivalent match to calibration targets) for the revised flow and transport models. Flow and transport model calibration targets and statistics are presented on **Table 2-3**. Both sets of targets were originally developed from data collected from 1994 to 1996; transport target simulated values were retrieved from the end of the model

simulation (1996). Calibration plots showing observed vs simulated residuals are presented in **Figure 2-13**.

Simulated groundwater model heads (model layer 1) and boron concentrations (maximum concentration from across the model layers) from 1996 are presented in **Figure 2-14**. The mean residual for this calibration is -0.5 (**Table 2-3**). The residual standard deviation indicates the magnitude and spread of the residuals. A residual standard deviation of less than 10 percent of the total range of water level targets is desirable. The residual standard deviation for this calibration is 1.29, which is approximately 10 percent of the observation range (12.7). The residual statistics and simulated hydraulic head distributions indicate a satisfactory model match to observed groundwater flow conditions, and model calibration for the CAP model update is generally consistent with the 2017 model calibration.

2.7 Transient Flow and Transport Model Calibration

The transient flow and transport models, which represented conditions from 1996 to 2023, were qualitatively calibrated by graphically comparing observed and simulated heads and boron concentrations from 1996 to 2023 to provide a qualitative assessment of calibration. Plots comparing simulated and observed heads and boron concentrations at the nine compliance wells are presented in **Figures 2-15** and **2-16**, respectively. The transient model calibration is consistent with the simulation results from the 2017 calibration; consistency with the previous model results was a primary objective of the CAP model update. Several observations regarding the transient model flow and transport model calibrations are further discussed below.

Flow Calibration
As shown in **Figure 2-15**, observed groundwater elevations at site wells fluctuate over time, between approximately 3 and 8 feet, depending on the well location. Generally, simulated heads are consistent with the lower elevation measurements, as is reasonable considering the intended simulation of baseflow conditions (*i.e.,* conditions of low river stage and groundwater elevations). Additionally, wells 22D, 50, 51 were installed after the 2017 model update, therefore these wells were not used as calibration targets during the 2017 model update.

Transport Calibration
Comparison of model simulated boron concentrations in **Figure 2-16** to the calibration obtained by the 2017 modeling (NRT, 2017b) indicates that the CAP model update is generally consistent with the calibration of the 2017 model). However, a number of the compliance wells used for evaluation of this revision were not installed or available for calibration in 2017. The simulated boron concentrations at wells 22D, 49, 50, and 51 are overpredicted. However, since an objective of this model revision was to retain similar predicted conditions and boron concentrations compared to the 2017 modeling, model parameters were not adjusted to improve the calibration at these locations. The overprediction of boron concentrations at these wells is not considered significant for this evaluation since observed concentrations at these four wells are either below the GWPS of 2 mg/L at the current time, or near the GWPS and trending downward. Model calibration to observed concentrations at well 35 is satisfactory from 1997-2019, but do not represent well the concentrations observed at this location from 2020 onward.

3. PREDICTIVE MODELING

Prediction models were evaluated from projected remedy completion of 2028 to 200 years in the future (2228). The objective of predictive modeling of the corrective action scenarios described below is to simulate boron concentrations in groundwater for different corrective actions to evaluate if implementation of these actions will reduce the amount of time to meet the GWPS of 2 mg/L for boron in groundwater. Simulated concentrations of boron were evaluated spatially using maps of maximum boron concentration within each layer at various points in time, and through time-series plots of boron concentrations for the compliance monitoring wells.

Figure 3-1 presents simulated boron concentrations in 2024 and 2028 as initial conditions for evaluation (maximum concentration of boron at each location across all model layers).

3.1 Model Prediction Scenarios

The physical components of each scenario, their representation within the model, and simulation results are presented below. 2028 was used as ”time zero” for completion of the construction of the corrective actions for the model prediction scenarios; discussion of cleanup times in years assumes 2028 as the starting point.

3.1.1 Alternative 1 - Source Control with Groundwater Polishing (GWP)

This scenario is consistent with the closure conditions (capping of the OWAP and Closure-by-removal of the OWPP) initially simulated in the 2017 model report and used to represent current conditions in the revised model as stress period 3. The completed closure and capping of the OWAP and OWPP provides source control for this scenario.

Simulation of GWP was performed by extending stress period 3 from 2028 to 2228. Boron concentrations at the compliance monitoring wells are shown in **Figure 3-2** and **Figure 3-3** presents a map of maximum boron concentrations at 30 years (2058) and 100 years (2128), respectively. Although model simulations were completed for a time frame of 200 years (2228), results were not presented beyond 2128, since concentrations decrease to GWPS at the compliance wells well within this 100-year time frame.

3.1.2 Alternative 2 – Source Control with Cutoff Walls

Alternative 2 consists of installation of a slurry wall cutoff wall surrounding the former OWAP, placed within the OWAP berm from ground surface to various depths with the deep cutoff wall combined with existing site features forming a continuous containment system. Cutoff walls were simulated using the HFB package in MODFLOW, with a thickness of 3 feet and a hydraulic conductivity of 1 x 10^{-7} cm/s. These scenarios assume no changes to the cover system installed during OWAP closure (*i.e.,* any disturbance to the existing cap on the OWAP will be remedied following cutoff wall installation).

- **Alternative 2a – Deep Cutoff Wall (continuous containment system)**. This simulation assumed the cutoff wall was keyed into the relatively impermeable bedrock beneath the overlying unlithified materials, with HFBs simulated in model layers 1 through 6.
- **Alternative 2b – Partial Cutoff Wall**. This simulation assumed the cutoff wall was placed to a base elevation of 400 feet, in order to promote constructability by avoiding cobbles and boulders within deeper layers. HFBs were simulated in model layers 1 through 5.

- **Alternative 2c – Shallow Cutoff Wall**. This simulation assumed the cutoff wall was placed to a base elevation of 420 feet, in order to further improve constructability of the wall. HFBs were simulated in model layers 1 through 3.

Simulation of the cutoff walls assumed remedy completion (begin simulation) in 2028. Boron concentrations at compliance monitoring wells for each of the three cutoff wall alternatives are shown in **Figure 3-4**. Maps of maximum boron concentrations for each of the three cutoff wall alternatives are shown in **Figure 3-5** (30 years, 2058) and **Figure 3-6** (100 years, 2128).

Simulated hydraulics were evaluated for each of the three Alternative 2 scenarios to identify any potential mounding of groundwater inside of the cutoff wall (**Figures 3-5** and **3-6**). Simulation results before and after remedy implementation for the deep cutoff wall (2a) indicated that heads inside the cutoff wall vary from 443.16 to 444.6 feet prior to implementation, and are uniform at 444.19 feet 200 years after implementation. Due to the average of less than 1 foot of head increase within the pond footprint 200 years after implementation of the deep cutoff wall, mitigation of mounding through use of pumping wells or other action was not required to reduce mounding or time to meet GWPS. Minimal change to pre-implementation heads on the interior of the cutoff wall for scenarios 2b and 2c were simulated.

3.1.3 Alternative 3 – Source Control - In-Situ Solidification/Stabilization (ISS)

The third simulated alternative consists of ISS across a portion of the OWAP. The target area for ISS was assigned based upon the estimated extent of CCR present at portions of the WAPS with the lower base elevations. The ISS target area consisted of portions of the OWAP below an elevation of 445.7 feet; portions of the former ash pond where the base of ash elevation was higher than this value were not included in the ISS footprint. **Figure 3-7** depicts the target area for ISS and the estimated thickness of ash where ISS would be conducted at each location.

Simulation of ISS was performed by assigning a hydraulic conductivity of 1×10^{-7} cm/s to the ISS target area. The constant-concentration boundary cells within the footprint were removed to represent immobilization or treatment of dissolved phase mass in the solidified material; however, the recharge concentrations were retained for the OWAP to represent assignment of boron concentration to vertical infiltration through the overlying ash material. The final cover of the OWAP is assumed to be replaced or repaired consistent with the 2017 design specifications (Geosyntec, 2017) following ISS, therefore the simulated rate of vertical surface infiltration through the final cover did not change relative to current conditions for this alternative.

Boron concentrations at the compliance monitoring wells are shown in **Figure 3-8**, and **Figure 3-9** presents a map of maximum boron concentrations at 30 years (2058) and 100 years (2128).

3.2 Assessment of Geochemical Processes

This groundwater transport model estimates the time for boron to reach the GWPS under different potential corrective actions, incorporating the physical components of groundwater polishing. As described above, it was assumed that boron would not significantly sorb or chemically react with aquifer solids (Kd was set to 0 mL/g, which is a conservative estimate for estimating contaminant transport times).

The GPR was prepared as an attachment to the Corrective Actions Alternative Analysis (CAAA). The geochemical modeling effort presented in the GPR supports the assessment of groundwater

polishing as a component of the proposed corrective action by evaluating the potential for chemical attenuation of constituents of concern (COCs) (and for previously attenuated COCs to be mobilized to groundwater as groundwater quality returns to background conditions) as a means of contextualizing the times estimated in the flow and transport model. The GPR also provides a foundation for understanding groundwater chemistry to inform adaptive site management as a key component of the Corrective Action Groundwater Monitoring Program.

As concluded in the GPR:

> *"The results of the groundwater polishing evaluation indicate that chemical attenuation of modeled COCs (arsenic, boron and sulfate) is feasible under current conditions through sorption to iron and aluminum oxide minerals. Though some degree of desorption is predicted with background water interaction, aqueous boron and sulfate (and therefore TDS) concentrations should decrease below the GWPS at all wells in the compliance monitoring network following source control. Remobilization of boron and sulfate is unlikely to affect the estimated time to reach the GWPS based on modeling results. Aqueous arsenic concentrations are predicted to increase at wells with current exceedances following remobilization of arsenic in post-source control conditions. Remobilization may impact the time to reach the GWPS for arsenic. Lithium was not evaluated in the geochemical modeling because lithium concentrations continue to decline following unit closure."*

The results of the GPR geochemical modeling indicate attenuation of COCs boron, lithium, sulfate, and TDS through sorption and chemical mechanisms will complement results of the groundwater transport modeling, in that time to reach GWPS may be shorter than the simulated timeframes. Remobilization of arsenic, which exceeds GWPS at two wells (51 and 21R), may increase the time to reach GWPS from the simulated results.

3.3 Prediction Scenario Results Discussion

Simulation of corrective action alternatives for the OWAP through the next 200 years indicates that concentrations of boron in groundwater will decrease over time regardless of the remedy selected. A summary of predicted boron concentrations and time to meet the GWPS at the compliance monitoring wells is provided in **Table 3-1** and summarized in **Table C** on the next page. As shown, concentrations are expected to fall below 2 mg/L by 2061 for all corrective action alternatives, with the majority of wells (6 of 9) reaching GWPS by 2030 (two years after remedy implementation) regardless of the selected corrective action alternative.

Table C. Estimated Timeframes to Attain GWPS in Groundwater Monitoring Wells†

	Alternative	2 years‡	5 years‡	10 years‡	20 years‡	33 years‡
Percentage of Wells predicted to attain GWPS†	1	67%	89%	89%	89%	100%
Percentage of Wells predicted to attain GWPS†	2a	67%	67%	67%	89%	100%
Percentage of Wells predicted to attain GWPS†	2b	89%	89%	89%	89%	100%
Percentage of Wells predicted to attain GWPS†	2c	67%	89%	89%	89%	100%
Percentage of Wells predicted to attain GWPS†	3	67%	89%	89%	89%	100%

†: Estimated timeframes per the 9 compliance wells
‡: Years counted starting from 2028

3.3.1 Comparison of Corrective Action Alternatives

Comparison of predicted concentrations at the compliance wells indicates that the time to reach GWPS is similar across each of the evaluated remedies, with Alternatives 1, 2b, 2c, and 3 reaching GWPS in 2055 (27 years after 2028), and Alternative 2a reaching GWPS by 2061 (33 years after 2028). Comparison of the engineered corrective action alternatives to GWP shows that Alternatives 2b, 2c, and 3 produce similar cleanup times to Alternative 1, with only slight decreases in time to reach GWPS in 1, 2, or 3 wells (less than 5 years improvement). Alternative 2a results in increased time to reach GWPS in wells 23 and 49 due to reduced advection of groundwater immediately downgradient of the deep cutoff wall (*i.e.,* stagnation of groundwater near wells 23 and 49).

Well 21R is the last to meet GWPS in four of five alternatives; this result is due to the simulated location of this well within the silt and clays, which results in lower groundwater velocities and a consequently longer time for flushing of concentrations after closure of the OWAP in 2020 than for the higher-permeability materials. The cleanup time at well 21R (27 years) is also reduced compared to the cleanup time at this well from the 2017 simulation of OWAP closure; this is due to the assignment of a Kd of 0 mL/g to the silts and clays in this model revision (no retardation of boron).

4. CONCLUSIONS

Existing site-specific three-dimensional groundwater flow (MODFLOW) and transport models (MT3DMS) were revised and employed to evaluate the effectiveness of groundwater corrective action alternatives in reduction of time to reach GWPS in groundwater at the Hennepin WAPS following the closure of the OWAP and OWPP, which were completed in 2020. Boron was selected for simulation of groundwater quality changes resulting from the WAPS. It was assumed that boron would not significantly sorb or chemically react with aquifer solids (Kd was set to 0 mL/g) which is a conservative estimate for predicting contaminant transport times in the model.

Five corrective action alternatives were simulated, consisting of GWP (Alternative 1), three configurations of a cutoff wall surrounding the OWAP (Alternatives 2a, 2b, and 2c), and ISS (Alternative 3). Comparison of predicted concentrations at the compliance wells indicates that the time to reach GWPS is similar for each of the evaluated remedies, with Alternatives 1, 2b, 2c, and 3 reaching GWPS in 2055, and Alternative 2a reaching GWPS by 2061. Comparison of the "engineered" corrective action alternatives to GWP indicates that Alternatives 2b, 2c, and 3 produce similar cleanup times to Alternative 1, with only slight decreases in time to reach GWPS. Alternative 2a, the continuous containment system, results in a longer time to reach the GWPS due to the creation of a stagnant flow zone (area of reduced advection) downgradient of the cutoff wall.

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TABLES

Table 2-1
Model Input Values: Steady-State Flow Model / Transport Model
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Horizontal Hydraulic Conductivity	**ft/d**	**cm/s**		**Revision Notes**
Sand & River Sand (Zone 1)	30.0	1.1E-02		
Outwash Gravel, Layers 1-5 (Zone 2)	200.0	7.1E-02		
Alluvium (Zone 3)	1.5	5.3E-04		
Channel Fill Silts (Zone 4)	1.4	4.9E-04		
Ash (Zone 10)	0.05	1.8E-05		
Outwash Gravel, Layer 6 (Zone 12)	100.0	3.5E-02		New for Rev1

Vertical Hydraulic Conductivity	**ft/d**	**Kh/Kv**		**Revision Notes**
Sand & River Sand (Zone 1)	15.0	2.0		
Outwash Gravel (Zone 2)	100.0	2.0		
Alluvium (Zone 3)	0.15	10.0		
Channel Fill Silts (Zone 4)	0.14	10.0		
Ash (Zone 10)	0.05	1.0		
Outwash Gravel, Layer 6 (Zone 12)	50	2.0		New for Rev1

Recharge[2]	ft/d	in/yr	**Boron Concentration (mg/L**	**Revision Notes**
Sand & River Sand (Zone 1)	1.0E-03	4.4		Decreased by 10%
Outwash Gravel (Zone 2)	1.0E-03	4.4		Decreased by 10%
Channel Fill Silts (Zone 4)	5.0E-04	2.2		
Ash-Pond 1 (Zone 9)	3.83E-03	16.8	9.0	
Ash-Pond 3 East (Zone 8)	4.0E-02	175.2	9.0	Increased by 10%
Ash-Pond 3 Center (Zone 10)	2.7E-02	118.3	9.0	Increased by 5%
Ash-Pond 3 West (Zone 6)	2.7E-02	118.3	19.0	
Ash-Pond 3 Northwest (Zone 5)	2.7E-02	118.3	7.0	
Ash-Secondary Pond (Zone 7)	2.0E-02	87.6	7.0	

River Parameters	**Illinois Riv.**	**Duck Ponds**	**Duck Pond (Creek)**	**Revision Notes**
Stage (ft)	441.7	445.5	444.8	Retained
Bottom (ft)	435	440	440	Modified (Illinois River)
Conductance (ft2/d)	200-1000	62.5-10,000	2.5E+05	Modified (see report)

Dispersivity	**dispersivity (ft^2/d)**	**Revision Notes**
Longitudinal (all layers)	50	Retained
Transverse (all layers)	6.25	Retained
Vertical (all layers)	0.313	Retained

Storage/Porosity	**S_S (1/ft)**	**Sy**	**porosity**	**Revision Notes**
Entire Domain	0.01	0.20	0.20	Retained

Notes:

1 The steady-state flow model and transient transport calibration represent conditions from 1966-1996 (30 years) during ash pond operation

2 See figures for delineation of model zones

Table 2-2
Model Input Values: Transient Flow Model / Transport Model
Groundwater Modeling Technical Memorandum
West Ash Pond System, Hennepin Power Plant

	Calibration		
Stress Periods[1]	**Days, # of time steps**	**Dates**	
Stress Period 1	**500, 6**	**1/1997-5/1998**	
Stress Period 2	**8096, 20**	**5/1998-7/2020**	
Stress Period 3	**2710, 10**	**8/2020-1/2028**	
Recharge[2] (Stress Period 1)	**ft/d**	**in/yr**	**Boron Concentration (mg/L)**
Ash-Pond 1 (Zone 9)	3.83E-03	16.8	9.0
Ash-Pond 3 East (Zone 8)	2.E-02	87.6	9.0
Ash-Pond 3 Center (Zone 10)	2.E-02	87.6	9.0
Ash-Pond 3 Center (Zone 6)	2.E-02	87.6	9.0
Ash-Pond 3 West (Zone 12)	2.E-02	87.6	19.0
Ash-Pond 3 West (Zone 13)	2.E-02	87.6	19.0
Ash-Pond 3 Northwest (Zone 5)	2.E-02	87.6	7.0
Ash-Pond 3 Northwest (Zone 11)	2.E-02	87.6	9.0
Ash-Old West Polishing Pond (Zone 7)	2.E-02	87.6	7.0
Recharge[2] (Stress Period 2)	**ft/d**	**in/yr**	**Boron Concentration (mg/L)**
Ash-Pond 1 (Zone 9)	3.83E-03	16.8	9.0
Ash-Pond 3 East (Zone 8)	2.96E-03	13.0	9.0
Ash-Pond 3 Center (Zone 10)	2.96E-03	13.0	9.0
Ash-Pond 3 Center (Zone 6)	2.E-02	87.6	9.0
Ash-Pond 3 West (Zone 12)	2.E-02	87.6	19.0
Ash-Pond 3 West (Zone 13)	2.96E-03	13.0	19.0
Ash-Pond 3 Northwest (Zone 5)	2.96E-03	13.0	7.0
Ash-Pond 3 Northwest (Zone 11)	2.E-02	87.6	9.0
Ash-Old West Polishing Pond (Zone 7)	2.96E-03	13.0	7.0
Recharge[2] (Stress Period 3)	**ft/d**	**in/yr**	**Boron Concentration (mg/L)**
Ash-Pond 3 East (Zone 8)	5.55E-07	0.0	9.0
Ash-Pond 3 Center (Zone 10)	5.55E-07	0.0	9.0
Ash-Pond 3 West (Zone 12)	5.55E-07	0.0	19.0
Ash-Pond 3 Northwest (Zone 11)	5.55E-07	0.0	7.0

Notes:

1 Transient flow and transport models described above represent years 1996-2023 (2028)

2 See figures for delineation of model zones; recharge values outside ash pond are same as Table 2-1.

Table 2-3

Calibration Targets and Statistics: Steady-State Flow Model / Transport Model
Groundwater Modeling Technical Memorandum
West Ash Pond System, Hennepin Power Plant

Flow Model Calibration Targets

Well ID	Model Layer	Observed Head (feet)	Simulated Head (feet)	Residual (observed - simulated, feet)	Simulated Head, 1997 model (feet)
21	5	446.89	446.38	0.51	446.00
23	3	446.56	445.92	0.64	445.36
24	5	446.85	446.07	0.78	445.54
26	1	446.82	446.94	-0.12	446.10
27	4	446.02	446.06	-0.04	445.95
30	4	446.15	446.49	-0.34	446.10
31	1	446.09	446.49	-0.40	446.10
32	1	446.10	446.39	-0.29	446.17
33	5	444.46	444.43	0.03	444.37
34	4	441.56	442.40	-0.84	441.69
L1	1	454.25	455.96	-1.71	455.22
L4	1	448.10	452.32	-4.22	451.59

Notes:
Flow Model targets were developed using data collected from 1994-1996.
Flow model targets were retained from the previous (2017) model.

Flow Model Calibration Statistics		
Residual Mean	-0.50	ft
Absolute Residual Mean	0.83	ft
Residual Std. Deviation	1.29	ft
Sum of Squares	23.1	ft^2
RMS Error	1.4	
Number of Observations	12	
Range in Observations	12.7	

Transport Model Calibration Targets

Well ID	Model layer	Observed boron concentration (mg/L)	Simulated boron concentration (mg/L)	Residual (Observed - Simulated, mg/L)	Simulated boron concentration, 1997 model (mg/L)
21	5	4.9	7.0	-2.0	5.8
22	1	8.1	7.7	0.4	8.9
23	3	6.9	9.2	-2.3	8.7
24	5	7.7	8.6	-1.0	8.7
26	1	1.1	0.2	0.9	0.4
27	4	6.0	5.4	0.6	7.5
30	4	2.3	2.0	0.3	1.5
31	1	0.2	0.4	-0.2	0.7
32	1	0.1	0.0	0.1	0.0
33	5	0.1	0.0	0.1	0.0
34	4	0.1	0.0	0.1	0.0
L1	1	14.4	18.5	-4.1	18.9
L4	1	26.1	7.3	18.8	4.8

Notes:
Transport model targets were developed using data collected from 1994-1996. Calibration targets were retained from the previous (2017) model.

Table 3-1
Estimated Time to Achieve GWPS at Compliance Wells
Groundwater Modeling Technical Memorandum
West Ash Pond System, Hennepin Power Plant

	Simulated Boron Concentrations (mg/L)		Years to Reach GWPS (2 mg/L) from 2028				
Compliance Wells	7/30/2020 (Completed Closure)	1/1/2028 (Completed Remedy)	1 - GWP + Source Control	2A –Bedrock Wall	2B – Partial Wall	2C – Shallow Wall	3 – ISS
21R- L5	6.4	5.7	**27**	20	27	27	27
22- L1	7.8	3.5	**2**	2	1	2	2
22D- L5	5.2	*1.4*					
23- L3	8.4	3.2	**4**	16	1	4	4
27- L4	2.1	*1.2*					
35- L1	5.5	2.4	**2**	0	1	1	2
49- L3	7.1	3.4	**5**	33	0	3	4
50-L2	4.4	*0.6*					
51- L6	9.8	*1.1*					
		Year for GWPS	2055 (21R)	2061 (49)	2055 (21R)	2055 (21R)	2055 (21R)

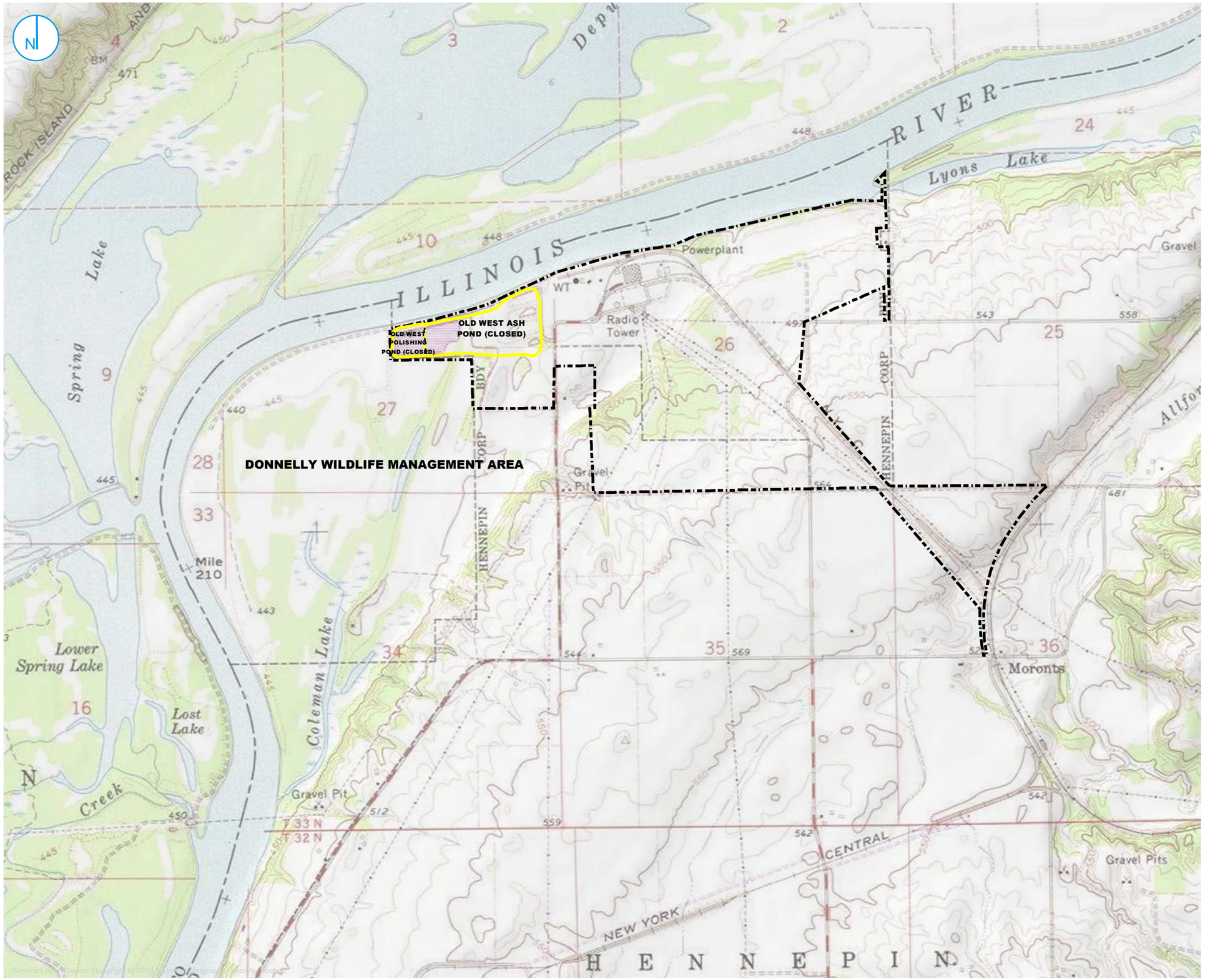
Notes

The GWPS for Boron is 2 mg/L.

Years to reach GWPS are in BOLD for Alternative 1. Blue shading denotes faster cleanup, gold denotes slower cleanup compared to Alternative 1.

Current concentrations are at or below GWPS of 2 mg/L at wells 22D, 49, 50, and 51; concentrations are overpredicted at these wells for 2023.

FIGURES



REGULATED UNIT (SUBJECT UNIT)

PROPERTY BOUNDARY

0 750 1,500 Feet

SITE LOCATION MAP

GROUNDWATER MODELING
TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 1-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Service Layer Credits: Copyright © 2013 National Geographic Society, i-cubed

PROJECT: 169000XXXX | DATED: 1/10/2024 | DESIGNER: GALARNMC

Y:\Mapping\Projects\22\2285\MXD\Model_Figures\Hennepin\OWAP_804\Figure 1-1. Site Location Map.mxd

COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
LEACHATE WELL
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 200 400
Feet

SITE FEATURES AND MONITORING WELLS

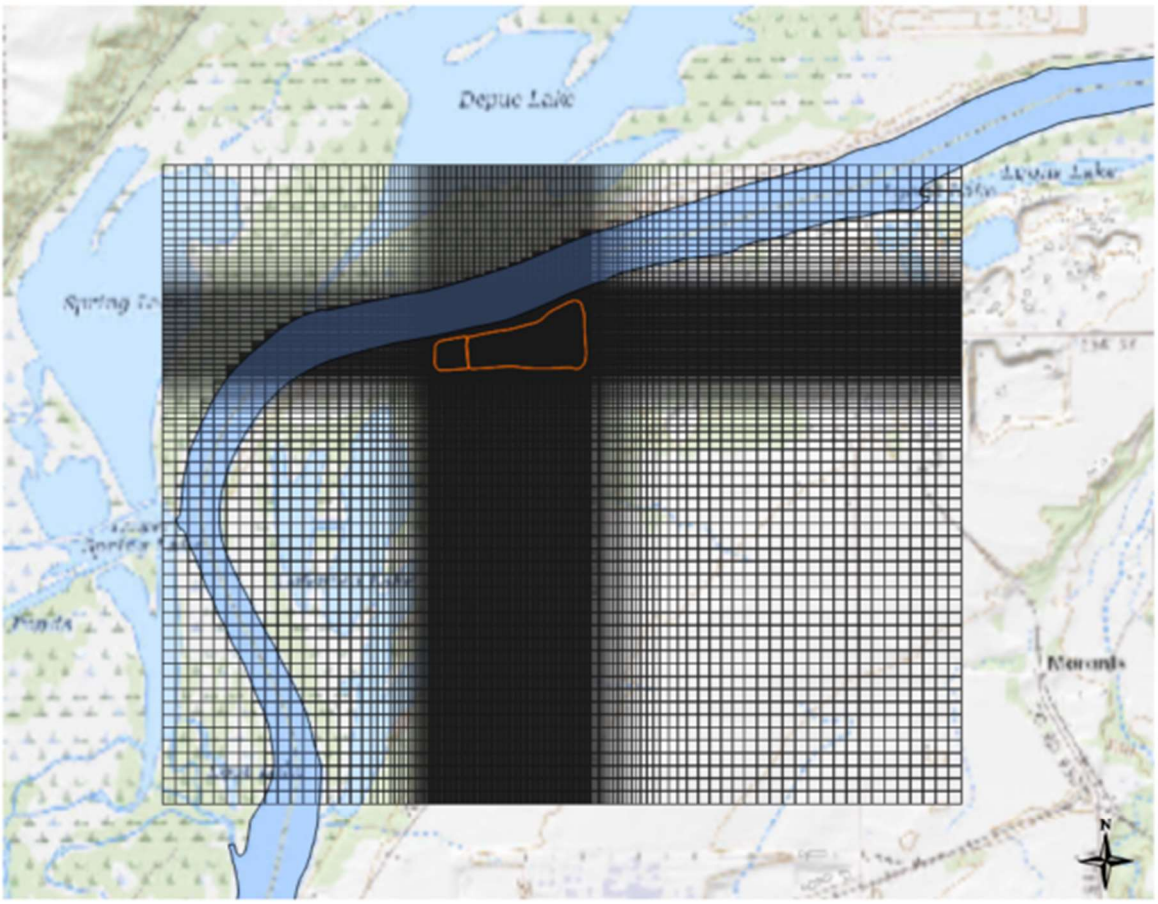
GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 1-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\22285\MXD\Model_Figures\Hennepin\GWAP_804\Figure 1-2. Site Features and Monitoring Wells.mxd
PROJECT: 169000XXXX | DATED: 1/10/2024 | DESIGNER: GALARNMC



LEGEND

MODEL GRID (VARIABLE SPACING OF 25-200 FEET)

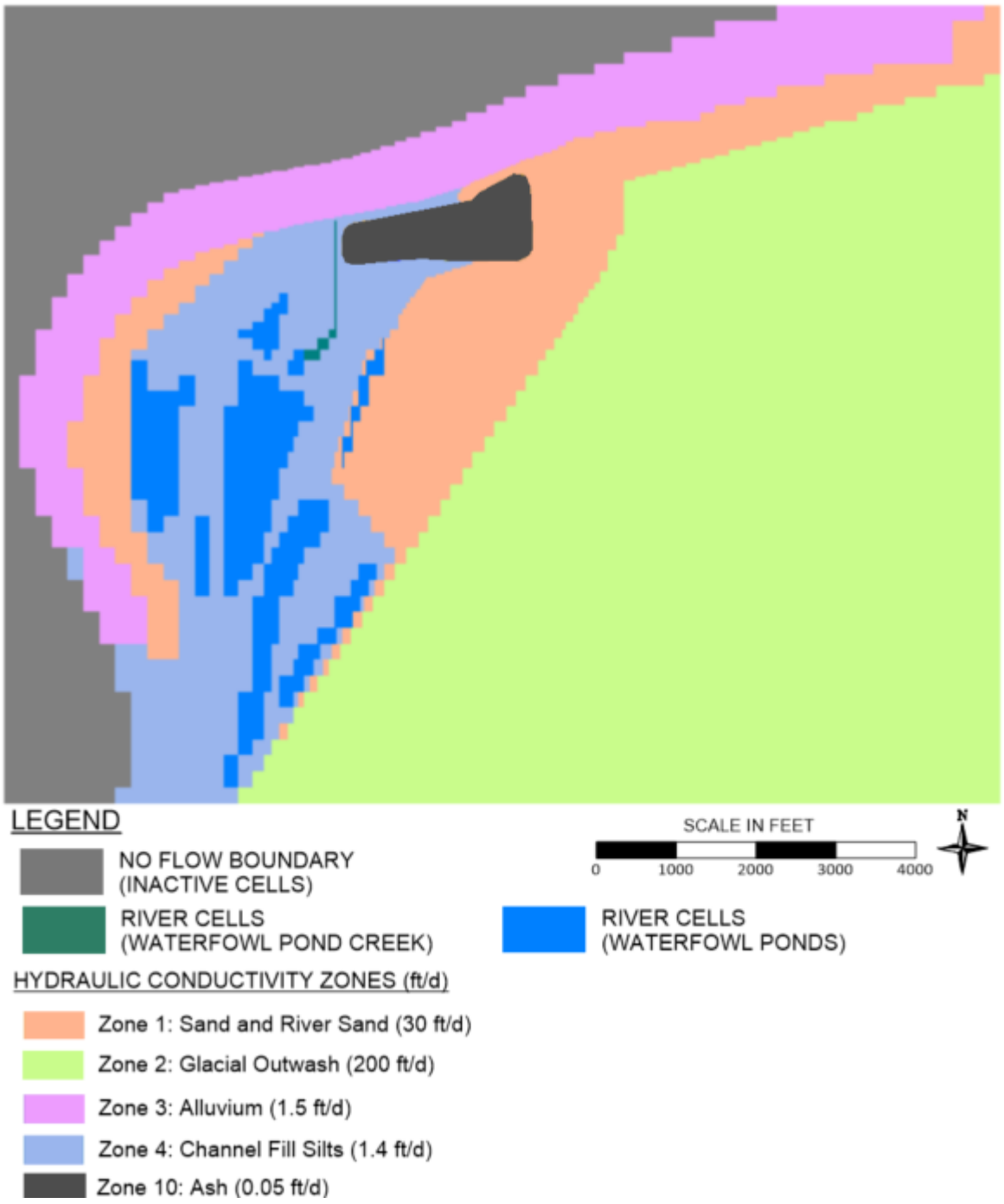
WEST ASH POND SYSTEM
POND BOUNDARIES

SCALE IN FEET
0 1000 2000 3000 4000

MODEL GRID

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL



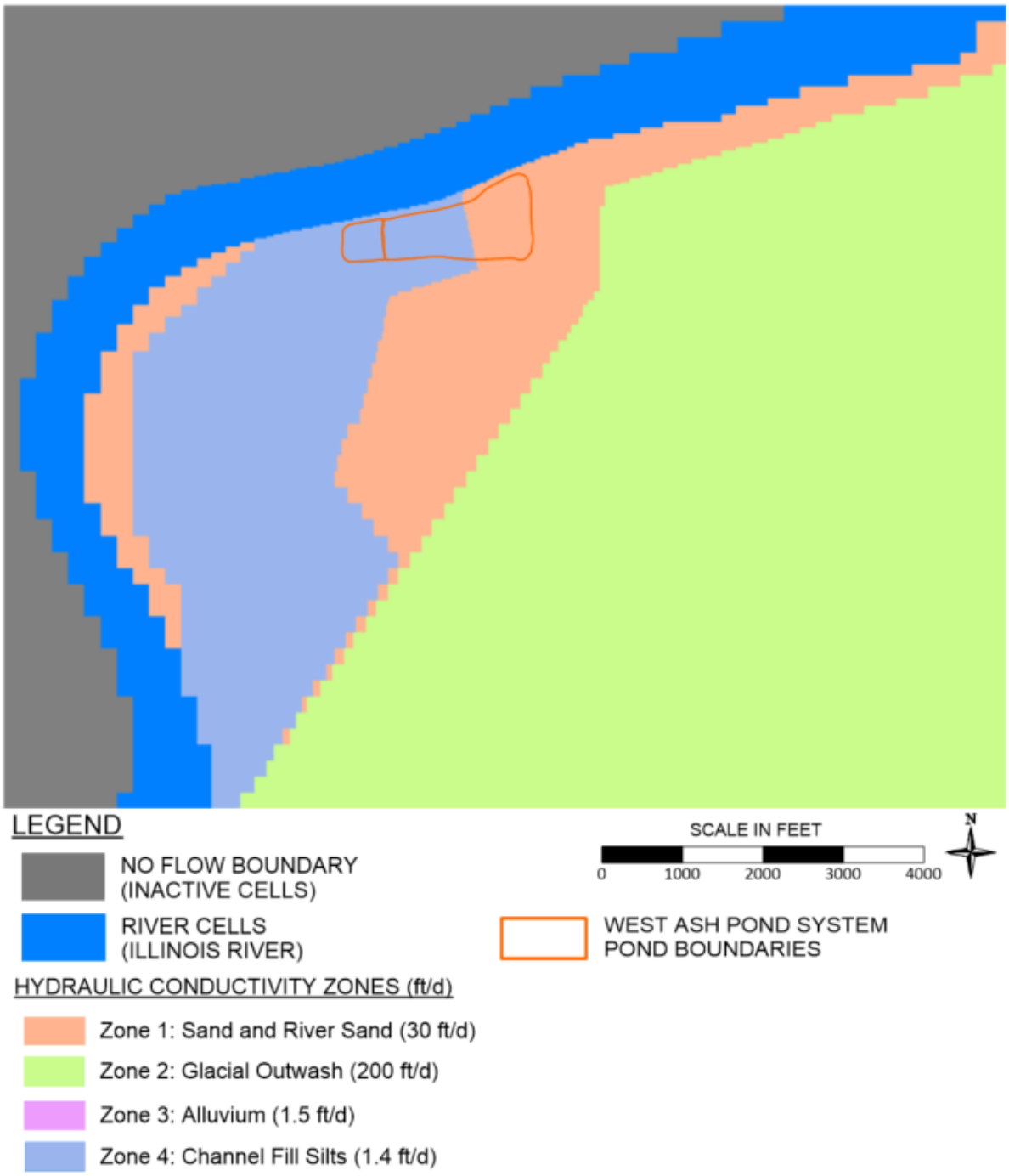
Notes

Constant-concentration cells representing the ash in model layer 1 are presented in Figures 2-9 through 2-12.

BOUNDARY CONDITIONS AND HYDRAULIC CONDUCTIVITY (K) ZONES
MODEL LAYER 1

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL



Notes

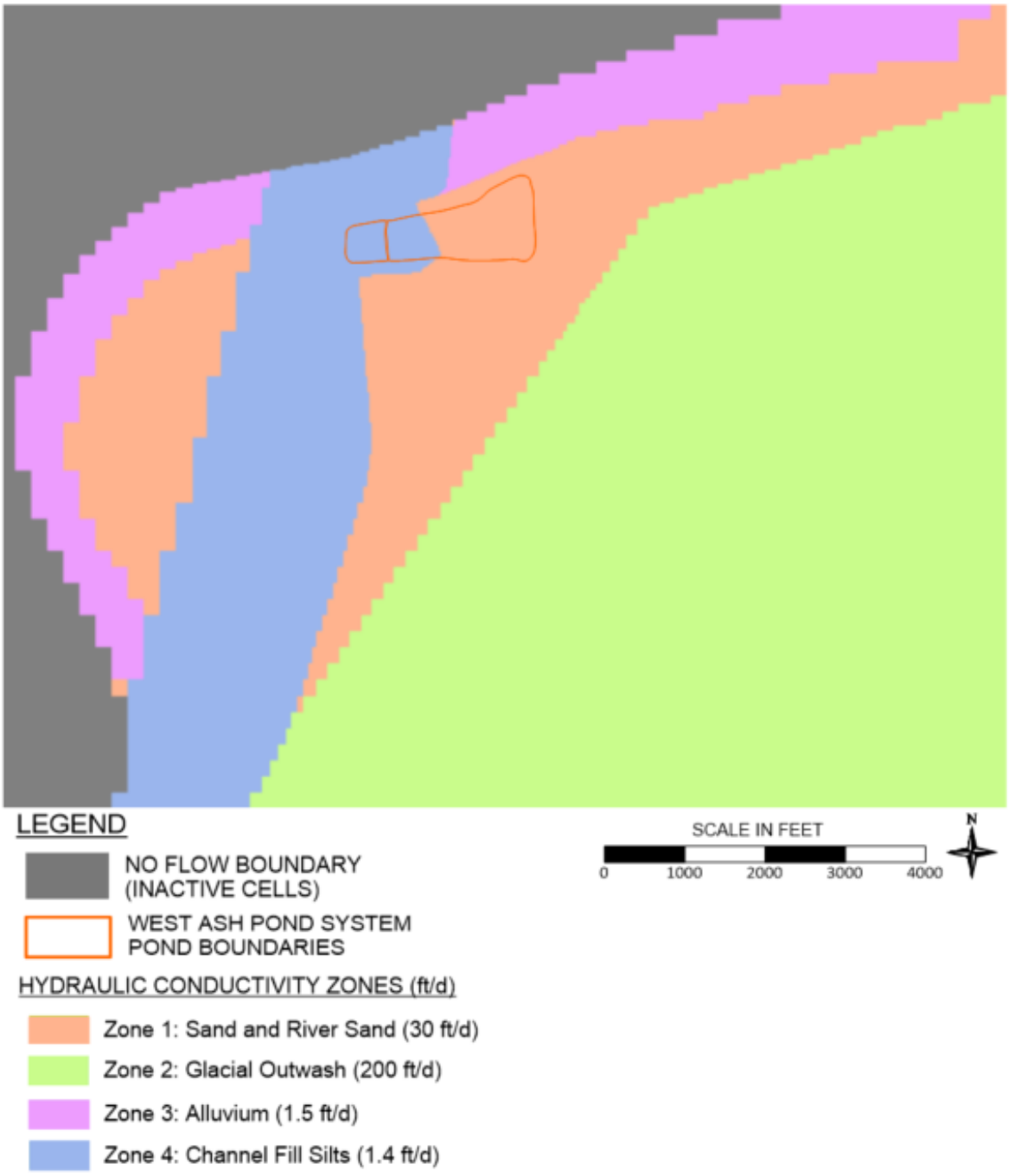
The river boundary cells representing the Illinois River are coincident with K zone 3 (Alluvium).

BOUNDARY CONDITIONS AND HYDRAULIC CONDUCTIVITY (K) ZONES
MODEL LAYER 2

GROUNDWATER MODELING TECHNICAL
MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL

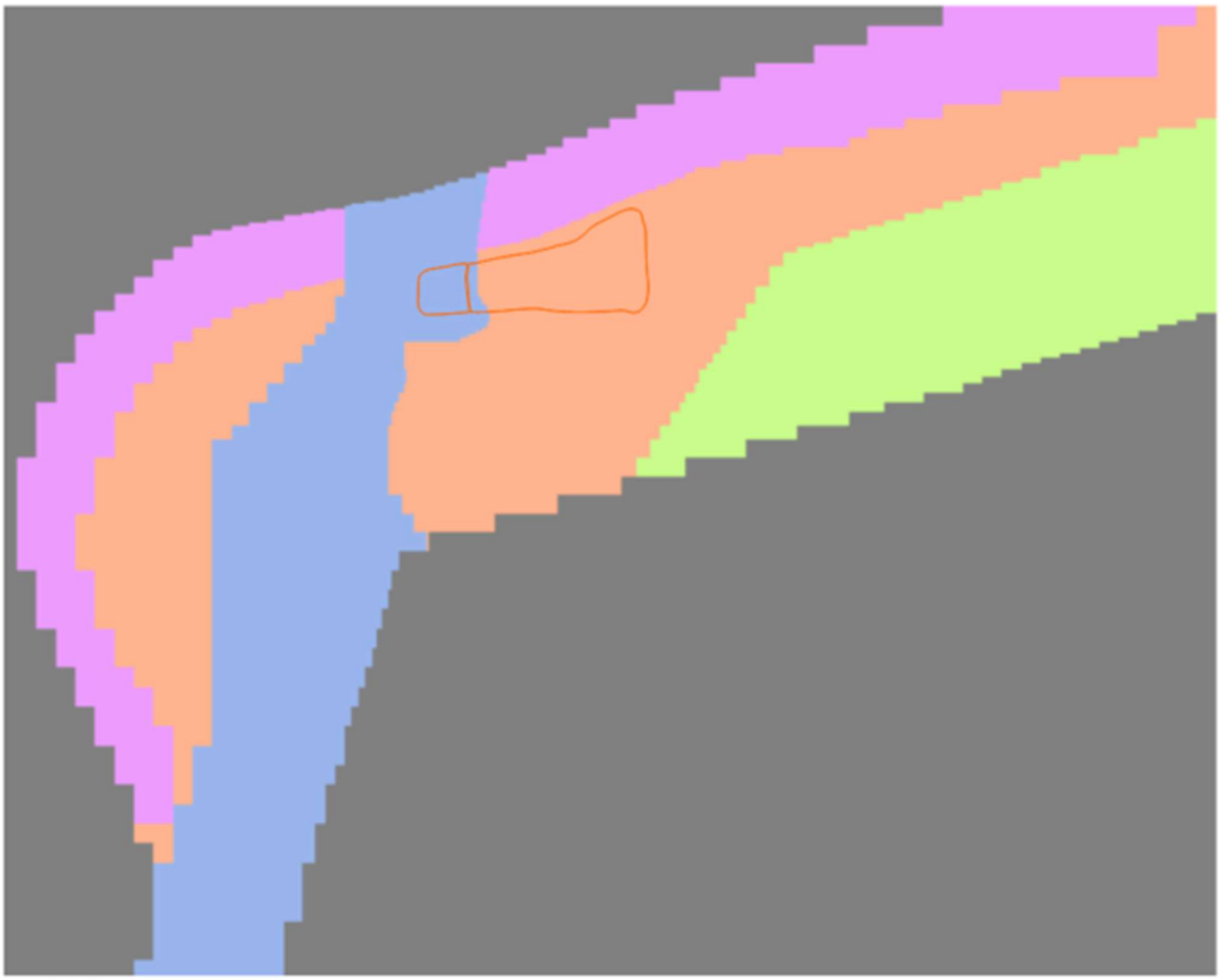
FIGURE 2-4



BOUNDARY CONDITIONS AND HYDRAULIC CONDUCTIVITY (K) ZONES
MODEL LAYER 3

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-5



LEGEND

NO FLOW BOUNDARY (INACTIVE CELLS)

WEST ASH POND SYSTEM POND BOUNDARIES

HYDRAULIC CONDUCTIVITY ZONES (ft/d)

Zone 1: Sand and River Sand (30 ft/d)

Zone 2: Glacial Outwash (200 ft/d)

Zone 3: Alluvium (1.5 ft/d)

Zone 4: Channel Fill Silts (1.4 ft/d)

SCALE IN FEET

0 1000 2000 3000 4000

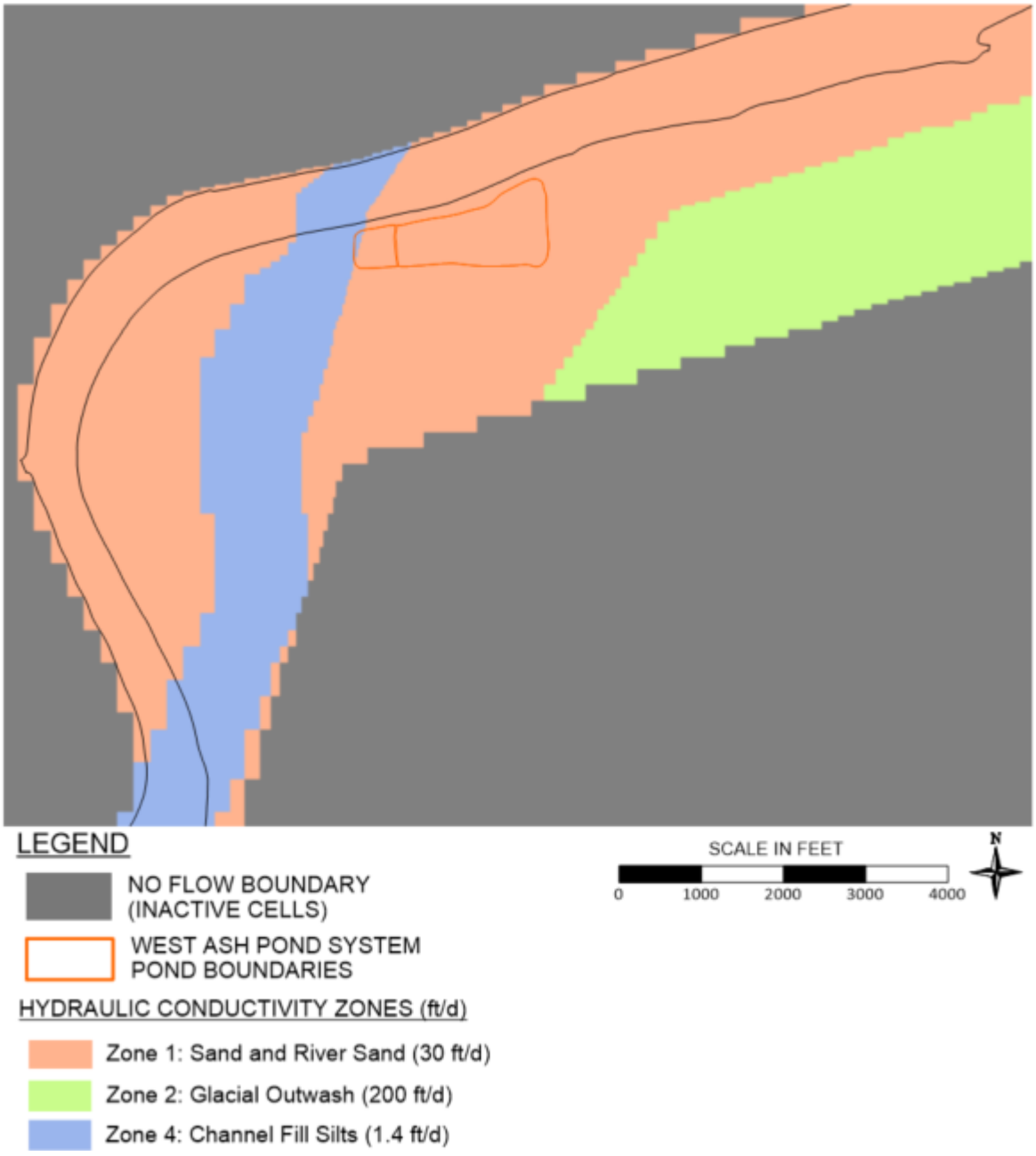
N

BOUNDARY CONDITIONS AND HYDRAULIC CONDUCTIVITY (K) ZONES
MODEL LAYER 4

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL

FIGURE 2-6

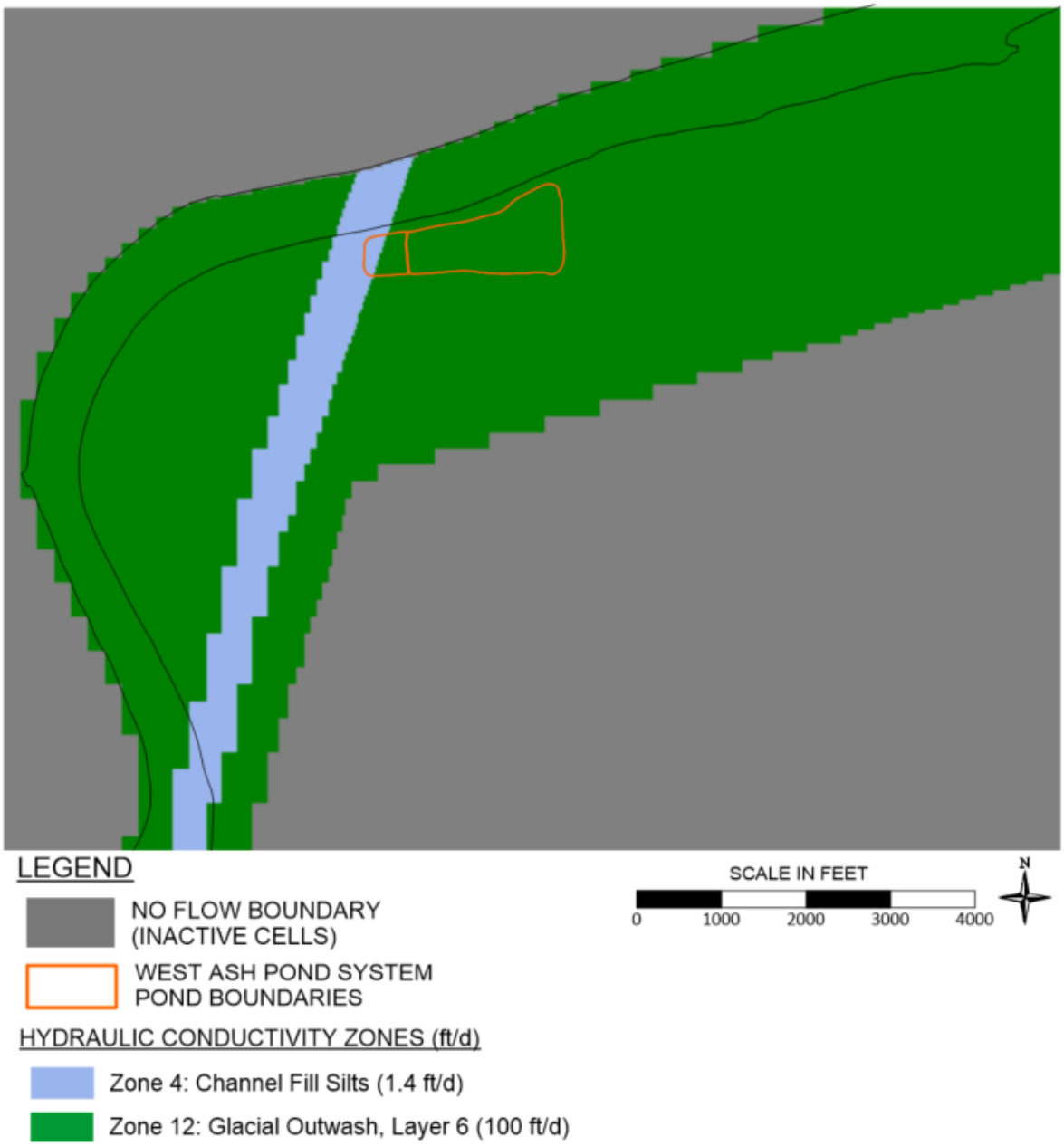


BOUNDARY CONDITIONS AND HYDRAULIC CONDUCTIVITY (K) ZONES
MODEL LAYER 5

GROUNDWATER MODELING TECHNICAL MEMORANDUM

WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

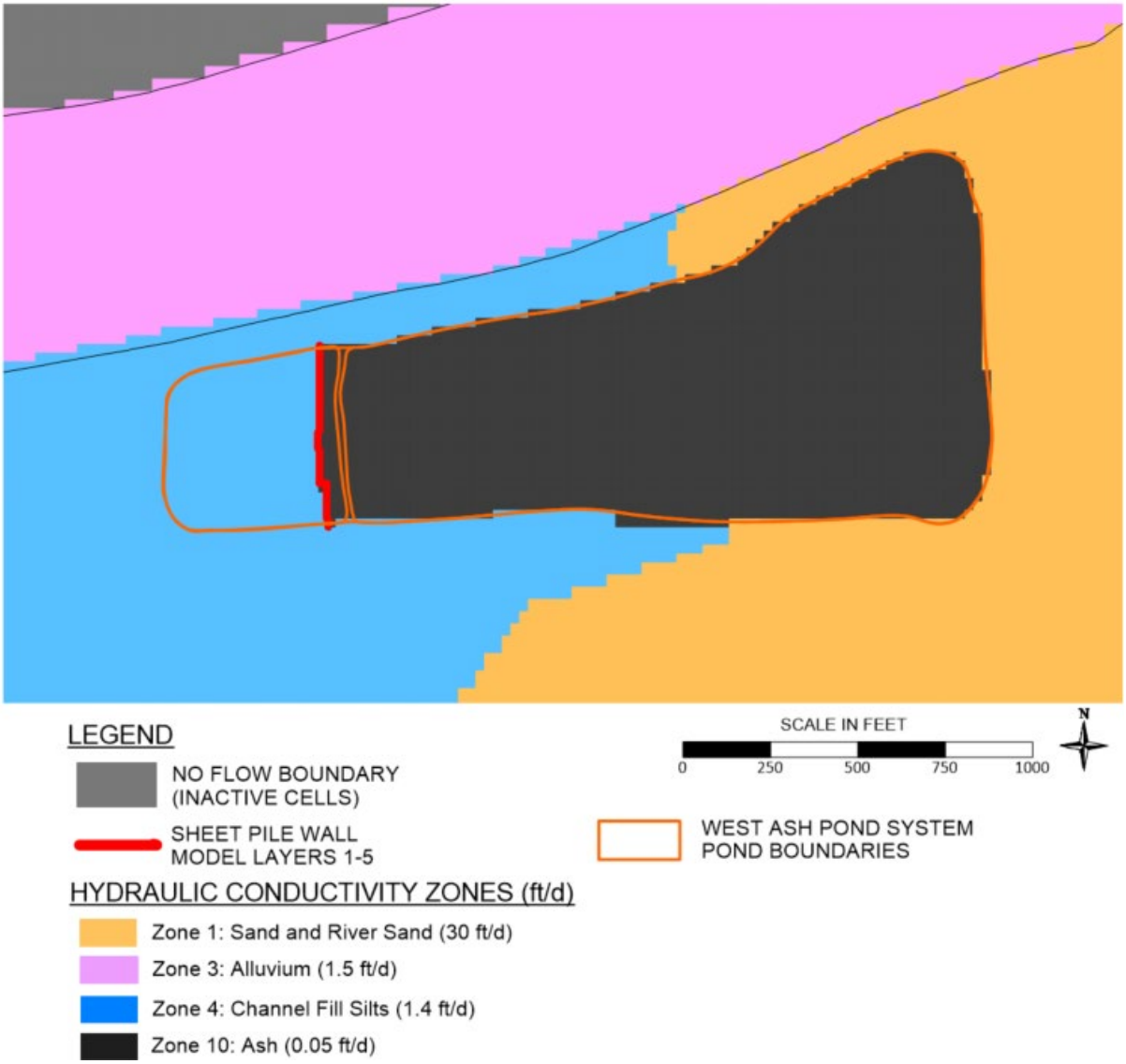
RAMBOLL



BOUNDARY CONDITIONS AND HYDRAULIC CONDUCTIVITY (K) ZONES
MODEL LAYER 6

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

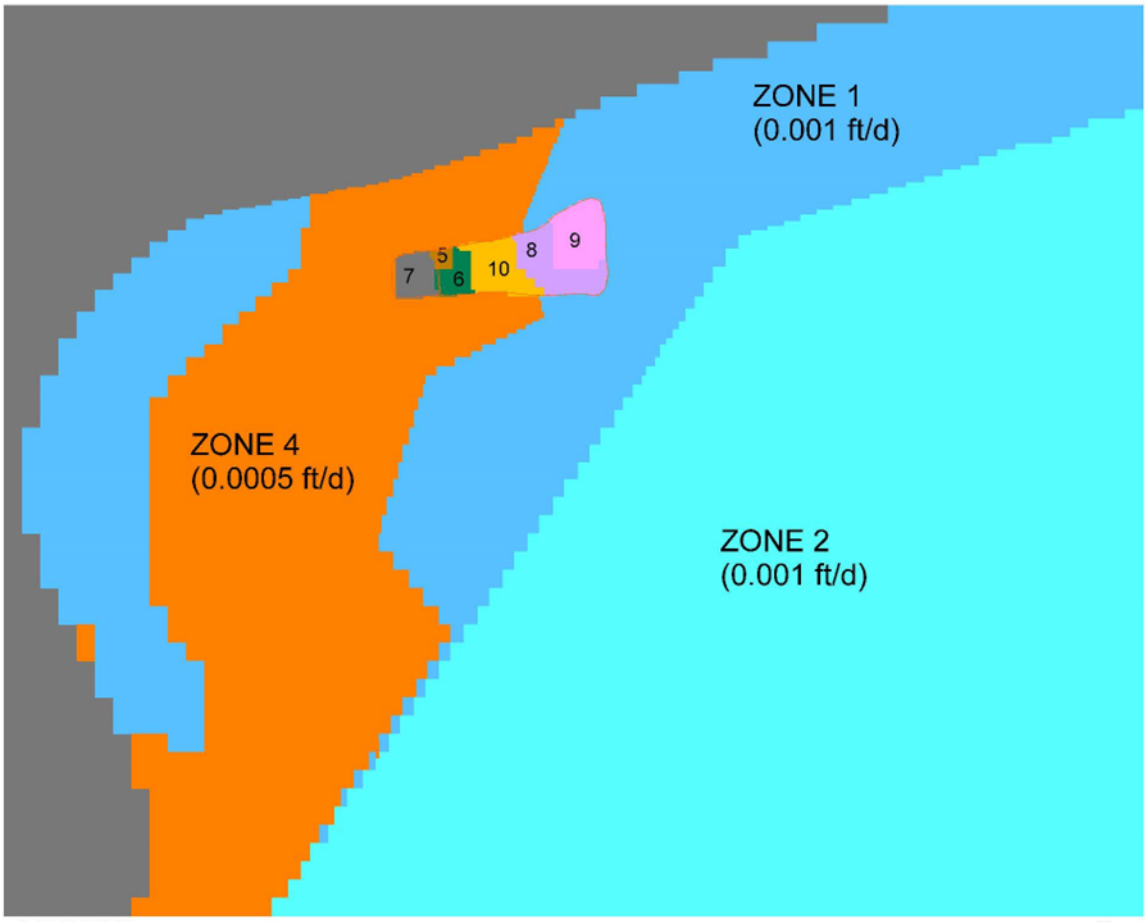
RAMBOLL



BOUNDARY CONDITIONS AND HYDRAULIC CONDUCTIVITY (K) ZONES
MODEL LAYER 1, STRESS PERIOD 3

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL

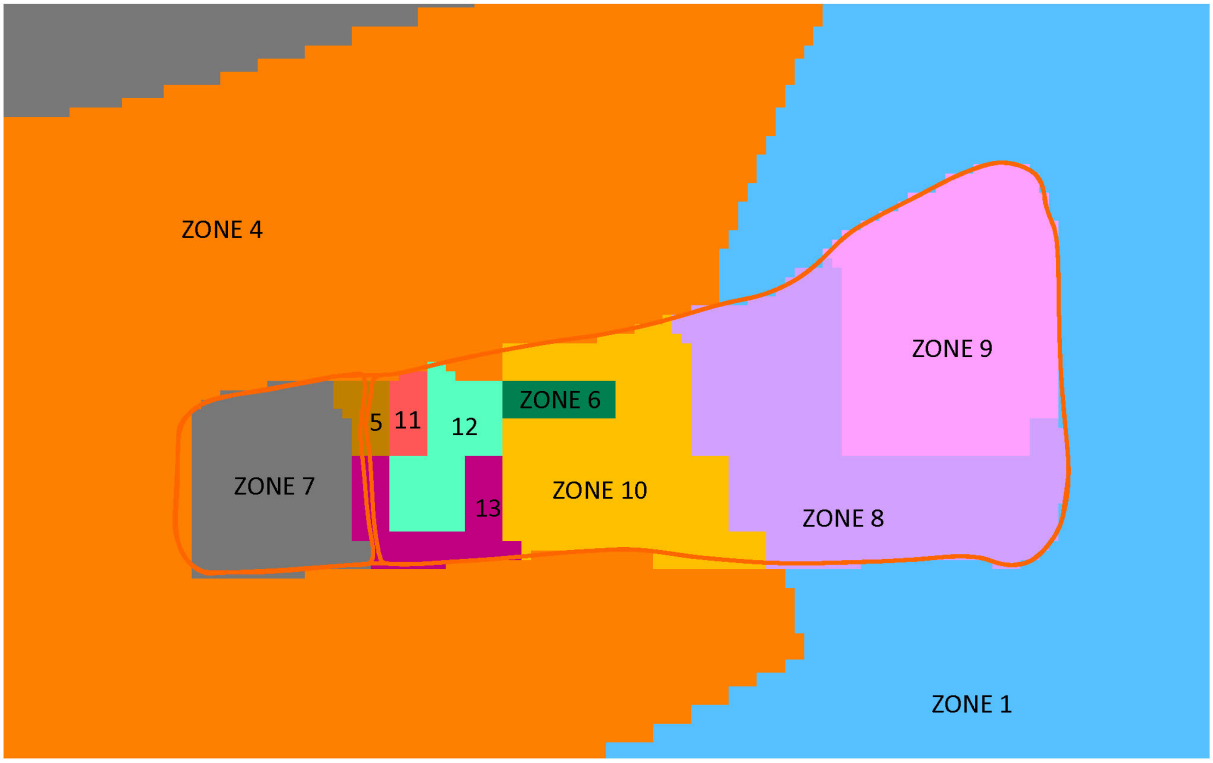


RECHARGE ZONES (ft/d) WITH BORON [mg/L] marked on map

Model Recharge	ft/d	in/yr	Boron Concentration (mg/L)
Sand & River Sand (Zone 1)	1.0E-03	4.4	
Outwash Gravel (Zone 2)	1.0E-03	4.4	
Channel Fill Silts (Zone 4)	5.0E-04	2.2	
Ash-Pond 1 (Zone 9)	3.8E-03	16.8	9.0
Ash-Pond 3 East (Zone 8)	4.0E-02	175.2	9.0
Ash-Pond 3 Center (Zone 10)	2.7E-02	118.3	9.0
Ash-Pond 3 West (Zone 6)	2.7E-02	118.3	19.0
Ash-Pond 3 Northwest (Zone 5)	2.7E-02	118.3	7.0
Ash-Secondary Pond (Zone 7)	2.0E-02	87.6	7.0

Note: Constant-concentration boundaries specified in model layer 1 are consistent with boron recharge values.

MODEL RECHARGE, STEADY-STATE FLOW MODEL / TRANSPORT MODEL



LEGEND

NO FLOW BOUNDARY (INACTIVE CELLS)

WEST ASH POND SYSTEM POND BOUNDARIES

SCALE IN FEET

0 250 500 750 1000

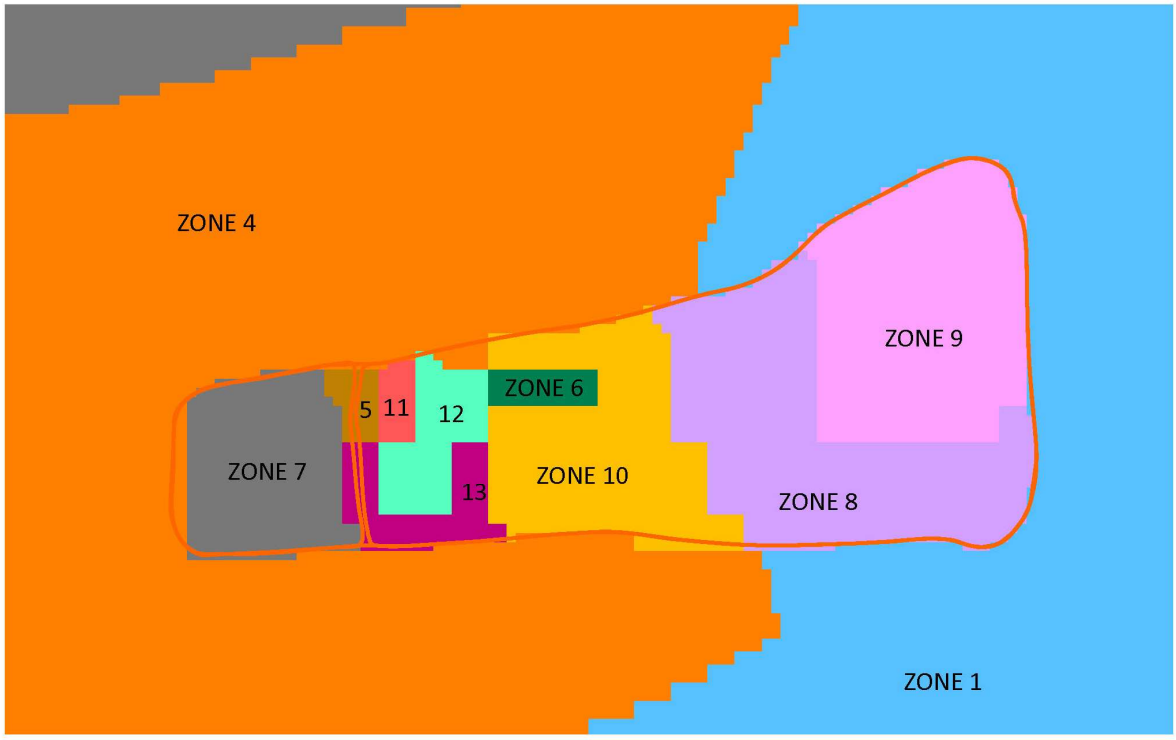
N

RECHARGE ZONES (ft/d) WITH BORON [mg/L] marked on map

Model Recharge	ft/d	in/yr	Boron Concentration (mg/L)
Sand & River Sand (Zone 1)	1.0E-03	4.4	
Outwash Gravel (Zone 2)	1.0E-03	4.4	
Channel Fill Silts (Zone 4)	5.0E-04	2.2	
Ash-Pond 1 (Zone 9)	3.8E-03	16.8	9.0
Ash-Pond 3 East (Zone 8)	2.0E-02	87.6	9.0
Ash-Pond 3 Center (Zone 10)	2.0E-02	87.6	9.0
Ash-Pond 3 Center (Zone 6)	2.0E-02	87.6	9.0
Ash-Pond 3 West (Zone 12)	2.0E-02	87.6	19.0
Ash-Pond 3 West (Zone 13)	2.0E-02	87.6	19.0
Ash-Pond 3 Northwest (Zone 5)	2.0E-02	87.6	7.0
Ash-Pond 3 Northwest (Zone 11)	2.0E-02	87.6	9.0
Ash-Old West Polishing Pond (Zone 7)	2.0E-02	87.6	7.0

Note: Constant-concentration boundaries specified in model layer 1 are consistent with boron recharge values.

MODEL RECHARGE, TRANSIENT MODEL STRESS PERIOD 1



LEGEND

NO FLOW BOUNDARY (INACTIVE CELLS)

WEST ASH POND SYSTEM POND BOUNDARIES

SCALE IN FEET

0 250 500 750 1000

N

RECHARGE ZONES (ft/d) WITH BORON [mg/L] marked on map

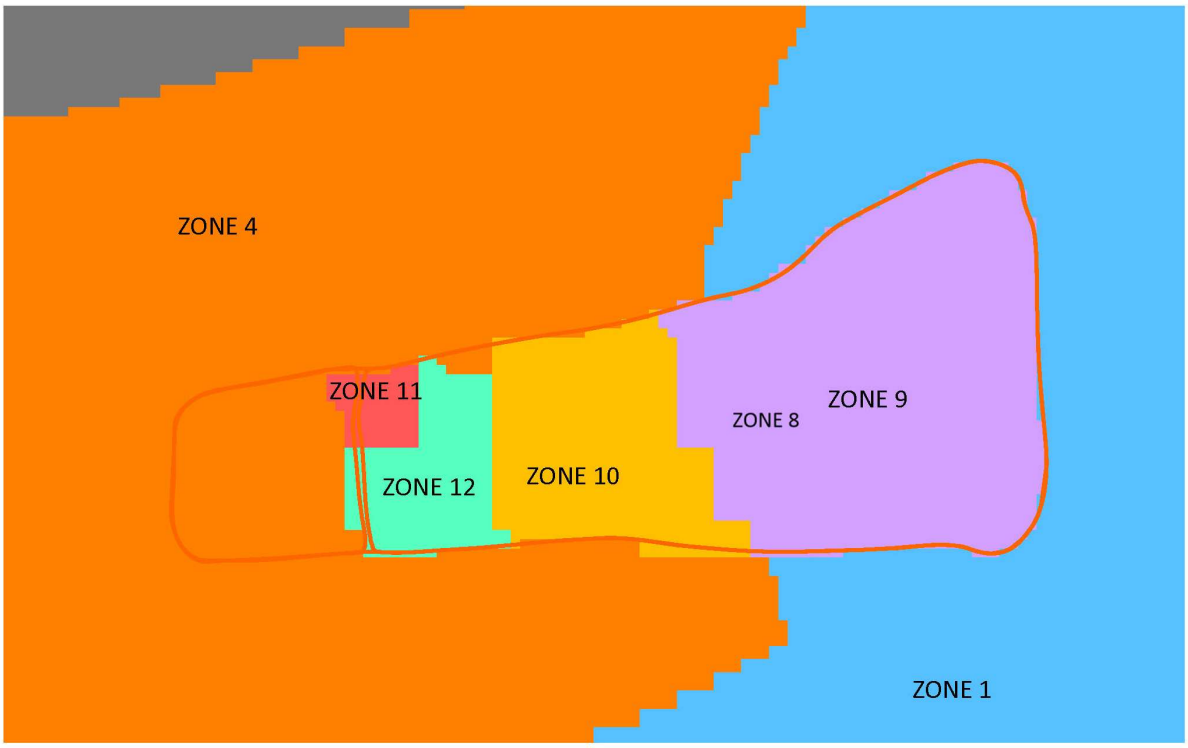
Model Recharge	ft/d	in/yr	Boron Concentration (mg/L)
Sand & River Sand (Zone 1)	1.0E-03	4.4	
Outwash Gravel (Zone 2)	1.0E-03	4.4	
Channel Fill Silts (Zone 4)	5.0E-04	2.2	
Ash-Pond 1 (Zone 9)	3.8E-03	16.8	9.0
Ash-Pond 3 East (Zone 8)	3.0E-03	13.0	9.0
Ash-Pond 3 Center (Zone 10)	3.0E-03	13.0	9.0
Ash-Pond 3 Center (Zone 6)	2.0E-02	87.6	9.0
Ash-Pond 3 West (Zone 12)	2.0E-02	87.6	19.0
Ash-Pond 3 West (Zone 13)	3.0E-03	13.0	19.0
Ash-Pond 3 Northwest (Zone 5)	3.0E-03	13.0	7.0
Ash-Pond 3 Northwest (Zone 11)	2.0E-02	87.6	9.0
Ash-Old West Polishing Pond (Zone 7)	3.0E-03	13.0	7.0

Note: Constant-concentration boundaries specified in model layer 1 are consistent with boron recharge values.

MODEL RECHARGE, TRANSIENT MODEL STRESS PERIOD 2

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL



LEGEND

NO FLOW BOUNDARY (INACTIVE CELLS)

WEST ASH POND SYSTEM POND BOUNDARIES

SCALE IN FEET

0 250 500 750 1000

N

RECHARGE ZONES (ft/d) WITH BORON [mg/L] marked on map

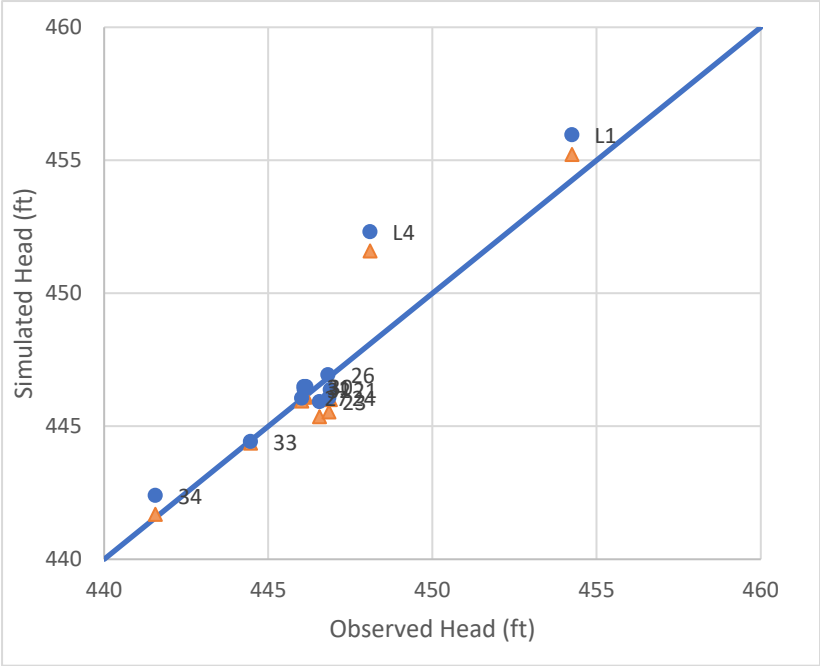
Model Recharge	ft/d	in/yr	Boron Concentration (mg/L)
Sand & River Sand (Zone 1)	1.0E-03	4.4	
Outwash Gravel (Zone 2)	1.0E-03	4.4	
Channel Fill Silts (Zone 4)	5.0E-04	2.2	
Ash-Pond 3 East (Zone 8)	5.6E-07	0.0	9.0
Ash-Pond 3 Center (Zone 10)	5.6E-07	0.0	9.0
Ash-Pond 3 West (Zone 12)	5.6E-07	0.0	19.0
Ash-Pond 3 Northwest (Zone 11)	5.6E-07	0.0	7.0

Note: Constant-concentration boundaries specified in model layer 1 are consistent with boron recharge values.

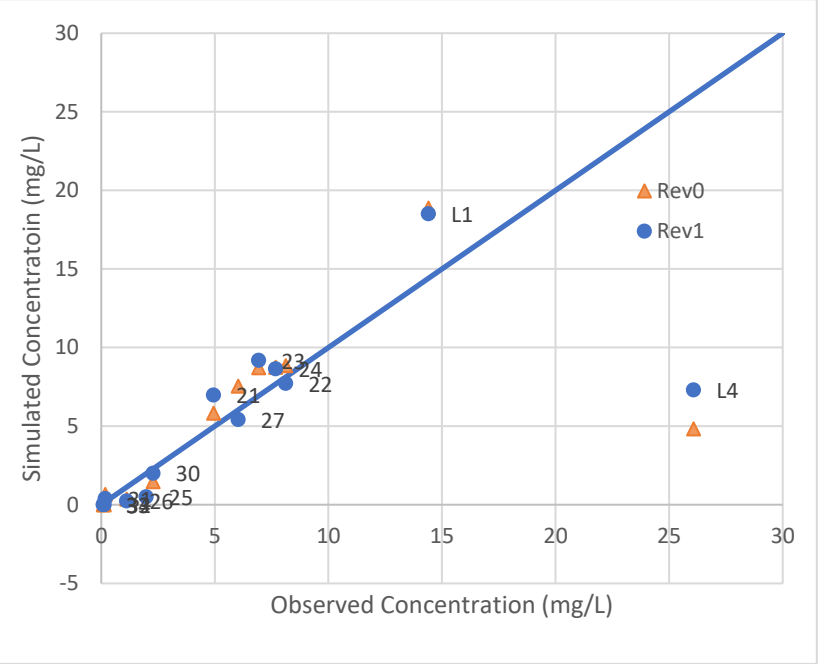
MODEL RECHARGE, TRANSIENT MODEL STRESS PERIOD 3
GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL

Figure 2-13



Flow Model Observed vs Simulated Heads



Transport Model Observed vs Simulated Boron Concentrations

Notes:

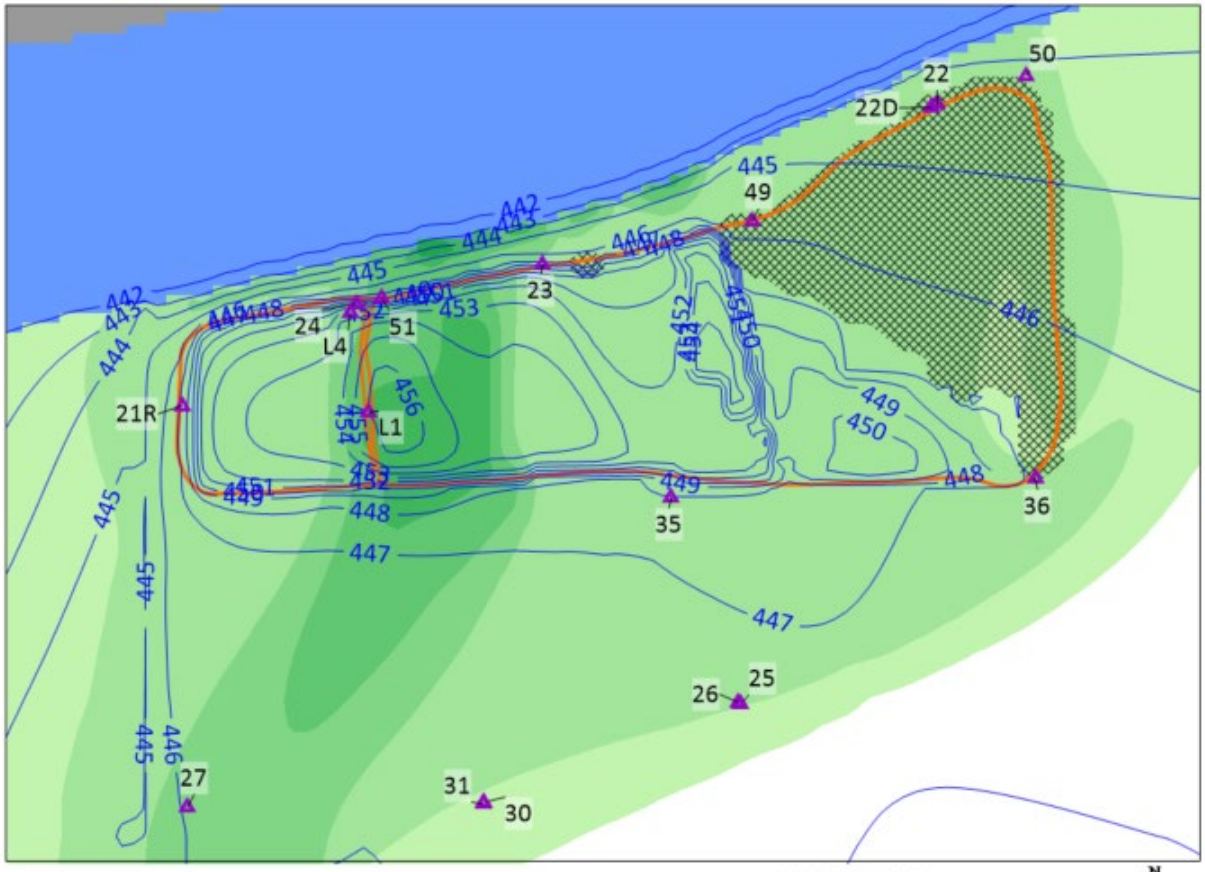
1. The steady-state flow model and paired transport model were calibrated using data collected from 1994-1996, summarized as 1996.

2. Calibration targets (heads and boron concentrations) were preserved from the 2017 model update (Rev0) for this model revision (Rev1)
3. Plots show the 1:1 line for reference (equivalent observed and simulated)

CALIBRATION PLOTS: STEADY-STATE FLOW MODEL / TRANSPORT MODEL
GROUNDWATER MODELING TECHNICAL MEMORANDUM

WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL



LEGEND

- NO FLOW BOUNDARY (INACTIVE CELLS)
- WEST ASH POND SYSTEM POND BOUNDARIES
- ILLINOIS RIVER
- 446 — Simulated groundwater elevation contour (water table, feet)
- 23 Monitoring Well
- Dry Cells (Model Layer 1)

SCALE IN FEET

0 250 500 750 1000

N

SIMULATED BORON CONCENTRATION (mg/L)

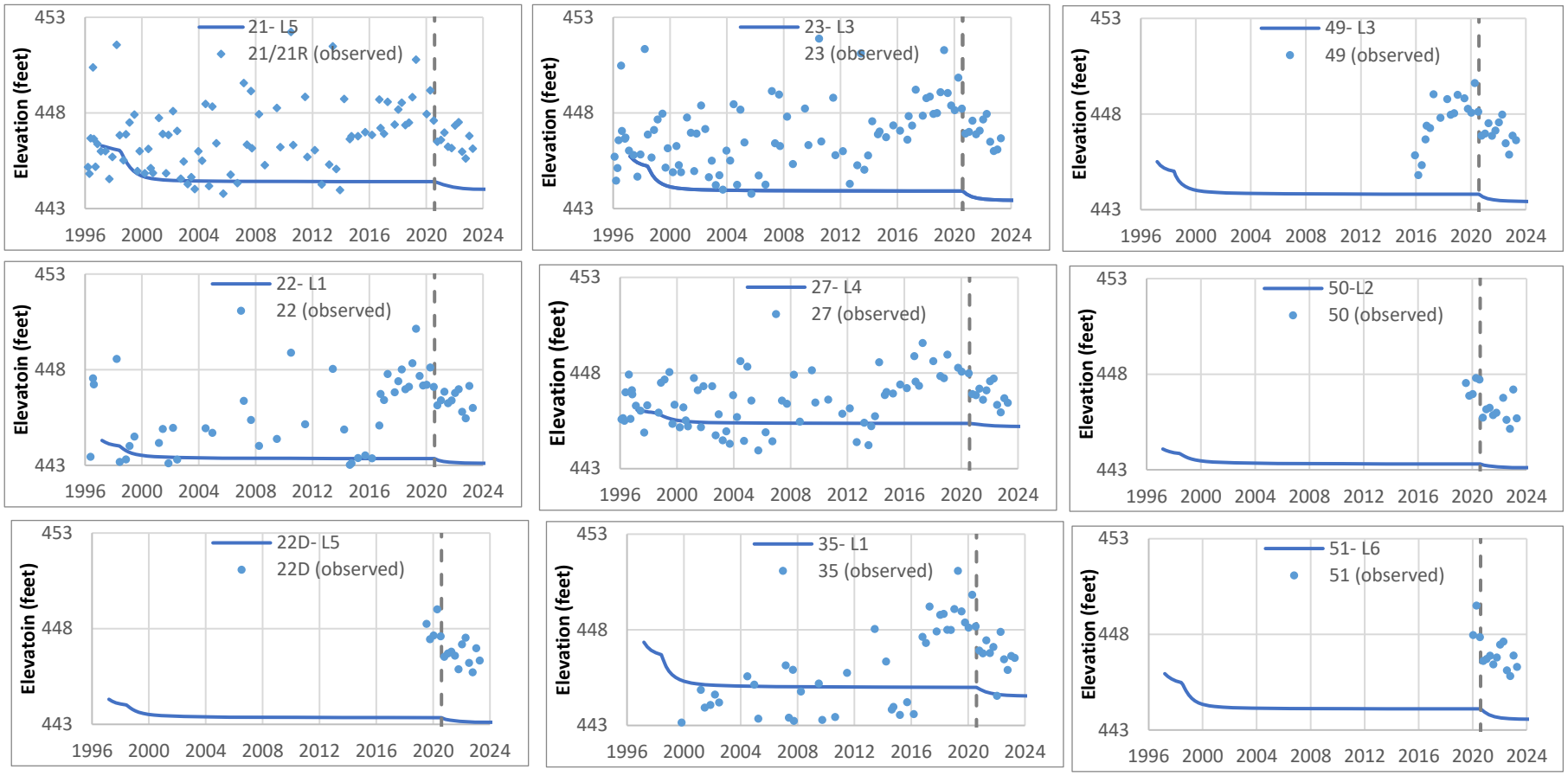
2 6 10 14 18 22 26

Note: Displayed boron concentrations represent the maximum concentration at each location from model layers 1-6.

SIMULATED GROUNDWATER ELEVATIONS AND BORON CONCENTRATIONS, STEADY-STATE FLOW MODEL / TRANSPORT MODEL (1996)
GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL

Figure 2-15

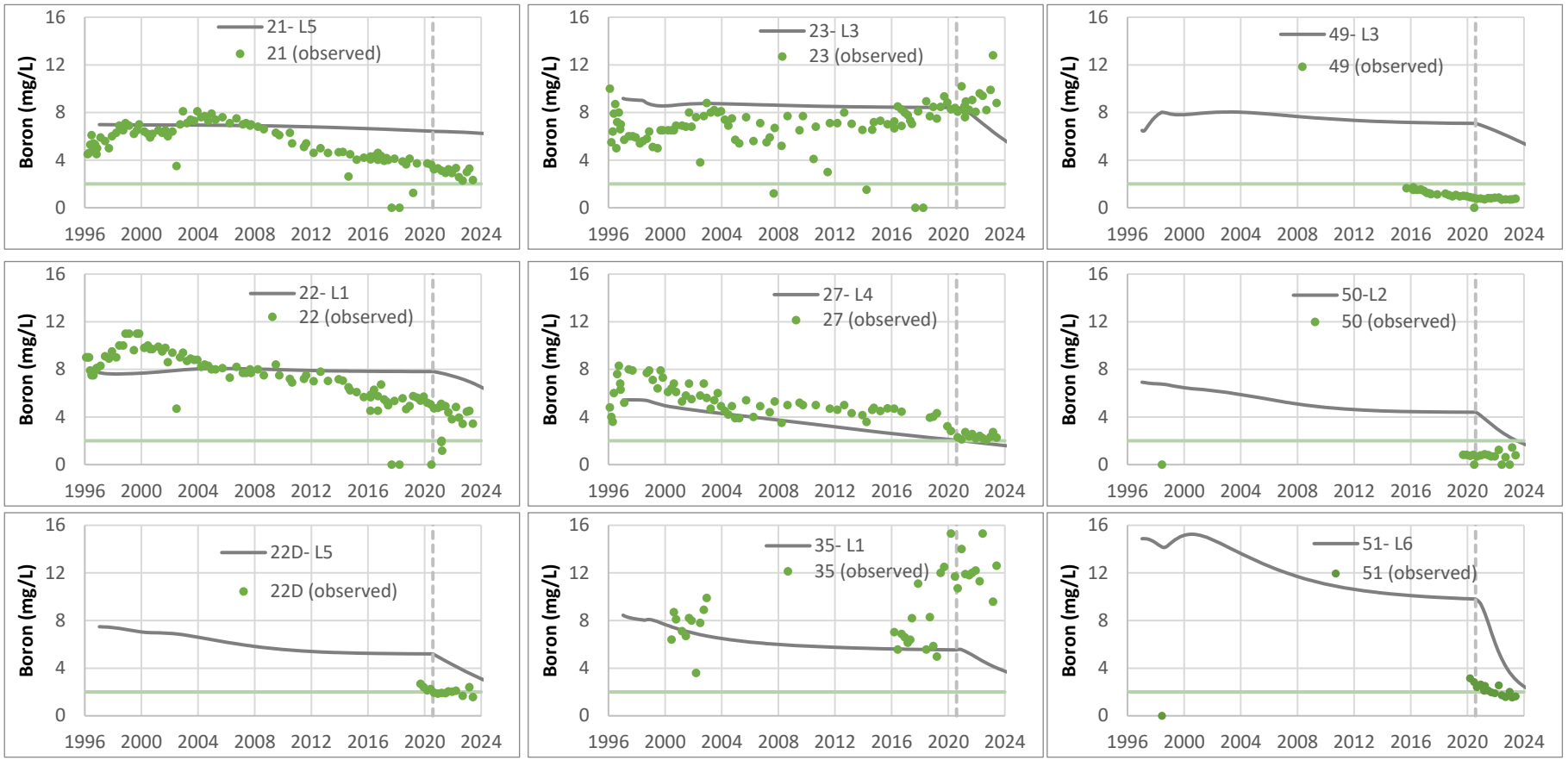


TRANSIENT FLOW MODEL CALIBRATION: OBSERVED VS SIMULATED HEADS (1997-2023)

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL

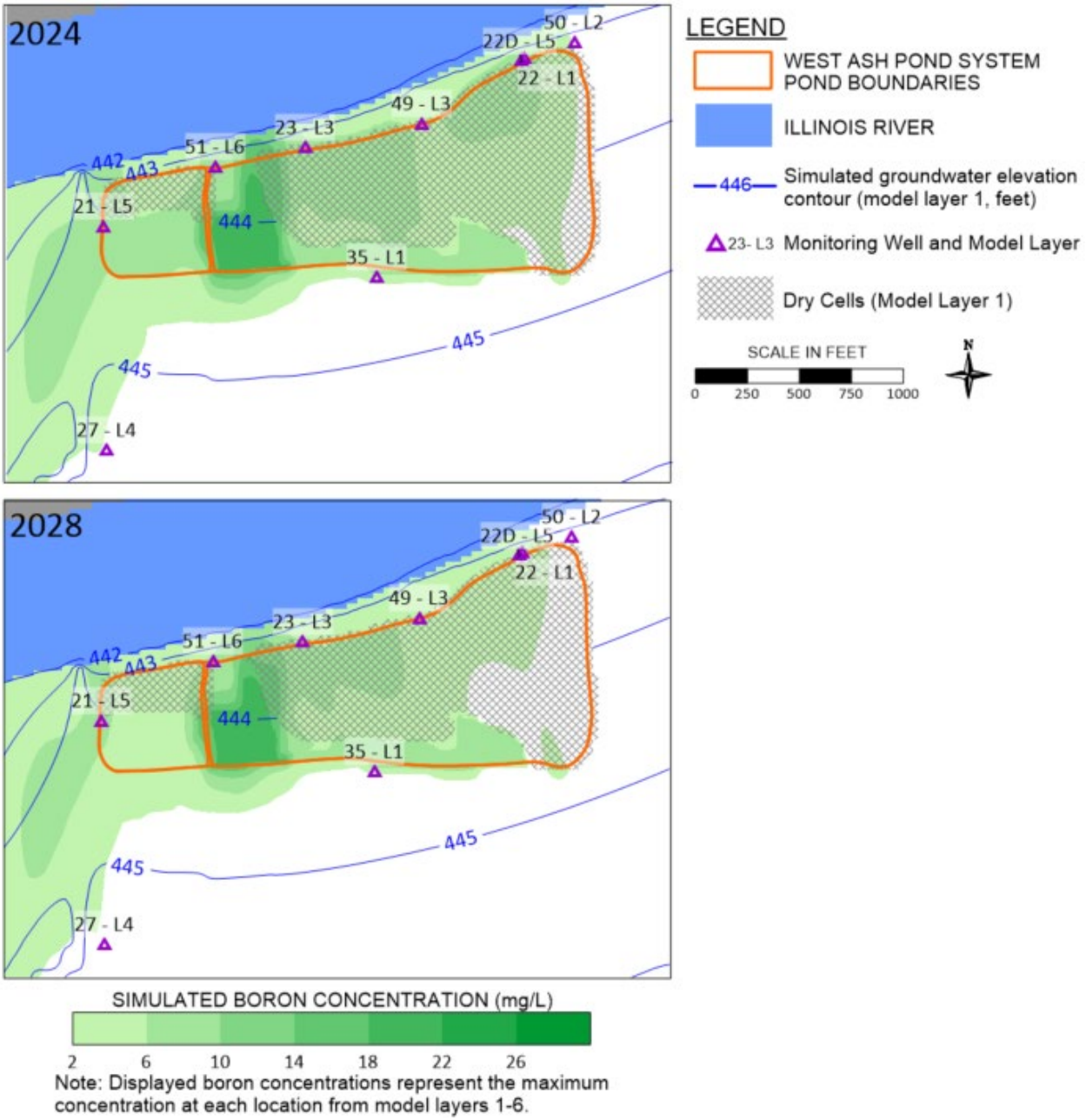
Figure 2-16



TRANSIENT TRANSPORT MODEL CALIBRATION: OBSERVED VS SIMULATED BORON CONCENTRATIONS (1997-2023)

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL



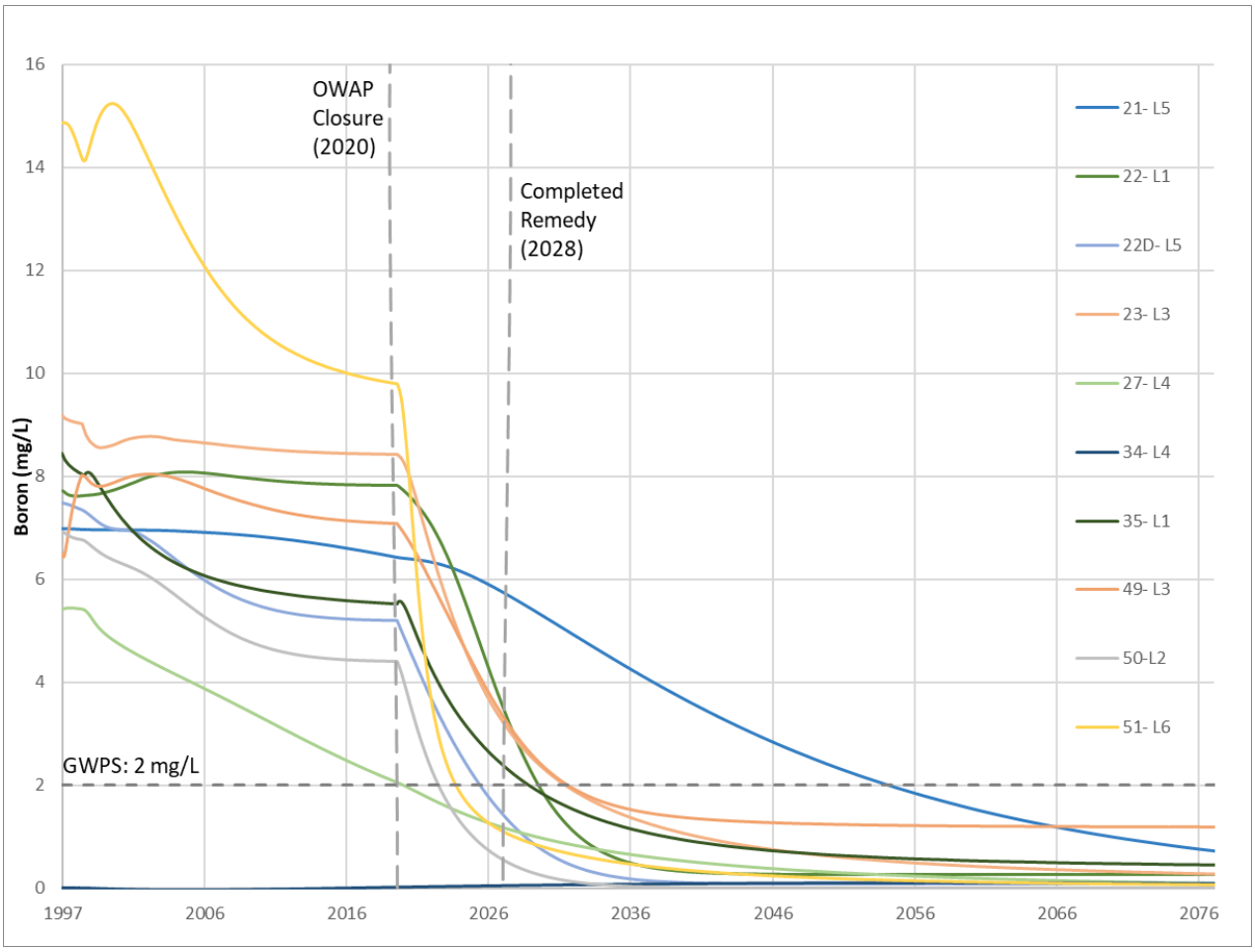
SIMULATED GROUNDWATER ELEVATIONS AND BORON CONCENTRATIONS, 2024 and 2028

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL

FIGURE 3-2

Concentrations of Boron at Site Monitoring Wells, Groundwater Polishing (GWP)



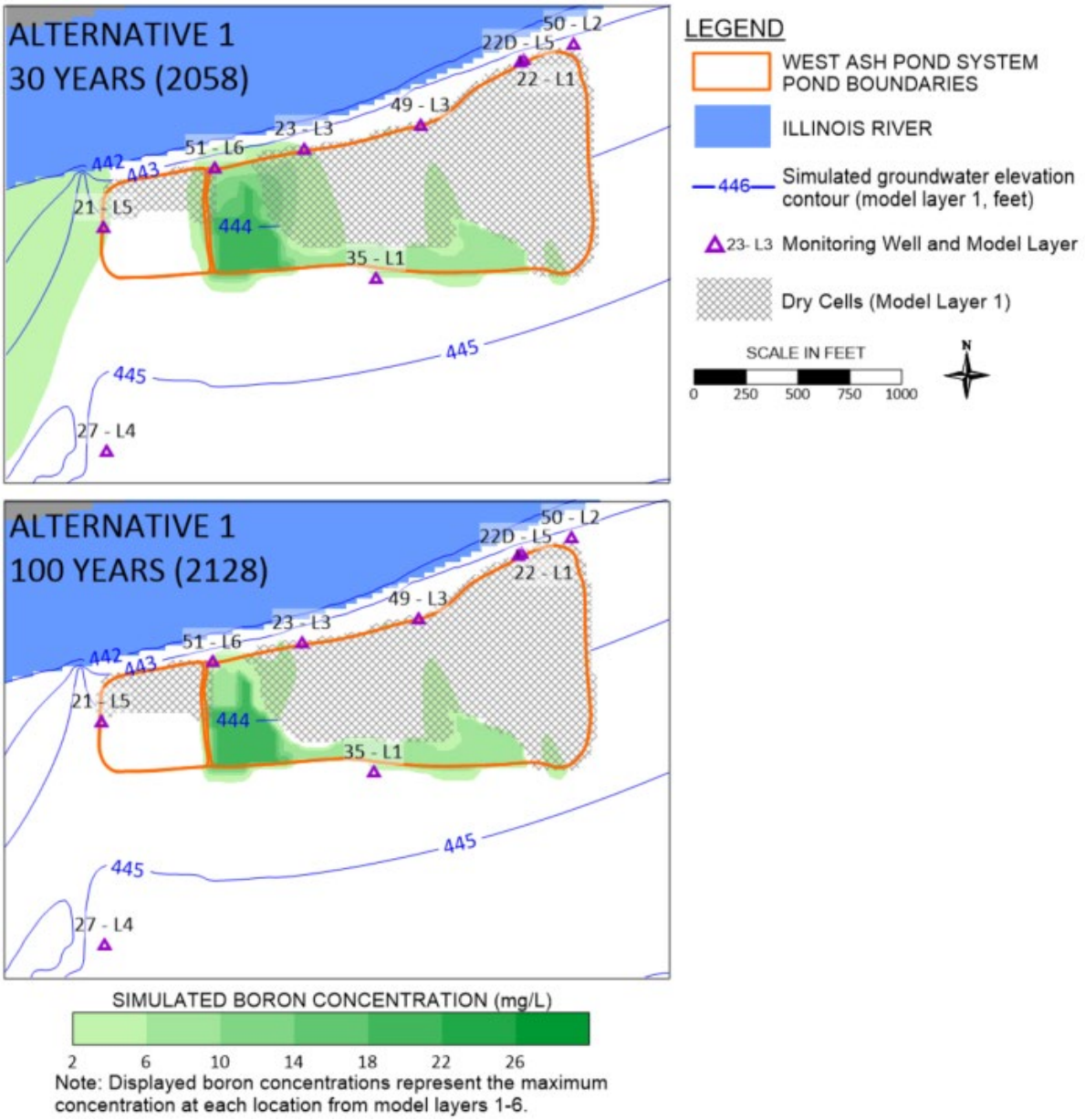
Notes

Concentrations were simulated through 2228, however the chart is truncated at 2078 (50 years following remedy completion) due to decrease of concentrations below GWPS by that time.

SIMULATED BORON CONCENTRATIONS AT COMPLIANCE MONITORING WELLS: ALTERNATIVE 1 (GWP)

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER STATION
HENNEPIN, ILLINOIS

RAMBOLL



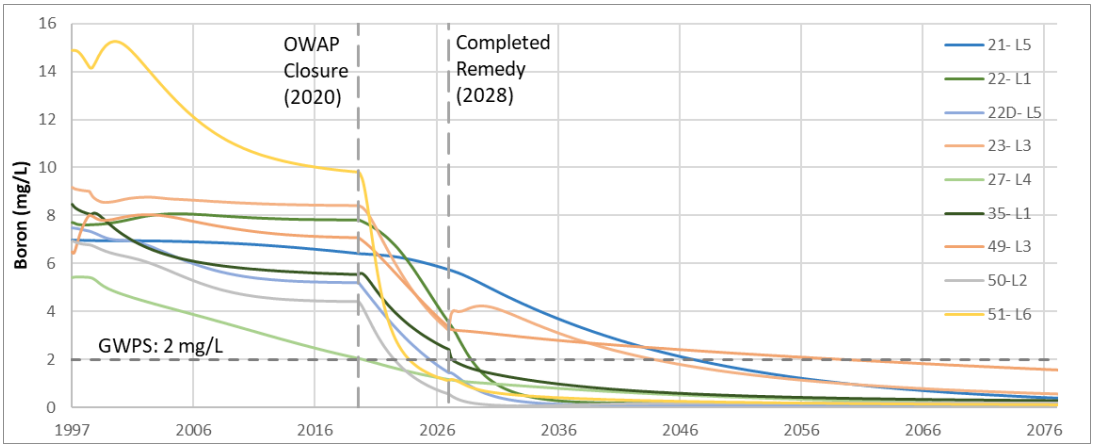
SIMULATED BORON CONCENTRATIONS, 30 AND 100 YEARS, ALTERNATIVE 1 (GWP)

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

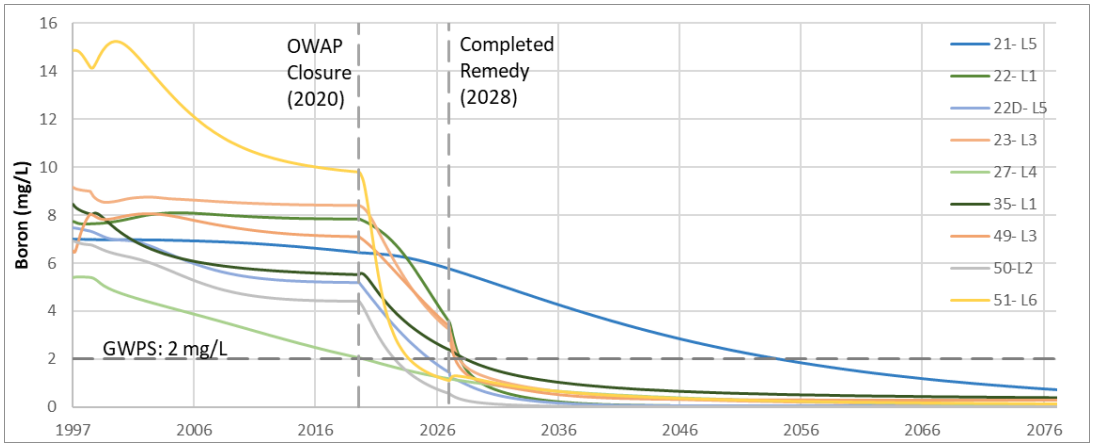
RAMBOLL

FIGURE 3-4

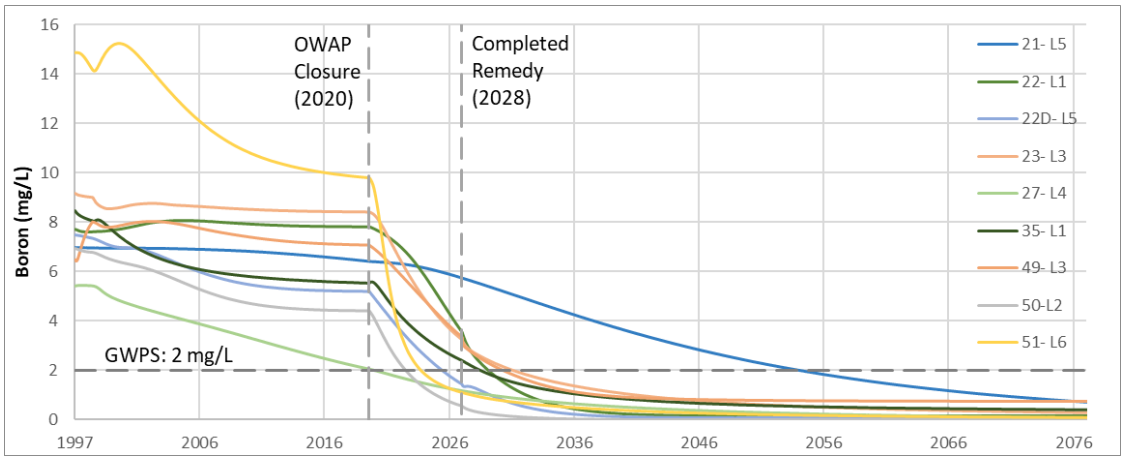
Concentrations of Boron at Site Monitoring Wells, Alternative 2a (Full-Depth Cutoff Wall)



Concentrations of Boron at Site Monitoring Wells, Alternative 2b (Partial-Depth Cutoff Wall)



Concentrations of Boron at Site Monitoring Wells, Alternative 2a (Shallow Cutoff Wall)



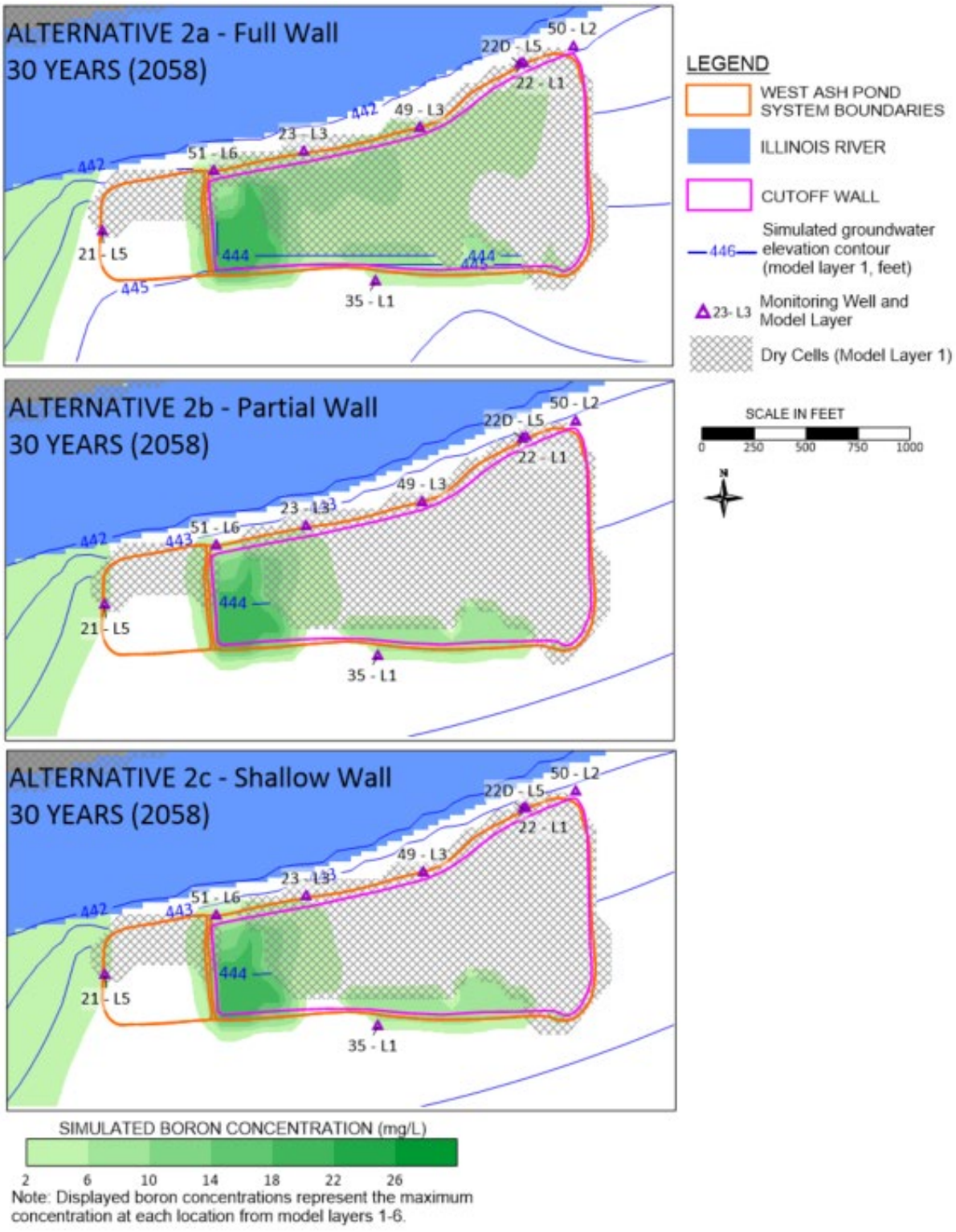
Notes

Concentrations were simulated through 2228, however the chart is truncated at 2078 (50 years following remedy completion) due to decrease of concentrations below GWPS by that time.

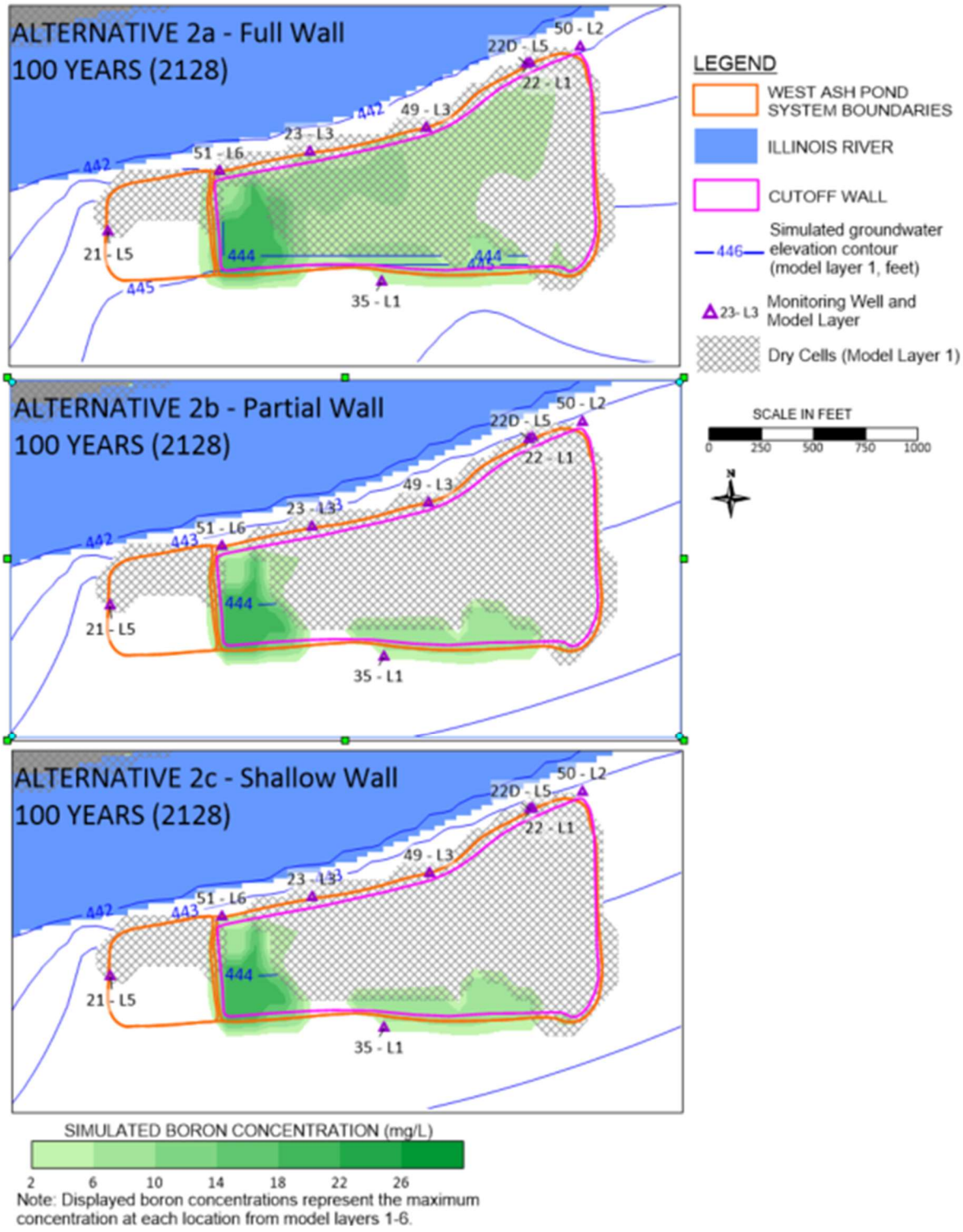
SIMULATED BORON CONCENTRATIONS AT COMPLIANCE MONITORING WELLS: ALTERNATIVES 2a, 2b, 2c (CUTOFF WALLS)

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL



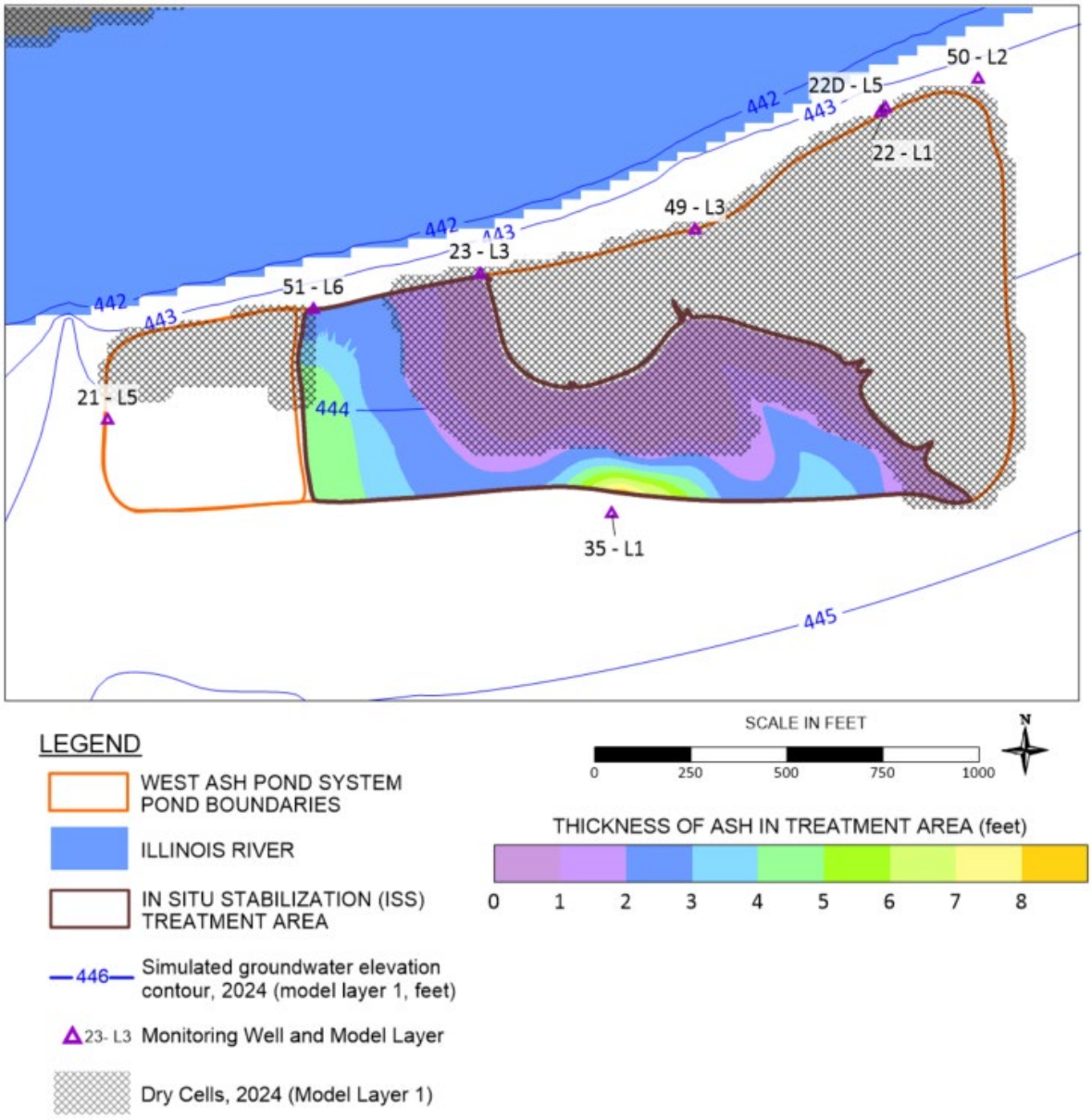
SIMULATED BORON CONCENTRATIONS, 30 YEARS: ALTERNATIVES 2a, 2b, 2c (CUTOFF WALLS)



SIMULATED BORON CONCENTRATIONS, 100 YEARS: ALTERNATIVES 2a, 2b, 2c (CUTOFF WALLS)

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL

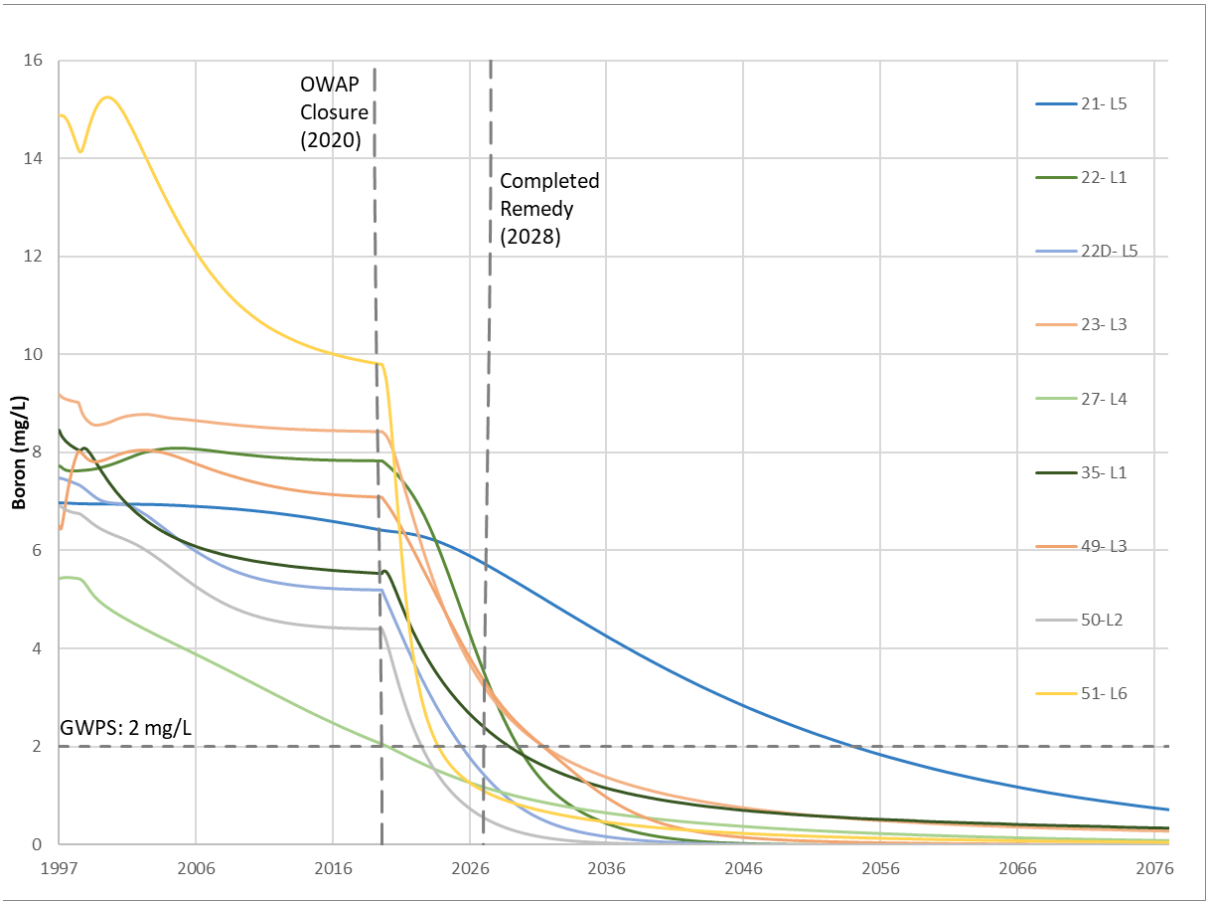


ISS TREATMENT AREA
GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL

FIGURE 3-8

Concentrations of Boron at Site Monitoring Wells, In-Situ Stabilization (ISS)



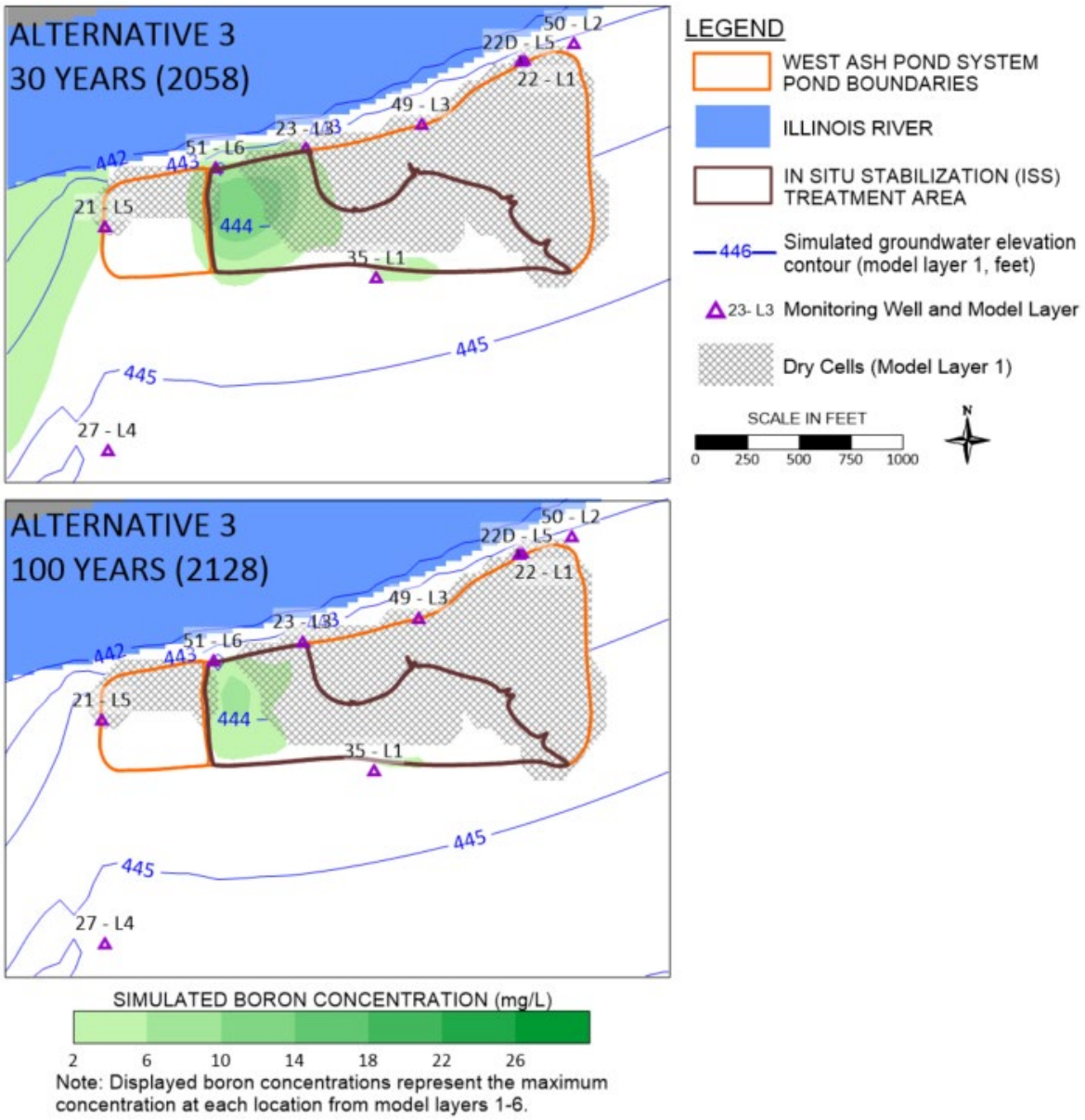
Notes

Concentrations were simulated through 2228, however the chart is truncated at 2078 (50 years following remedy completion) due to decrease of concentrations below GWPS by that time.

SIMULATED BORON CONCENTRATIONS AT COMPLIANCE MONITORING WELLS: ALTERNATIVE 3 (ISS)

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL



SIMULATED BORON CONCENTRATIONS, 30 AND 100 YEARS: ALTERNATIVE 3 (ISS)

GROUNDWATER MODELING TECHNICAL MEMORANDUM
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL

APPENDIX A
MODFLOW AND MT3DMS MODELING FILES

(ELECTRONIC ONLY)

APPENDIX B2
GROUNDWATER MODEL REPORT

OBG

Groundwater Model Report

Hennepin West Ash Pond System

Hennepin, Illinois

Dynegy Midwest Generation, LLC

FINAL

December 20, 2017

Natural Resource Technology

AN OBG COMPANY

DECEMBER 20, 2017 | FINAL | PROJECT #2413

Groundwater Model Report

Hennepin West Ash Pond System
Hennepin, Illinois

Prepared for:

Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

STUART J. CRAVENS, PG
Principal Hydrogeologist

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Data Innovation Engineer

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Appendix A MODFLOW AND MT3DMS MODELING FILES (ON CD)

ACRONYMS AND ABBREVIATIONS

CCR	coal combustion residual
CEC	Civil & Environmental Consultants, Inc.
WAPC	West Ash Pond Complex
DMG	Dynegy Midwest Generation, LLC
in/yr	inches per year
ft	feet
HELP	Hydrologic Evaluation of Landfill Performance
IAC	Illinois Administrative Code
IDNR	Illinois Department of Natural Resources
K_d	distribution coefficient
mg/L	milligrams per liter
mL/g	milliliters per gram
MW	megawatt
NRT	Natural Resource Technology, an OBG Company
WMA	Wildlife Management Area
yr	year

1 INTRODUCTION

1.1 OVERVIEW

This Groundwater Model Report has been prepared by Natural Resource Technology (NRT), an OBG company, on behalf of Dynegy Midwest Generation, LLC (DMG) to document the impact of proposed capping system for closure of the West Ash Pond Complex (WAPC) at the Hennepin Power Station, Hennepin, Illinois (Figure 1-1). The WAPS is located in the northeast quarter of Section 27, Township 33 North, Range 2 West, Putnam County, Illinois. The impoundment is situated less than 200 feet south of the Illinois River, and comprised of the Old West Ash Pond which includes Pond No. 1, Pond No. 3, and the Old West Polishing (Secondary) Pond. It is bordered to the southeast by agricultural fields, to the southwest and west by low lying floodplain within the Donnelley Wildlife Management Area (Donnelley WMA) administered by the Illinois Department of Natural Resources (IDNR) and to the east by the coal pile and power generating facility.

Site hydrogeology, and groundwater quality are summarized in Section 1, and described in detail in a separate *Hydrogeologic Investigation Report* (NRT, 2017b). The Hydrogeologic Investigation Report was completed to summarize data collected to comply with Federal Coal Combustion Residual (CCR) Rule (40 CFR Part 257) as well as comprehensive data collection and evaluations from prior hydrogeologic investigation reports completed at the Site. A Groundwater Monitoring Plan (NRT, 2017c) and a Groundwater Management Zone Application (NRT, 2017d) are also being prepared to support the closure of the WAPS. In addition, Hydrologic Evaluation of Landfill Performance (HELP) modeling has also been conducted to enable estimation of the time required for hydrostatic equilibrium of groundwater to be achieved beneath the WAPS. The HELP modeling also provided percolation rates for existing conditions and predicted cap scenario that were used as inputs in the groundwater flow and transport model. A description of the HELP model inputs and modeling results are found in the Hydrostatic Modeling Report (NRT, 2017a).

Groundwater transport modeling was established to assess the effects of the proposed capping system on surrounding groundwater quality, and is documented in Section 2. The model calibration and prediction results are presented in Sections 3 and 4, respectively. The report is summarized in Section 5.

1.2 BACKGROUND

1.2.1 Site History

The Hennepin Power Station has two coal-fired generating units with a total capacity of 280 megawatts (MW). The units were constructed in 1953 and 1959, respectively. DMG operated the WAPS at the Hennepin Power Station from 1952 until late 1996 when the WAPS was removed from service. All coal ash disposed to the WAPS is derived from Illinois coal.

The impoundment consists of the Old West Ash Pond (Figure 1-1) including Pond No. 1 (9.3 acres), at the eastern end of the impoundment, which primarily contains bottom ash and slag and Pond No. 3 (16.4 acres), in the central portion of the impoundment, which contains mixed coal ash. The Old West Polishing Pond (4.7 acres) is located at the western end of the impoundment. The berms, which are 15 feet above grade, were constructed from locally occurring sandy soils. Top of ash elevation in all three ponds is lower than the surrounding berms, providing full containment. There are no controls to collect storm water, so all runoff collects in the lowest portion of each pond, where it evaporates or infiltrates through the ash.

During operation, service water was used to sluice fly ash, bottom ash, and low-volume wastes to the impoundment. There was initially a surface water discharge from this impoundment; however, that discharge stopped after the impoundment was reworked in 1989. At the time the impoundment was removed from service in late 1996, there was no surface water discharge and all sluice water exfiltrated via evapotranspiration, seepage through the berms, or leakage through the base of the ponds. The ash is currently dry over most of the surface through most of the year with the exception of: (1) the Old West Polishing Pond, which always contains water; and, (2) within the Old West Ash Pond on the western end of Pond No. 3, where runoff water collects and is ponded most of the year.

1.2.2 Site Hydrogeology

Four principal stratigraphic layers (from top to bottom) encountered at the WAPS and adjacent areas are:

- Fill - coal combustion residuals (CCRs) consisting primarily of fly ash with lesser amounts of bottom ash and slag. This layer also includes the constructed fill berms around the ash ponds, which contain variable admixtures of CCRs and re-worked native silt, clay and sand.
- Alluvial fine grained silts and clays, classified as Cahokia Alluvium.
- Alluvial fine to medium sands.
- Sand and gravel with boulders, deposited by glacial meltwaters and classified as Henry Formation.

The river-laid deposits are classified as Cahokia Alluvium. The Henry Formation sands and gravels make up the upper and lower terraces, and fill the valley beneath the alluvium. A fifth stratigraphic layer (Layer 5) – loamy and sandy diamicton (i.e., till) of the Wedron or Glasford Formation – was encountered at one location (Boring 32) approximately 2,560 feet (½ mile) south of the western end of the impoundment; however, this layer is not significant to the hydrogeology at the impoundment.

The stratigraphy of unlithified materials underlying the Henry Formation is uncertain, but it is assumed based on nearby borings at the power plant, East Ash Pond System, and vicinity that the Henry Formation most likely sits directly on top of bedrock near the WAPS. However, based on the identification of till approximately ½ mile south of the impoundment, it is possible that till of the Wedron or Glasford Formation or an older sand formation, the Sankoty Sand, lies between the Henry Formation and bedrock.

The uppermost bedrock near the Hennepin Power Station, including the West Ash Pond Complex, is the Pennsylvanian Carbondale Formation, which consists of shale with thin limestone, sandstone, and coal beds. Three deeper borings around the perimeter of the East Ash Pond System indicate the presence of shale bedrock between elevations 400 and 410. Water well logs at the power plant indicate shale bedrock at an elevation of roughly 350.

The WAPS lies over both glacial deposits (Henry Formation) and alluvium (Cahokia Alluvium). The Old West Ash Pond, specifically Pond No. 1 lies on top of lower terrace glacial sand and gravel deposits, the eastern portion of Pond No. 3 overlies alluvial sand, while the western portion of Pond No. 3 and the Old West Polishing Pond overlay silty clay alluvial channel fill deposits. More details are presented in the *Hydrogeologic Investigation Report* (NRT, 2017b).

Monitoring wells installed at the West Ash Pond System are shown on Figure 1-2. Groundwater elevation data is available beginning in 1993. The Illinois River is the local and regional groundwater discharge area under normal river stage. River stage is usually lowest during the months of August through October. The river basin experiences annual spring flooding during the months of March, April, May, and sometimes June, while lesser flooding occasionally occurs during autumn. River stage during high precipitation and/or flood events seasonally rises above adjacent groundwater elevations and in low lying areas of the floodplain, particularly within the Donnelley WMA at wells 32, 33, and 34. Horizontal hydraulic gradients from the West Ash Pond Complex to off-site areas ranges from 0.001 foot per foot (ft/ft) during Illinois River flood stage to about 0.005 ft/ft during normal river stage, yielding a groundwater velocity ranging from 0.1 ft/day to 1.1 ft/day.

1.2.3 Groundwater Quality

Groundwater monitoring was performed for selected analytes in 1983, but consistent data collection began in 1996. The monitoring program in 2016 included the full list of inorganic and organic parameters listed in IAC 35 Part 620 Section 410 except for radium 224/226. The most recent data and analysis were submitted in the 2016 Closure Work Plan Annual Report (NRT, 2016).

Parameters that have historically (1996 to 2016) exceeded Class I groundwater standards include boron, iron, manganese and sulfate. Additional parameters that exceeded Class I Standards during the expanded monitoring

performed for the hydrogeologic investigation from June 2013 through March 2014 were arsenic, selenium, nitrate and lead but none of them were attributed to the WAPS.

1.3 CONCEPTUAL MODEL

The WAPS overlays alluvium, and outwash deposits in the Illinois River valley. The principal stratigraphic layers encountered at the WAPS and adjacent areas (from top to bottom) are coal combustion residuals (CCRs) consisting primarily of fly ash with lesser amounts of bottom ash and slag, alluvial fine grained silts and clays classified as Cahokia Alluvium, alluvial fine to medium sands as well as sand and gravel with boulders, deposited by glacial meltwaters which are classified as Henry formation. The primary directions of groundwater flow are north and west, with discharge to the Illinois River – a regional groundwater sink. There are two sources of water: natural recharge within the model domain; and, recharge (percolation) through the impoundment.

Boron was modeled because it is a primary indicator of coal ash leachate, exceeds the Class I standard, is mobile in groundwater, and is more representative of coal ash leachate than sulfate, which may originate from other anthropogenic or natural sources. The monitoring network of boron observations is shown in Figure 1-2. The conceptual model for transport assumes two boron sources: boron that leaches to recharge water during percolation through ash above the water table; and boron that leaches to groundwater as it flows through ash below the water table. Therefore, mass is added to groundwater via vertical recharge through coal ash, and horizontal groundwater flow through coal ash where it lies below the water table. Mass is discharged at the model representation of the Illinois River. The conceptual transport model assumes that boron concentration in leachate does not vary as a function of time, although the volume of leachate decreases over time as a function of pond dewatering and capping. There is no removal of mass from the groundwater system via adsorption or decay.

2 MODEL ESTABLISHMENT

2.1 MODEL BACKGROUND

The 2017 model is an update to, and was derived from, a model developed for the WAPS in 2014 (NRT, 2014). Updates made to this 2017 model include the following:

- The transient calibration period was extended through December 2016 to incorporate all available monitoring data.
- The WAPS ash thickness was re-assessed during a geological investigation conducted by Civil & Environmental Consultants, Inc. (CEC) in March, 2017. Accordingly, the bottom elevations of model Layer 1 at the WAPS location were adjusted to reflect the new data.
- The bottom elevations of model Layer 1 were also adjusted to meet model convergence criteria. One additional layer was inserted beneath Layer 1 to maintain the geological layering in the model.
- The hydraulic conductivities of coal ash, silt and sand were revised to improve calibration results. The updated values of coal ash and silt are close to laboratory conductivity measurements performed by AECOM in December, 2015.
- The river stage was revised to improve calibration results.
- Newly installed monitoring well MW-49 (built in 2016) was added to the monitoring network.
- The recalibrated model was then used to simulate the closure scenario, which was modeled over a period of 200 years, beginning in Year 2017.

2.2 MODEL APPROACH

Three modeling codes were used to model groundwater flow and contaminant transport: 1) percolation through the cap system was modeled using the Hydrologic Evaluation of Landfill Performance (HELP) model. All details regarding closure configurations and HELP model establishment are presented in a separate Hydrostatic Equilibrium Report (NRT, 2017a); 2) groundwater flow was modeled in three dimensions using MODFLOW; and, 3) contaminant transport was modeled in three dimensions using MT3DMS.

A three-dimensional groundwater flow and transport model was established to represent the conceptual flow system described above and then calibrated to match the groundwater monitoring results since 1994. The model was calibrated in four stages:

1. Stage 1: A steady-state flow model was calibrated to approximate head distributions observed while the impoundment was in service, based on median heads observed from 1994 through 1996.

2. Stage 2: The steady state transport model was calibrated to approximate concentrations observed while the impoundment was in service, based on observations from 1994 through 1996.

3. Stage 3: The steady state flow model was converted to a transient flow model and calibrated to match the decreasing heads measured after the impoundment was removed from service. The model period was December 1996 through December 2016 (Transient model stress periods 1 and 2).

4. Stage 4: The transport model was calibrated to approximate boron concentration trends observed since the impoundment was removed from service, using heads from the transient flow calibration model. The model period was December 1996 through December 2016 (Transient model stress periods 1 and 2).

Each subsequent calibration stage required changes to and recalibration of previous stages. The results provide a representative simulation of groundwater flow and transport conditions near the WAPS. The calibrated model was then used as a starting point to predict changes in boron concentrations over a transport period of 200 years under a baseline scenario and a closure configuration:

- Baseline: assumes no action is undertaken.
- Closure Configuration: Old West Polishing Pond is removed. Old West Ash Pond (Pond No. 1 and Pond No. 3) are fully capped by a geomembrane cover, comprised of (from top to bottom) 6-inch vegetative layer, 18-inch protective soil layer, a 0.2-inch geocomposite drainage layer and a 40-mil geomembrane layer.

Two transient stress periods (periods 3 and 4) were added at the end of the transient calibration model to simulate groundwater flow and transport after the capping system was completed (prediction modeling stress periods). The HELP model results (NRT, 2017a) indicated it would take seven years for percolation rates through the cover and CCR material to stabilize (reach equilibrium) after completion of the capping system. Therefore, transient stress period 3 was used for Years 2017 to 2024 to simulate dewatering of the material below the cap and stress period 4 was used to simulate the stabilized percolation rate for the remaining period of 193 years.

2.3 MODEL DESCRIPTION

MODFLOW uses a finite difference approximation to solve a three-dimensional head distribution in a transient, multi-layer, heterogeneous, anisotropic, variable-gradient, variable-thickness, confined or unconfined flow system. User-supplied inputs are hydraulic conductivity, aquifer/layer thickness, recharge, wells and boundary conditions. The program also calculates water balance at wells, rivers and drains.

MODFLOW was developed by the United States Geological Survey (McDonald and Harbaugh, 1988) and has been updated several times since. Major assumptions of the code are: 1) groundwater flow is governed by Darcy's law; 2) the formation behaves as a continuous porous medium; 3) flow is not affected by chemical, temperature, or density gradients; and 4) hydraulic properties are constant within a grid cell. Other assumptions concerning the finite difference equation can be found in McDonald and Harbaugh (1988).

MT3DMS (Zheng and Wang, 1998) is an update of MT3D. It calculates concentration distribution for a single dissolved solute as a function of time and space. Concentration is distributed over a three-dimensional, non-uniform, transient flow field. Solute mass may be input at discrete points (wells, drains, river nodes, constant head cells), or distributed evenly or unevenly over the land surface (recharge).

MT3DMS accounts for advection, dispersion, diffusion, first-order decay and sorption. Sorption can be calculated using linear, Freundlich, or Langmuir isotherms. First-order decay terms may be differentiated for the adsorbed and dissolved phases.

The program uses the standard finite difference method, the particle-tracking-based Eulerian-Lagrangian methods and the higher-order finite-volume TVD method for the solution schemes. The finite difference solution can be prone to numerical dispersion for low-dispersivity transport scenarios, and the particle-tracking method has problems in conserving mass-balance. The TVD solution is not subject to numerical dispersion and conserves mass well, but is computationally intensive. For this modeling, the TVD solution was used.

Major assumptions are: 1) changes in the concentration field do not affect the flow field; 2) changes in the concentration of one solute do not affect the concentration of another solute; 3) chemical and hydraulic properties are constant within a grid cell; and 4) sorption is instantaneous and fully reversible, while decay is not reversible.

2.4 MODEL SETUP

2.4.1 Grid and Boundary Conditions

A six layer, 63 by 79 node grid, was established with variable grid spacing ranging from 100 feet to 200 feet (Figure 2-1). The largest node spacing was upgradient at the lateral model boundary, and the finest node spacing was near the impoundment.

Flow and transport boundaries were the same for all scenarios. The upgradient (east and south) edge of the model was a no-flow boundary (Figure 2-1). The downgradient (north) and lateral (west) boundaries were

either MODFLOW river (Mixed) boundaries (layer 1) or no flow (layers 2-5). Pond No. 1 (Layer 1) was set as no flow condition to ensure the ash remained unsaturated during model simulations. The upper boundary was a time-dependent specified flux (Neumann) boundary, with specified flux rates equal to the recharge rate or the rate of percolation from the impoundment.

The model included two types of transport boundaries (constant concentration and recharge), both in layer 1 (Figure 2-2). Saturated ash areas were represented by constant concentration boundaries. All water passing through these boundaries was assigned a specified concentration representative of ash leachate concentration. The base elevation of nodes representing saturated ash was set to represent depth of ash borings observed in the field. In addition, recharge water in areas overlain by ash was assigned a specified concentration, and the concentration in the underlying node was a result of mixing the recharge flux with the flux passing laterally through the node (unless that node was a saturated ash area, in which case all water passing through was assigned the maximum observed leachate concentration by the constant concentration boundary cell).

2.4.2 Flow Model Input Values and Sensitivity

Flow model input values and results of sensitivity analyses are listed in Table 2-1 and described below.

Layer Top/Bottom

The top of layer 1 was the water table, therefore the elevation of model layer 1 was set at 460 feet, a value higher than the maximum water table elevation (in the impoundment). The top of layers 2 through 6 were set to the base of the overlying layer. The saturated thickness of layer 1 depended on modeled water table elevation. The base of layer 1 at the WAPS was set as the bottom of coal ash elevations and the bottom elevation of the surrounding cells were adjusted to meet the model convergence criteria (Figure 2-3). The base of layer 2 was set at 430 feet and each underlying layer (Layer 3 to Layer 6) was 10 feet thick.

Hydraulic Conductivity

Hydraulic conductivity values (Figure 2-4) were initially derived from field-measured and laboratory tested values and adjusted during calibration. Calibrated values were within observed ranges for the formations present at the site. Vertical anisotropy ratios were set at 2.0 for the sand and gravel and 10 for the silty clay and alluvium. The Kx/Kz ratios represent expected stratification within the formations.

The model had moderate to high sensitivity to the horizontal hydraulic conductivity used over most of the domain. Sensitivity to vertical hydraulic conductivity varied, with the low permeability zones being most sensitive.

Storage

No field data was available defining these terms, so representative values for similar materials were obtained from Smith and Wheatcraft (1993). Sensitivity analysis was not performed on this parameter. The storage coefficient used in the model was 0.01 and the specific yield was 0.30.

Recharge

Recharge rates for the impoundment while in-service and during dewatering were determined during model calibration. Recharge rates for the model domain were adopted from the previous 2014 model and were adjusted during calibration. Recharge zones during the transient calibration period are illustrated in Figure 2-5. Recharge rates after cap completion were set based on the HELP simulations and shown in Figure 2-6. Transient stress period 3 was used for Years 2017 to 2024 to simulate dewatering of the material below the cap. Transient stress period 4 was used to simulate the stabilized percolation rate for the remaining period of 193 years.

Calibrated heads were highly sensitive to changes in recharge rates in zones 5, 6, and 7 of Ash Pond 3 and the outwash gravel (Zone 2). The flow model displayed low to moderate sensitivity to the other recharge zones in the model.

River Parameters

The Illinois River was represented by head-dependent flux nodes that required inputs for river stage, width, bed thickness and bed hydraulic conductivity. The latter three parameters are used to calculate a conductance term for the boundary node. This conductance term was determined by adjusting hydraulic conductivity during model calibration. For simplicity, it was assumed that river stage does not fluctuate and that river gradient is negligible along the reach modeled. In addition, the waterfowl ponds and a small creek that feeds the waterfowl ponds were simulated using MODFLOW river nodes (Figure 2-1).

Sensitivity analysis showed that the model was highly sensitive to river stage, and insensitive to conductance values.

2.4.3 Transport Model Input Values and Sensitivity

Transport model input values are listed in Table 2-2 and described below. The results of sensitivity analyses are also presented in Table 2-2.

Initial Concentration

Initial concentration for the steady state calibration model was set at zero, implying a background concentration of zero, which is reasonable for boron. The final concentrations from the steady state calibration model were used as the initial concentration for the transient calibration model. The prediction model was built by adding two transient stress periods to the transient calibration model as discussed above. The transient calibration model is stress periods 1 and 2, the dewatering phase of the prediction model is stress period 3, and the hydrostatic equilibrium phase of the prediction model is stress period 4.

Source Concentration

Boron source concentrations (from saturated ash) were set during model calibration at values between 7 and 19 mg/L, the range observed in monitoring wells near the impoundment. The setting of source concentration is consistent with the 2014 model. As mentioned in Section 2.4.1, Pond No. 1 (Layer 1) was set as no flow condition instead of a constant concentration boundary to simulate unsaturated ash observed at Pond No. 1. Source concentration originating from Pond No. 1 (leachate percolating through the unsaturated ash) was simulated by applying concentration to the recharge zone above the no flow cells, which was then applied to the highest active layer (Layer 2). Using a combination of no flow cells and recharge inputs for simulating Pond No. 1 ensures the only source concentration entering the model from Pond No. 1 is in the form of leachate through the base of the unsaturated ash.

Since clean closure will be applied to the Old West Polishing pond, the source concentration at the Old West Polishing pond was set as zero during stress periods 3 and 4 (Figure 2-7).

Boron source concentrations from recharge were also determined during model calibration (Table 2-2) and remained the same during the prediction stress periods 3 and 4. The recharge rates were reduced as discussed above.

Effective Porosity

Effective porosity values were based on ranges provided by Mercer and Waddell (1993). Predicted concentrations at some wells distant from the impoundment (wells 26, 30, 31) had moderate sensitivity to this parameter (Table 2-2).

Dispersivity

Dispersivity was set during model calibration. Transverse and vertical dispersion were estimated according to ratios developed by Gelhar et al. (1985). Calibrated concentrations at some wells distant from the impoundment (wells 26, 30, 31, 36) were highly sensitive to the longitudinal dispersivity value and to the vertical dispersivity multiplier, while calibrated concentrations were not sensitive to the transverse dispersivity multiplier.

Retardation

Retardation was calculated by the model based on the distribution coefficient (K_d), which was set during calibration. Concentration match was best when K_d was set at zero for the sand and gravel units, and at 1.0 mL/g in the silty units (channel-fill deposit and alluvium) (Figure 2-8). The K_d value of 1.0 mL/g resulted in a retardation factor of 9.0 in the silt units. Calibrated concentrations at wells distant from the impoundment (wells 26, 27, 30, 31, 36) were highly sensitive to the K_d value modeled for the sand units, while the model exhibited low sensitivity to the range of K_d values tested for the silt units.

Diffusion

Diffusion was also set to 0 for the entire model domain.

3 MODEL RESULTS

3.1 Flow and Transport Model Assumptions and Limitations

Simplifying assumptions are necessary when numerically representing the natural environment in a groundwater flow and transport model. Outside of assumptions inherent to the codes used to develop the model, several simplifying assumptions were made, including:

- Leachate instantaneously migrates to groundwater (e.g., rapid migration through the unsaturated zone).
- Fluctuations in river stage are short in duration and do not affect groundwater flow and transport.
- Recharge rate outside the impoundment is constant over time.
- Source concentrations remain constant over time.
- Boron minimally adsorbs and does not decay, and mixing and dispersion are the primary attenuation mechanisms.
- Cap construction has an instantaneous effect on recharge and percolation because it is constructed over a brief period relative to the length of the model simulation.

The model is limited by the data used for calibration, which adequately define the local groundwater flow system and the source and extent of the plume. These data, collected from 1994 through 2016, are from points near the WAPC. Model predictions of transport distant from the impoundment will not be as reliable as predictions of transport near the impoundment, and the reliability of model predictions decreases with increasing time because changes to the system may occur that the model does not account for.

3.2 Calibration Flow and Transport Model Results

Results of the MODFLOW/MT3DMS modeling are presented below. A CD containing the model files is attached to this report (Appendix A).

Figure 3-1 compares modeled versus observed steady-state heads for the period while the impoundment was in service. Figure 3-2 compares modeled versus observed heads for the period 1994 through 2016 at Wells 21, 22, 23, 24, 25/26, 27, 30, 31, 32, 33, 34, 35, 36, L1, L4 and 49. Modeled heads at all monitoring wells fall within the range of observed values. The modeled and observed heads demonstrate a linear trend that falls just above the ideal 1 to 1 line, which indicates the calibrated groundwater elevations are slightly higher than observed but adequately represent the calibration data across the range of observed values. The graph of observed values and calibration residuals indicates most of the residuals are negative, which also suggests the steady state model results are biased a little high. However, the data have a good degree of scatter, indicating the model is not biased across the range of elevations observed. The relative standard deviation, given as a percentage of standard deviation to data mean, was determined to be 7.1%, which is within the acceptable target of less than 10%. This statistical result is strong evidence of the steady state model's ability to simulate flow within the range of groundwater elevations observed. Modeled heads in the transient model follow observed trends observed from 1997 through 2016, and successfully capture the hydraulic head drops after the impoundments were removed from service (Figure 3-2). The consistency between observable data and modeling results indicate that this model provides a reasonable simulation of the effects of the WAPS on groundwater flow.

The simulated boron concentration trends are compared to observed data in Figure 3-3. The simulated boron concentrations reasonably match the observed concentrations. For example, the transport model exhibits a successful simulation of the short-term concentration increase at Well 24 between 1998 and 2000, and captures the decreasing concentration trends at wells 22, 24, 25/26, 27, 30 and 31 after removing the impoundment from service (well locations are shown on Figure 1-2). It also predicts no decrease in concentration relative to initial conditions at wells 21 and 23. The model made conservative simulations of boron concentration at Well 24 after Year 2009 and at Well 49, which was installed in 2015 and has limited data. The agreement between modeled

and predicted concentrations demonstrates the capability of the transport model for the prediction of contaminant transport in groundwater at the site.

3.3 Model Prediction

As stated in the previous sections, the prediction model was extended 200 years following the cap completion (2017 to 2217) to evaluate boron concentrations in groundwater under a baseline (no action) scenario and the closure configuration. The predicted hydraulic heads under the two conditions are compared in Figure 3-4. The predicted boron concentrations under the two conditions are compared in Figure 3-5.

3.3.1 Baseline

Under the baseline scenario, it was assumed that no action was taken to cover or remove existing ash. As shown in Figures 3-4 and 3-5, both hydraulic head and boron concentrations are predicted to remain stable except at Well 27, in which the boron concentration would decrease even when no action was applied. As shown in Figure 1-2, Well 27 is located further downgradient from the pond. The continuous decrease of boron concentration at this location under the baseline scenario is its response to the pond removal from service.

Figure 3-6 depicts the predicted boron plume where it exceeds the Illinois Class I groundwater protection standard (2 mg/L) 50 years after cap completion. The boron plume is predicted to extend north beneath the Illinois River. As illustrated in Figure 3-5, the boron concentrations at wells become asymptotic; no further reduction is expected with time and most wells with boron concentrations that exceed the standard will remain above the standard after 200 years.

3.3.2 Capping Scenario

Under the capping scenario, it was assumed that the Old West Polishing Pond would be excavated and the remaining WAPS (Old West Ash Pond, including Pond No. 1 and Pond No. 3) would be capped in place with a geosynthetic cover that was expected to yield a percolation rate as low as 0.002 inch/yr (NRT, 2017a).

Comparing the baseline to the capping option, significant reduction in boron concentrations is predicted in monitoring wells (Figure 3-5). All wells would reach the standard in 50 years except wells 21 and 23, the concentrations of which will eventually decrease to meet the criterion within the 200-year simulation. Slight drops in hydraulic heads are observed after the cap is in place, which is due to the infiltration decrease.

As shown in Figure 3-6 (50-year plume), the footprint of the plume under the capping scenario is significantly reduced and the highest boron concentrations are focused within the pond footprint. Groundwater impacts beneath the eastern portion of the pond are attenuated by 50 years. The remaining impacts are focused around the capped and saturated ash along with the lower permeability silty/clay material beneath the western portion of the pond. This lower permeability material results in slower release/attenuation of the impacts as compared to other portions of the site which are underlain by higher permeability sands. Figure 3-7 shows the plume configuration in Layer 4, where boron is slowly attenuated. The north-south shape of the western portion of the boron plume is consistent with the north-south hydraulic conductivity distribution shown in layers 4 through 6 on Figure 2-4.

After 200 years (year 2217), as shown in Figure 3-8, the footprint of exceedances (boron concentrations greater than 2 mg/L) will be limited to the property except for a few isolated areas where the western extent of the plume lingers in association with the silty material. The modeling results show that the proposed closure configuration effectively consolidates groundwater impacts to the footprint of the capped impoundment.

4 SUMMARY

A 3-dimensional groundwater flow and transport model was established to evaluate the effectiveness of the proposed closure plan on the WAPS at the Hennepin Power Station. The proposed closure configuration includes clean closure of the Old West Polishing Pond and capping the remaining impoundments in place with a geosynthetic cover, which consists of a 6-inch surface soil layer, a 18-inch soil layer, a geocomposite drainage layer and a geosynthetic layer. The model was developed based on a previous 2014 model with incorporation of new field and laboratory measurements and was recalibrated to fit additional monitoring data. In summary, the results of the modeling are:

- The consistency between modeling results and the observable data collected from 1994 through 2016 exhibits a successful calibration of the updated model, demonstrating the model's capability for the prediction of hydraulic flow and contaminant transport in groundwater at the site.
- When no action is taken, groundwater impacts will not be contained within the property and groundwater protection standards will not be met for boron. Boron concentrations become asymptotic after approximately 50 years (Year 2067) and no further reduction is expected with time.
- Under the proposed closure scenario, significant reduction in groundwater impacts are expected. Boron concentrations in most wells will meet the groundwater protection standards in 50 years upon cap completion (Year 2067) and all wells will meet the standards within 200 years (Year 2217).
- At 50 years after cap completion, the remaining impacts outside the footprint of the capped impoundment appear to be attributed to lower permeability silty/clay material beneath the western portion of the pond. After 200 years (year 2217), groundwater impacts are nearly removed and only isolated areas of impacts remain (also associated with the silty/clay materials). The proposed closure configuration effectively consolidates groundwater impacts to the footprint of the capped impoundment.

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Tables

Table 2-1a. Flow Model Input Values (steady-state calibration)
Groundwater Model Report
West Ash Pond System, Hennepin Power Station

Horizontal Hydraulic Conductivity	**ft/d**	**cm/s**	**Sensitivity[1]**
Sand & River Sand (Zone 1)	30.0	1.1E-02	high
Outwash Gravel (Zone 2)	200.0	7.1E-02	high
Alluvium (Zone 3)	1.5	5.3E-04	moderate
Channel Fill Silts (Zone 4)	1.4	4.9E-04	moderately high
Ash (Zone 10)	0.05	1.8E-05	moderate

Vertical Hydraulic Conductivity	**ft/d**	**Kh/Kv**	**Sensitivity[1]**
Sand & River Sand (Zone 1)	15.0	2.0	moderate
Outwash Gravel (Zone 2)	100.0	2.0	negligible
Alluvium (Zone 3)	0.15	10.0	high
Channel Fill Silts (Zone 4)	0.14	10.0	high
Ash (Zone 10)	0.05	1.0	high

Recharge[2]	**ft/d**	**in/yr**	**Sensitivity[1]**
Sand & River Sand (Zone 1)	1.1E-03	4.8	moderately high
Outwash Gravel (Zone 2)	1.1E-03	4.8	high
Channel Fill Silts (Zone 4)	5.0E-04	2.2	low
Ash-Pond No. 1 (Zone 9)	3.83E-03	16.8	low
Ash-Pond No. 3 East (Zone 8)	4.0E-02	175.2	moderately high
Ash-Pond No. 3 Center (Zone 10)	2.7E-02	118.3	moderately high
Ash-Pond No. 3 West (Zone 6)	2.7E-02	118.3	high
Ash-Pond No. 3 Northwest (Zone 5)	2.7E-02	118.3	high
Ash-Old West Polishing Pond (Zone 7)	2.0E-02	87.6	high

River Parameters	**Illinois Riv.**	**Duck Ponds/Creek**	**Sensitivity[1]**
Stage (ft)	441.7	445.5	high
Bed Thickness (ft)	1	1	not tested
Hydraulic Conductivity (ft/d)	10	1/5	not tested
Conductance (ft^2/d, normalized per ft^2 area)	10	1/5	negligible
River Width (ft)	100-200	100-200/10	not tested
River Cell Length (ft)	100-200	100-200/100	not tested

Notes:

1 - Sensitivity Explanation, based on maximum change in Sum of Squared Residuals (SSR)

Negligible - SSR changed by less than 1%

Low - SSR change between 1% and 10%

Moderate - SSR change between 10% and 50%

Moderately High - SSR change between 50% and 100%

High - SSR change greater than 100%

2 - See Table 2-1b for transient recharge values.

3 - See figures for delineation of model zones

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Table 2-1b. Flow Model Input Values (transient calibration)
Groundwater Model Report
West Ash Pond System, Hennepin Power Station

	Calibration	
Stress Periods[1]	**Days, #TS**	**Dates**
Stress Period 1	**500, 6**	**1/1997-5/1998**
Stress Period 2	**6804, 20**	**5/1998-12/2016**
Recharge[2] (Calibration SP1)	**ft/d**	**in/yr**
Ash-Pond No. 1 (Zone 9)	3.83E-03	16.8
Ash-Pond No. 3 East (Zone 8)	2.E-02	87.6
Ash-Pond No. 3 Center (Zone 10)	2.E-02	87.6
Ash-Pond No. 3 Center (Zone 6)	2.E-02	87.6
Ash-Pond No. 3 West (Zone 12)	2.E-02	87.6
Ash-Pond No. 3 West (Zone 13)	2.E-02	87.6
Ash-Pond No. 3 Northwest (Zone 5)	2.E-02	87.6
Ash-Pond No. 3 Northwest (Zone 11)	2.E-02	87.6
Ash-Old West Polishing Pond (Zone 7)	2.E-02	87.6
Recharge[2] (Calibration SP2)	**ft/d**	**in/yr**
Ash-Pond No. 1 (Zone 9)	3.83E-03	16.8
Ash-Pond No. 3 East (Zone 8)	2.96E-03	13.0
Ash-Pond No. 3 Center (Zone 10)	2.96E-03	13.0
Ash-Pond No. 3 Center (Zone 6)	2.E-02	87.6
Ash-Pond No. 3 West (Zone 12)	2.E-02	87.6
Ash-Pond No. 3 West (Zone 13)	2.96E-03	13.0
Ash-Pond No. 3 Northwest (Zone 5)	2.96E-03	13.0
Ash-Pond No. 3 Northwest (Zone 11)	2.E-02	87.6
Ash-Old West Polishing Pond (Zone 7)	2.96E-03	13.0
Storage/Porosity	**S_S/S_Y**	**Porosity**
Entire Domain	0.01/0.30	0.20

Notes:

1 - First column is model days and number of time steps, second column is approximate dates in mm/yyyy format.

2 - See figures for delineation of model zones; recharge values outside ash pond are same as Table 2-1a.

Table 2-1c. Flow Model Input Values (prediction)
Groundwater Model Report
West Ash Pond System, Hennepin Power Station

	Prediction	
Stress Periods[1]	**Days, #TS**	**Dates**
Stress Period 3	**2555, 10**	**1/2017-1/2024**
Stress Period 4	**70497, 50**	**1/2024-1/2217**
Recharge[2] (Closure Scenario SP3)	**ft/d**	**in/yr**
Ash-Pond No. 1 (Zone 14)	2.E-03	9.1
Ash-Pond No. 3 East (Zone 14)	2.E-03	9.1
Ash-Pond No. 3 Center (Zone 15)	2.E-03	9.1
Ash-Pond No. 3 West (Zone 17)	2.E-03	9.1
Ash-Pond No. 3 Northwest (Zone 16)	2.E-03	9.1
Ash-Old West Polishing Pond (Zone 4)	5.0E-04	2.2
Recharge[2] (Closure Scenario SP4)	**ft/d**	**in/yr**
Ash-Pond No. 1 (Zone 14)	5.53E-07	0.002
Ash-Pond No. 3 East (Zone 14)	5.53E-07	0.002
Ash-Pond No. 3 Center (Zone 15)	5.53E-07	0.002
Ash-Pond No. 3 West (Zone 17)	5.53E-07	0.002
Ash-Pond No. 3 Northwest (Zone 16)	5.53E-07	0.002
Ash-Old West Polishing Pond (Zone 4)	5.00E-04	2.2

Notes:

1 - First column is model days and number of time steps, second column is approximate dates in mm/yyyy format.

2 - See figures for delineation of model zones; recharge values outside ash pond are same as Table 2-1b (SP2).

3 - Cap percolation rate is applied to the impoundment.

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Table 2-2. Transport Model Input Values
Groundwater Model Report
West Ash Pond System, Hennepin Power Station

Initial Concentration (mg/L)	**Base Case**	**Alternatives**	**Sensitivity[1]**
Entire Domain	0.0	not tested	-
Source Concentration	**Base Case**	**Alternatives**	**Sensitivity[1]**
(Constant Concentration Zone/Recharge Zone)			
Pond No. 3 East (Zone 2 / Zone 14)	9	not tested	high[2]
Pond No. 3 Center (Zone 6 / Zone 15)	9	not tested	moderately high[2]
Pond No. 3 West (Zone 4 / Zone 17)	19	not tested	high[2]
Pond No. 3 Northwest (Zone 5 / Zone 16)	7	not tested	high[2]
Polishing Pond (Zone 3 / Zone 4)	7	not tested	high[2]
Pond No. 1 (no flow / Zones 9 & 14)	9	not tested	high[2]
Effective Porosity	**Base Case**	**Alternatives**	**Sensitivity[1]**
Entire Domain	0.20	0.15, 0.25	moderate
Dispersivity (ft)	**Base Case**	**Alternatives**	**Sensitivity[1]**
Entire Domain	50	25, 75	high
Transverse (all layers)	Dl / 8	Dl / 10	negligible
Vertical (all layers)	Dl / 160	Dl / 100	high
Retardation	**Base Case**	**Alternatives**	**Sensitivity[1]**
Bulk Density (g/cm^3)	1.6	not tested	-
Distribution Coefficient - Gravel, Ash, River Sands (mL/g)	0.0	0.5	high
Distribution Coefficient - Channel Fill (mL/g)	1.0	0.5, 1.5	moderate

Notes:

1 - Sensitivity Explanation

Negligible - little effect on concentrations

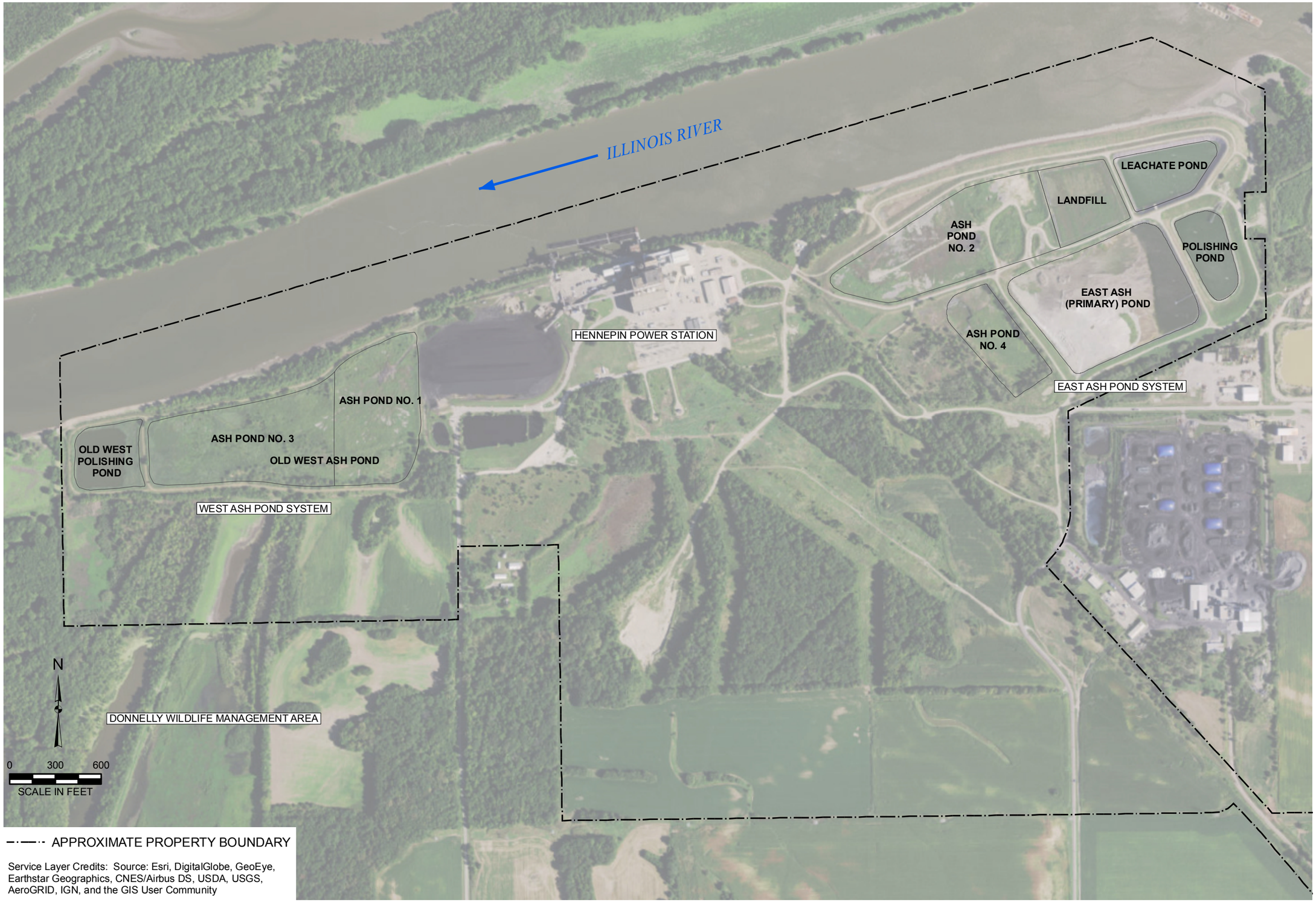
Low - concentrations at two or more wells changed by 2 to 10 percent

Moderate - concentrations at two or more wells changed by 10 to 20 percent

High - concentration at two or more wells changed by more than 20 percent

2 - Determined to be highly sensitive during transport model calibration

Figures



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

DRAWN BY/DATE: SDS 8/29/17
REVIEWED BY/DATE: RJK 8/30/17
APPROVED BY/DATE: SJC 8/31/17

SITE MAP

GROUNDWATER MODEL REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 1-1

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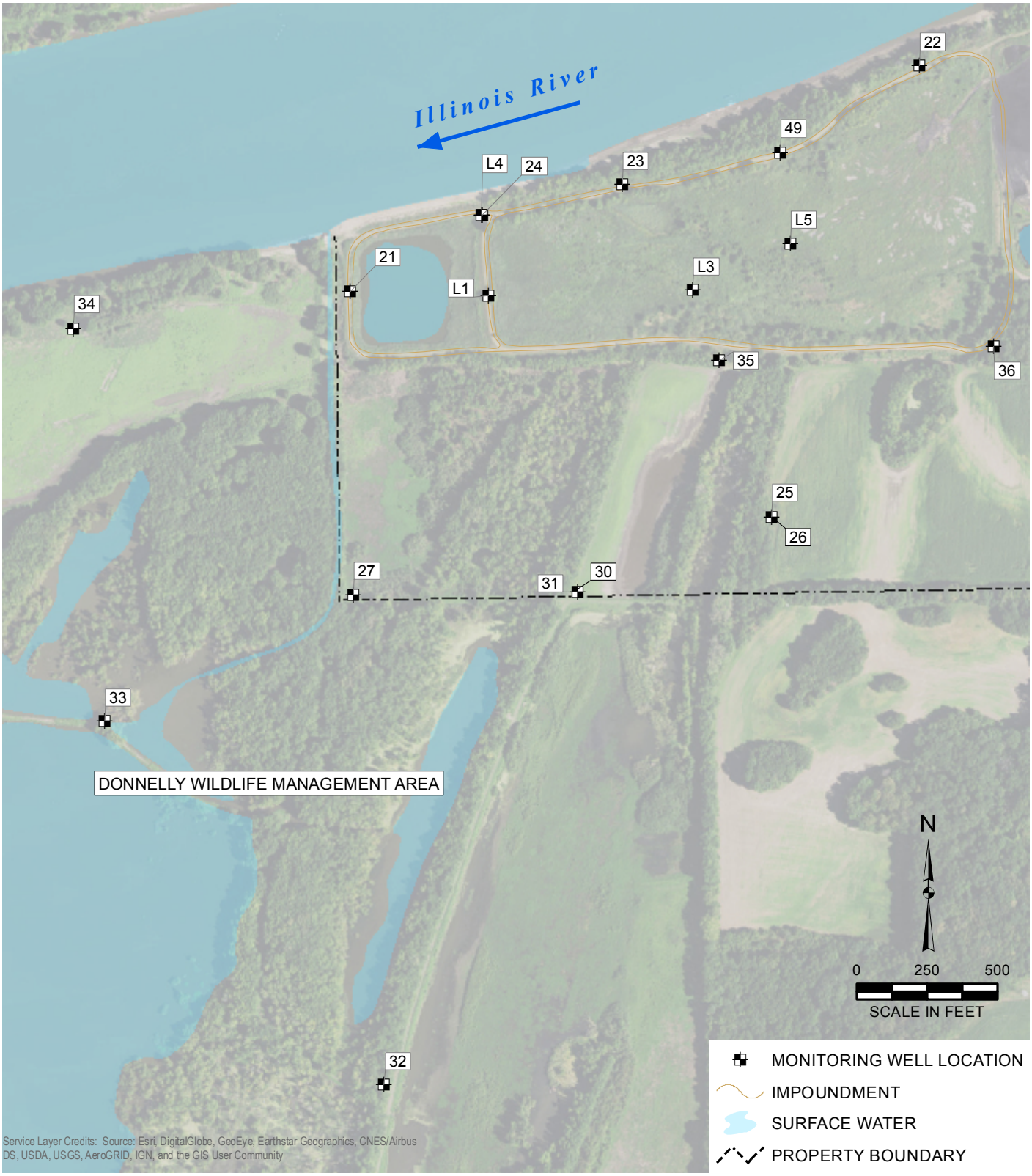

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RJK 8/30/17
APPROVED BY/DATE:
SJC 8/31/17

MONITORING WELL LOCATION MAP

GROUNDWATER MODEL REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

PROJECT NO: 2413

FIGURE NO: 1-2

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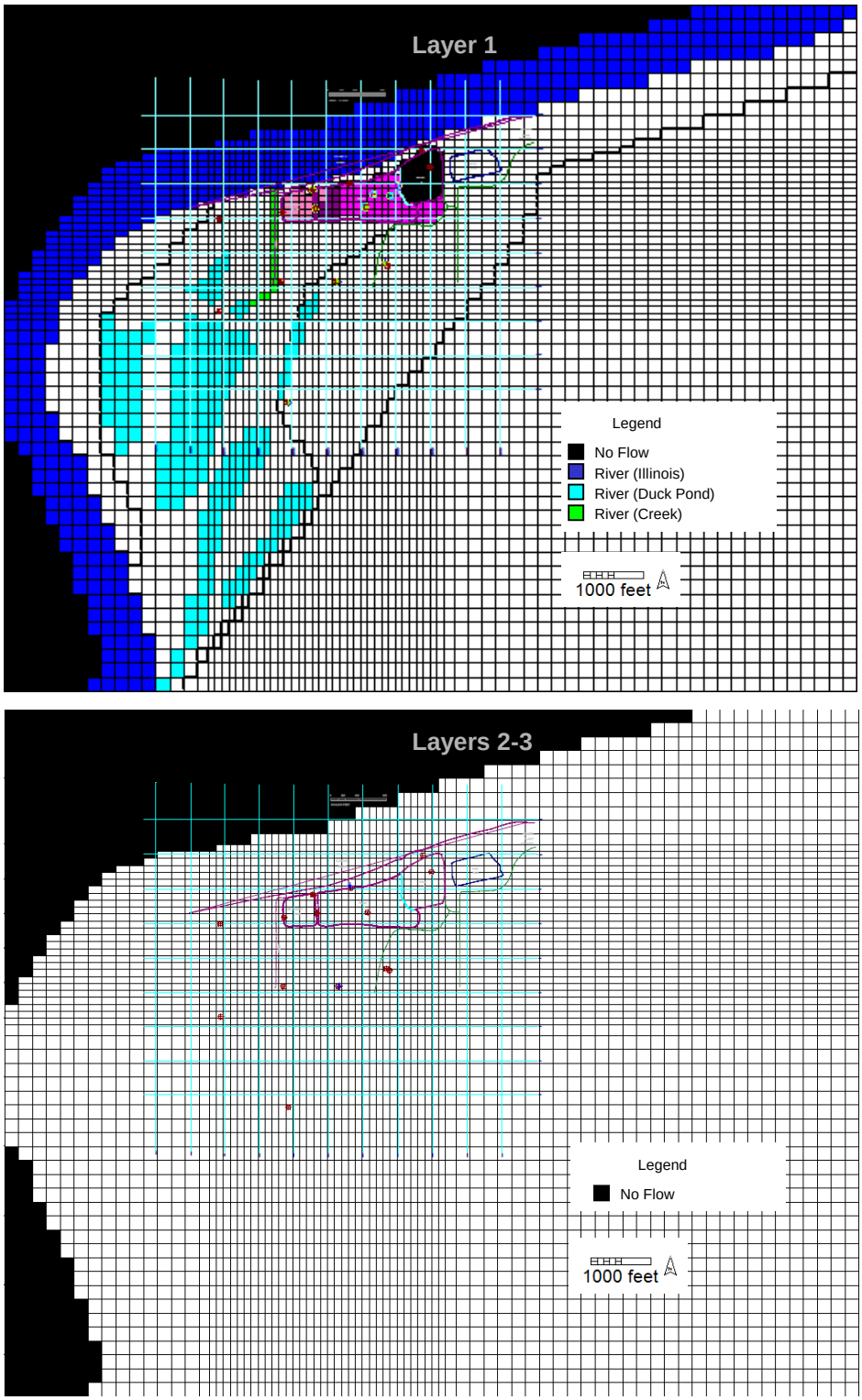

PREPARED BY/DATE:
M_W /08072017
REVIEWED BY/DATE:
BGH /08252017

MODFLOW Grid and Boundary Conditions for Layers 1 (top) and 2-3 (bottom)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-1

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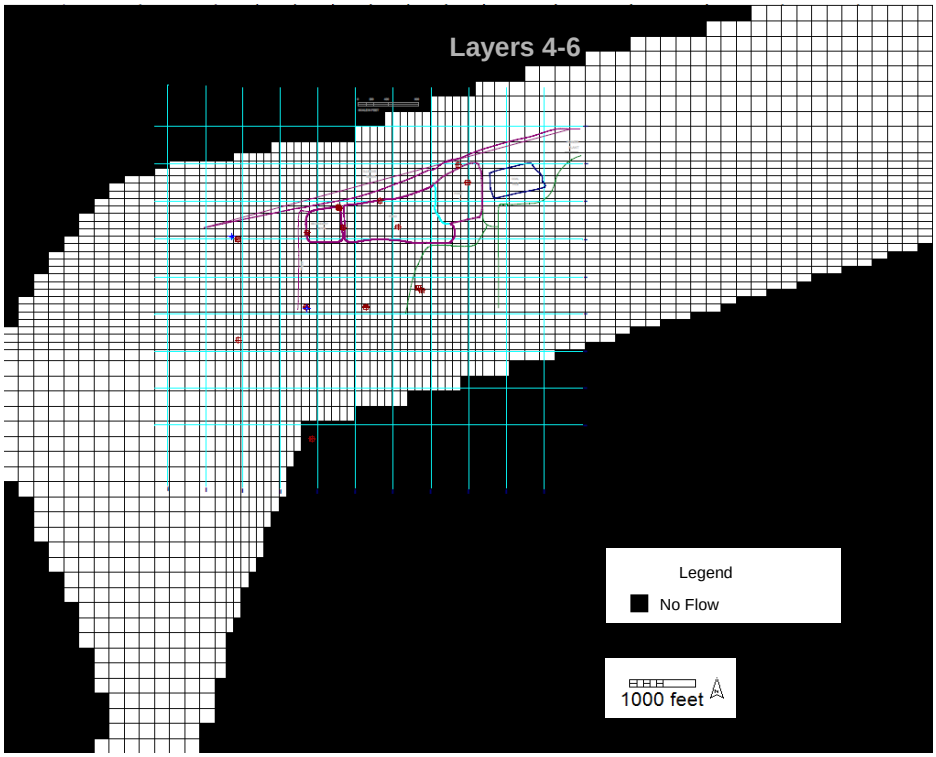

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MODFLOW Grid and Boundary Conditions for Layers 4-6

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-1

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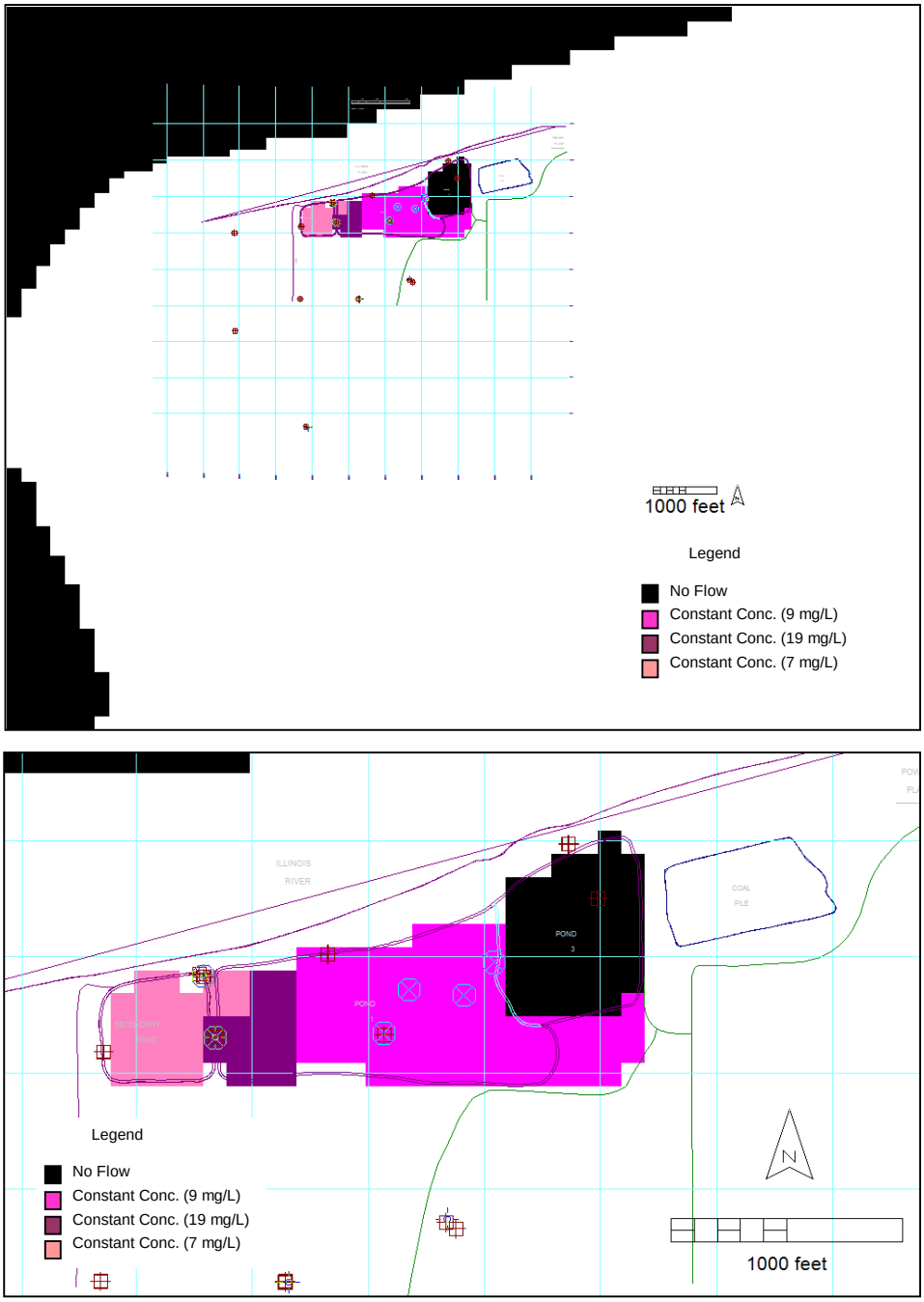

Note: Layers 2 through 6 only contain no-flow boundaries identical to the MODFLOW grid.

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MT3DMS Grid and Boundary Conditions for Layer 1

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HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-2

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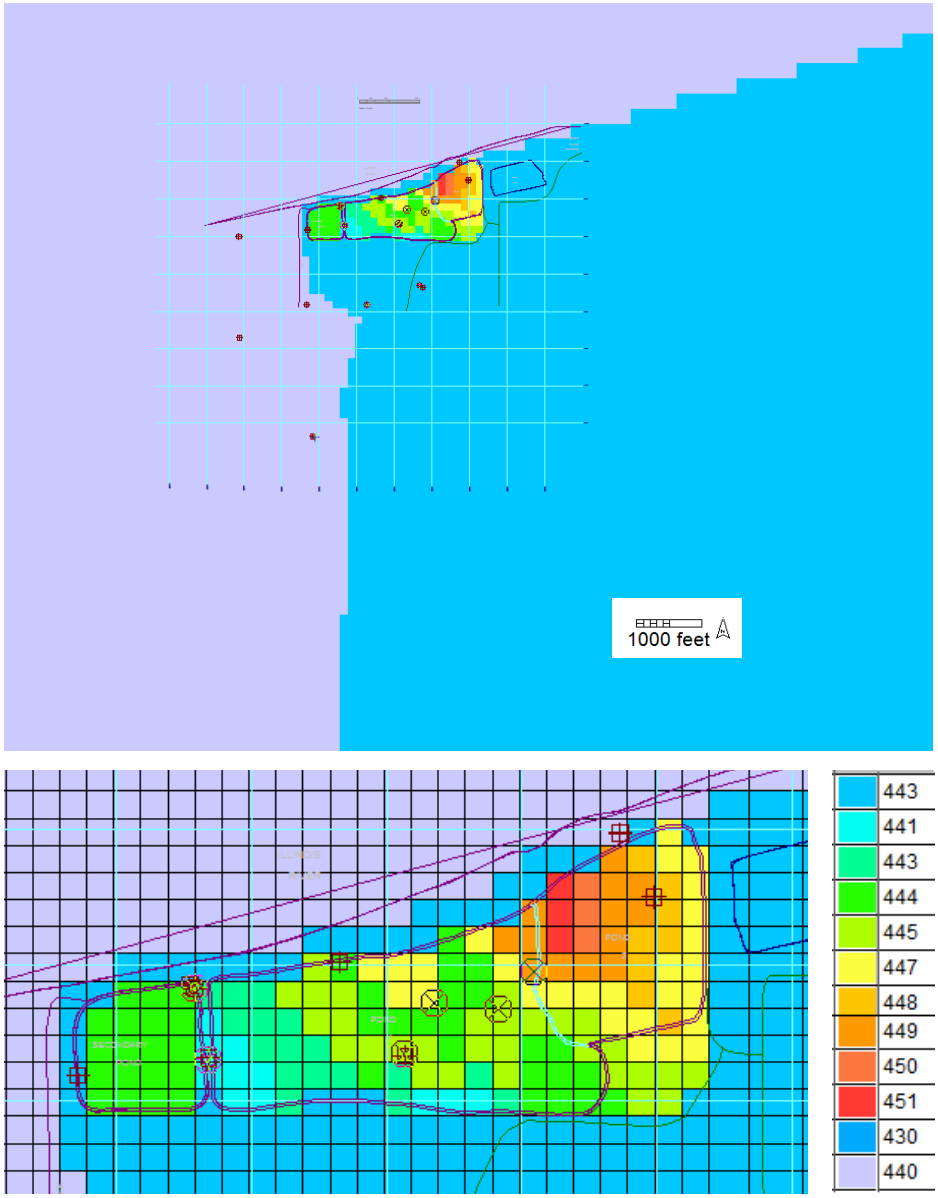

Note:

Top is entire model, bottom is zoomed around impoundment.

Layers 2-5 have uniform bottom elevations; 420, 410, 400, 390 feet, respectively.

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Bottom Elevation (feet) Array for Layer 1

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DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-3

Natural Resource Technology
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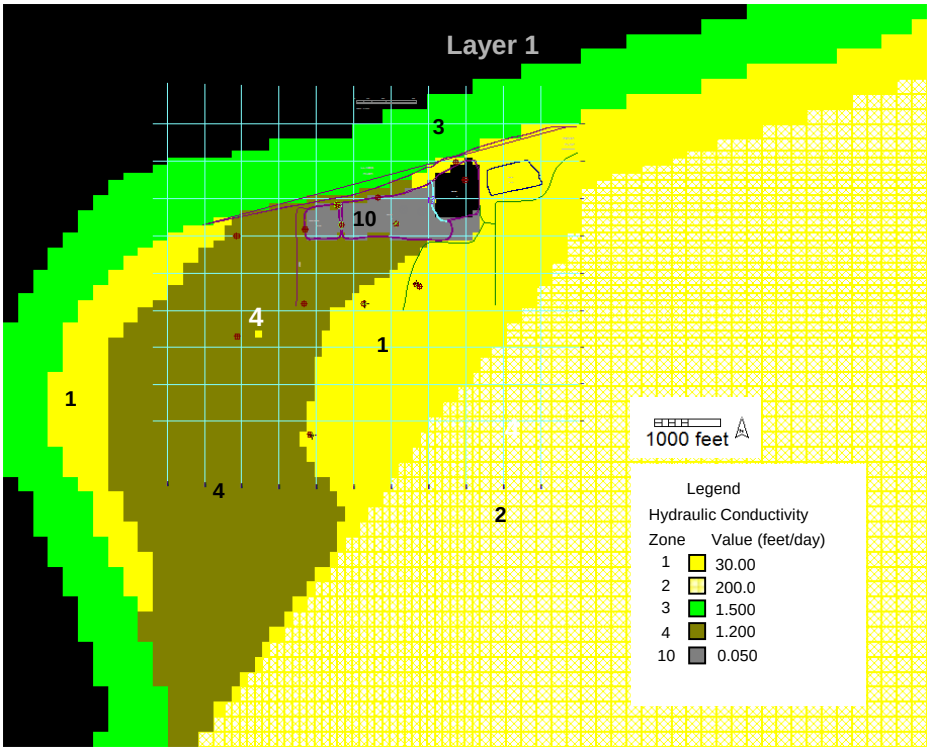

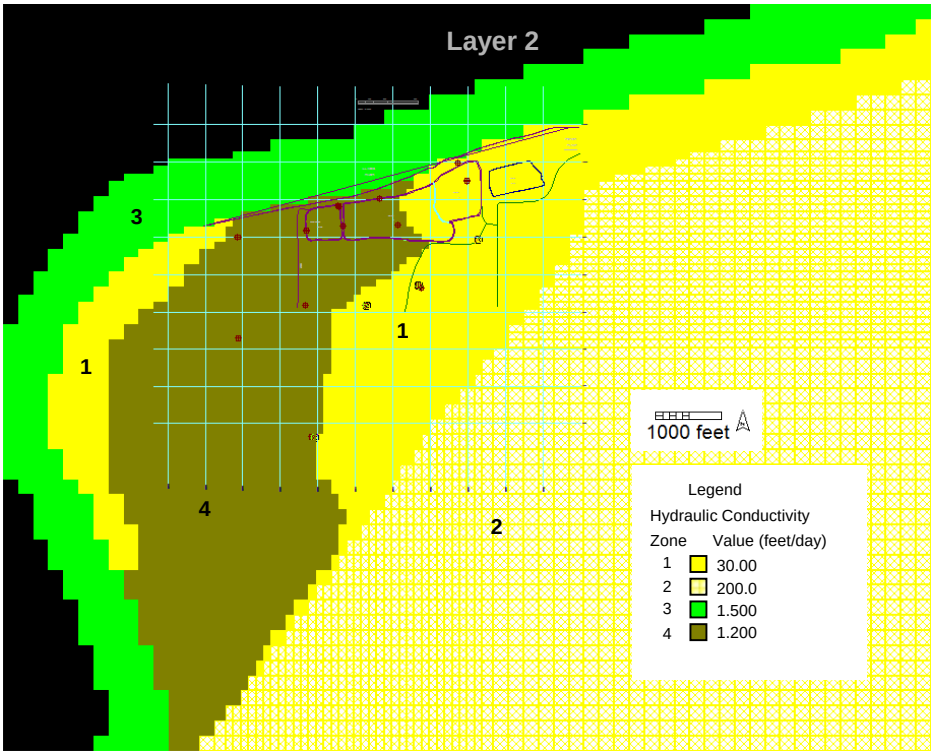

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Hydraulic Conductivity (ft/d) Array - Layers 1 (top) and 2 (bottom)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-4

Natural Resource Technology
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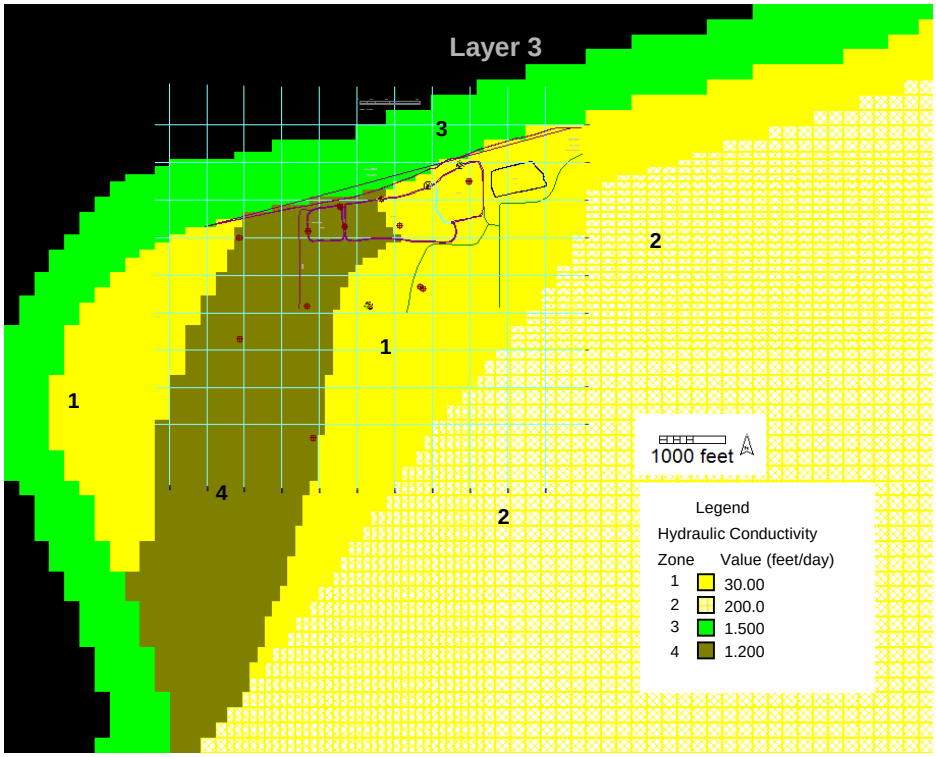

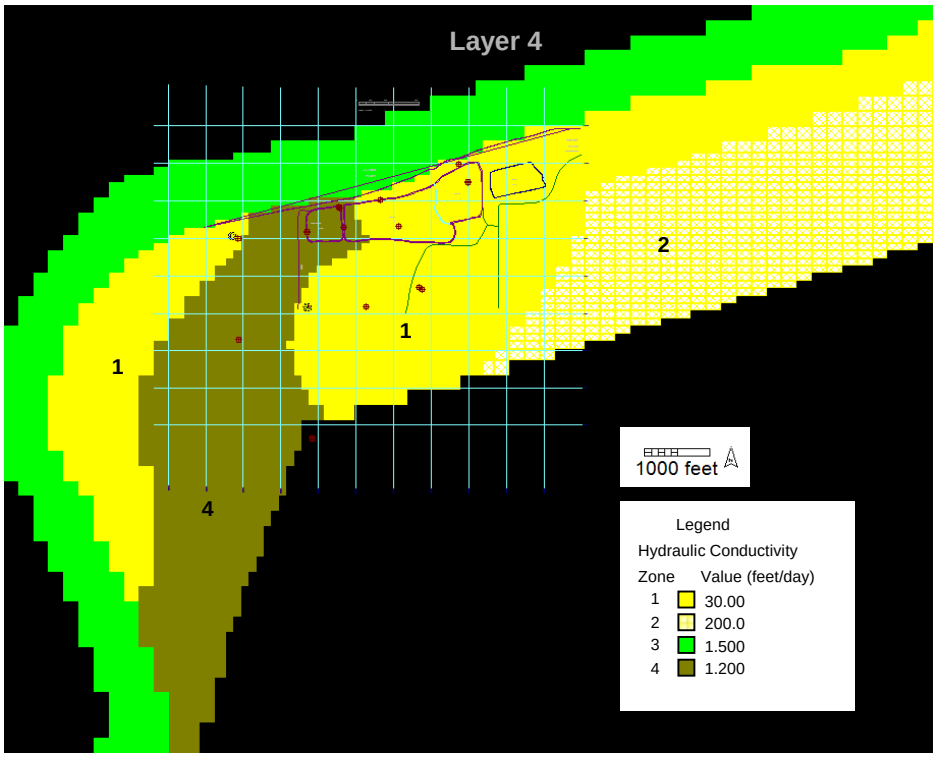

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Hydraulic Conductivity (ft/d) Array - Layers 3 (top) and 4 (bottom)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-4

Natural Resource Technology
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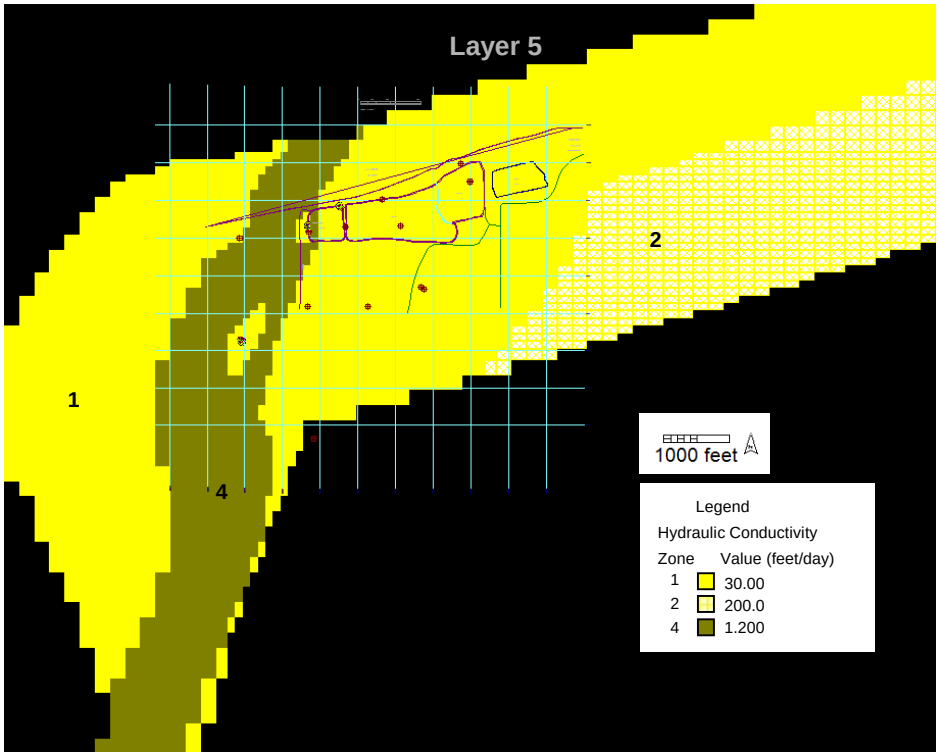

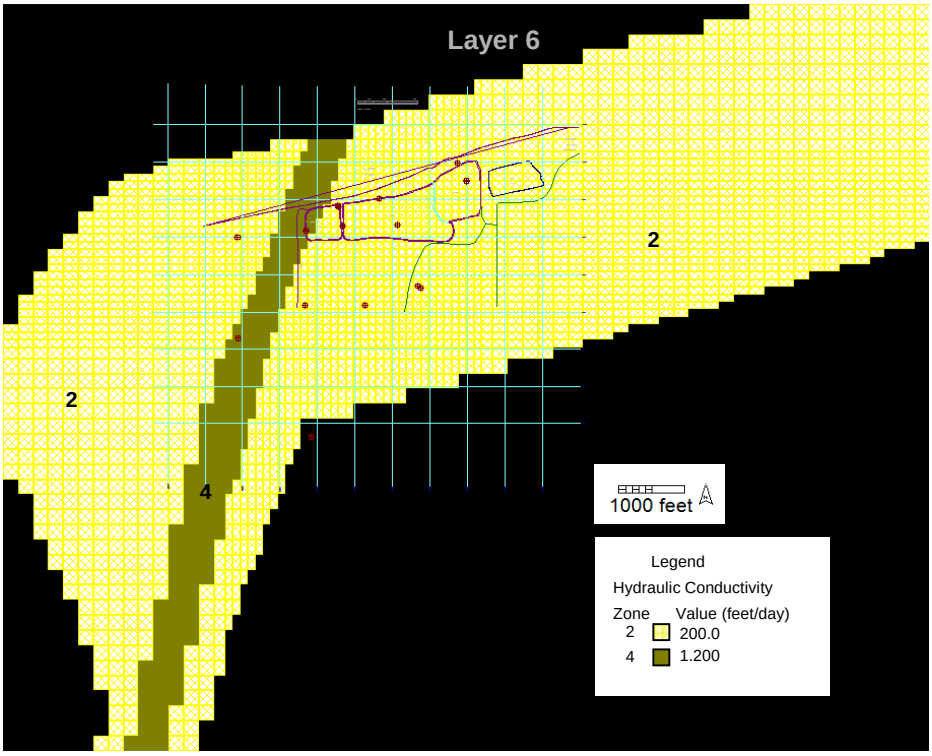

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Hydraulic Conductivity (ft/d) Array - Layers (top) 5 and 6 (bottom)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-4

Natural Resource Technology
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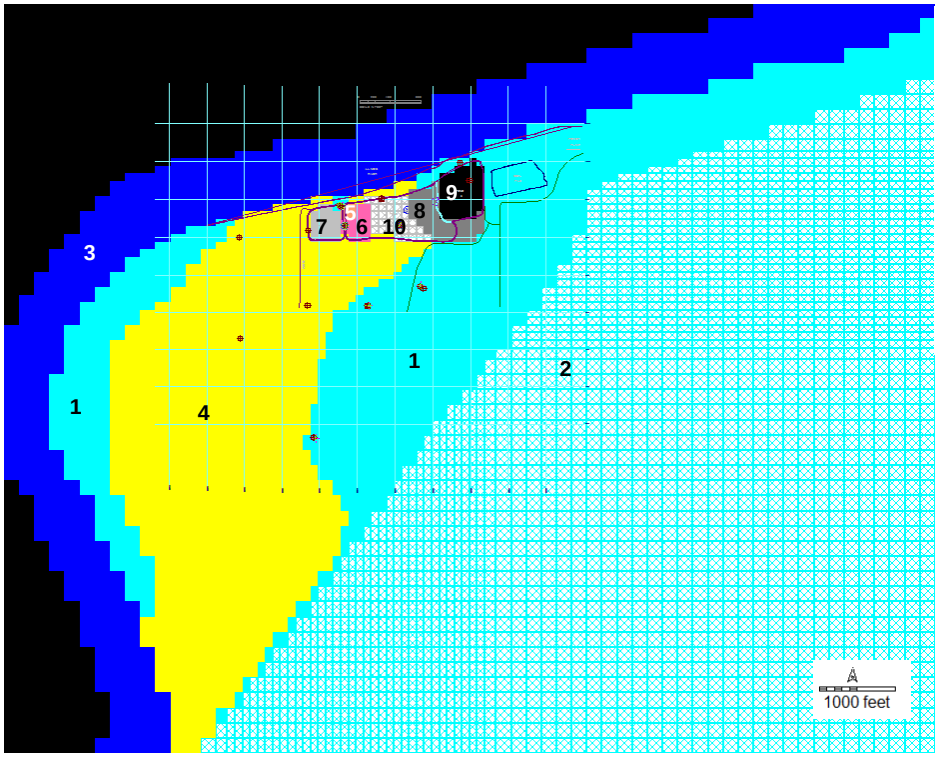

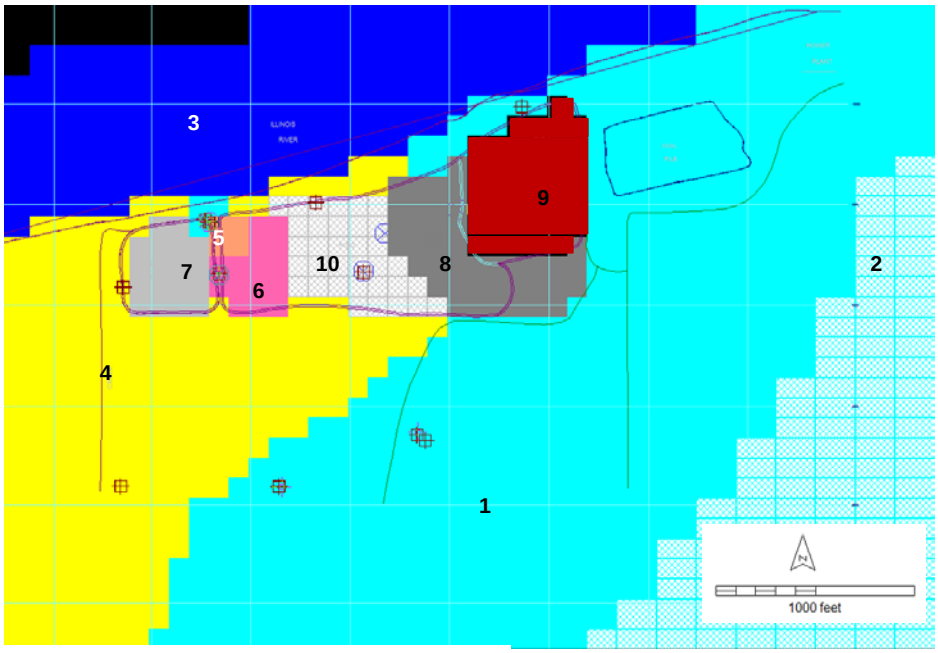

Note: Top is entire model, bottom is zoomed around impoundment. Values listed in legend are for the steady state model.

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Recharge (ft/d) Array (Steady State Model)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-5

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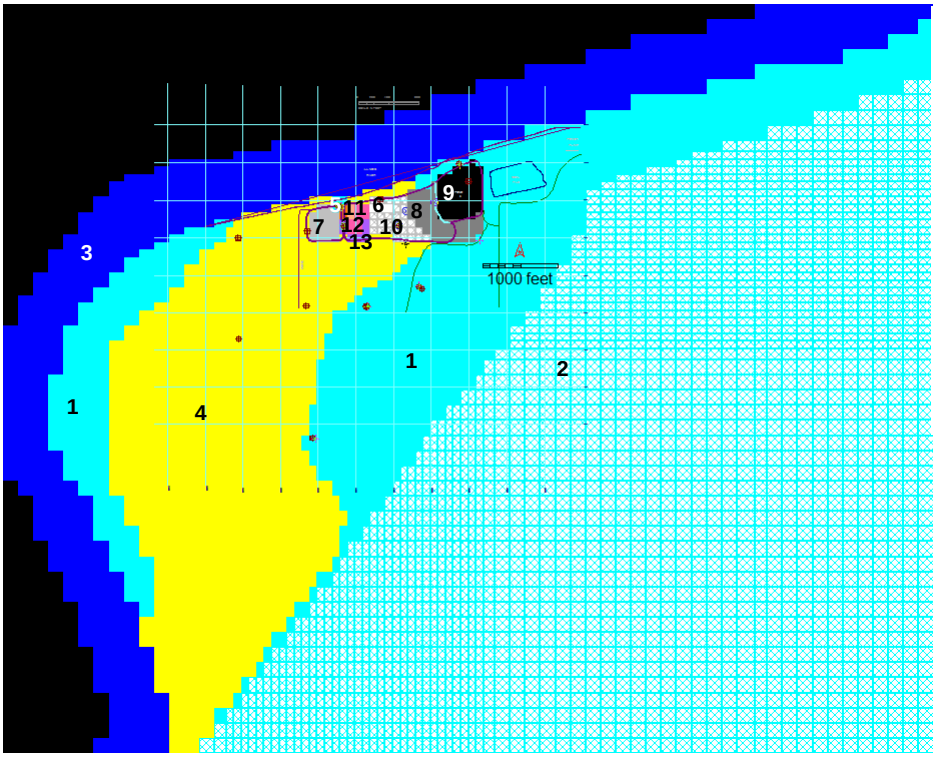
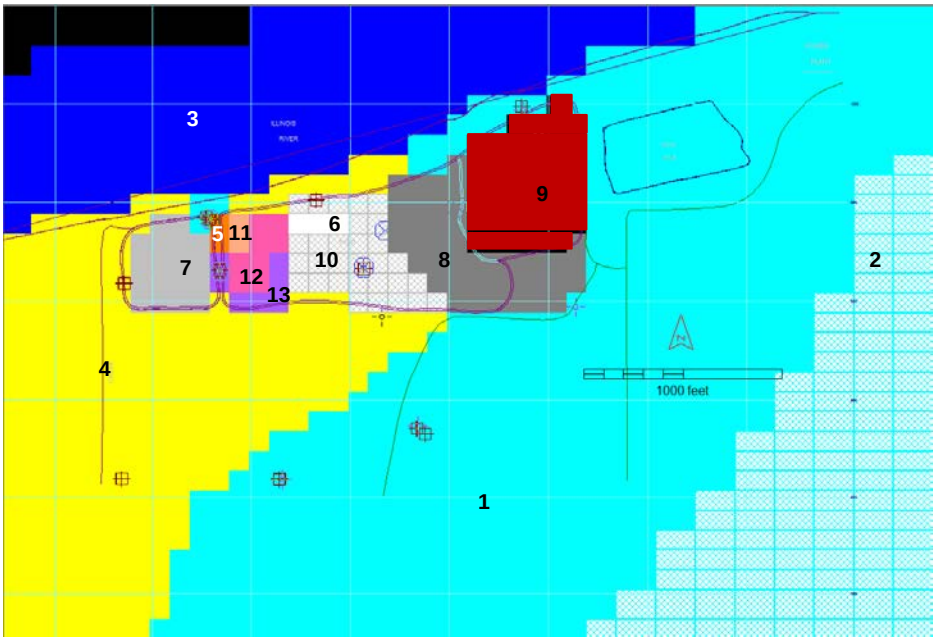


Legend

Recharge (Stress Period 1)

Zone	Value (feet/day)[mg/L]
1	1.100e-003
2	1.100e-003
3	0.000e+000
4	5.000e-004
5	2.000e-003 [7]
6	2.000e-002 [9]
7	2.000e-003 [7]
8	2.000e-003 [9]
9	3.830e-003 [9]
10	2.000e-003 [9]
11	2.000e-002 [7]
12	2.000e-002 [19]
13	2.000e-003 [19]
	No Flow



Legend

Recharge (Stress Period 1)

Zone	Value (feet/day)[mg/L]
1	1.100e-003
2	1.100e-003
3	0.000e+000
4	5.000e-004
5	2.000e-003 [7]
6	2.000e-002 [9]
7	2.000e-003 [7]
8	2.000e-003 [9]
9	3.830e-003 [9]
10	2.000e-003 [9]
11	2.000e-002 [7]
12	2.000e-002 [19]
13	2.000e-003 [19]
	No Flow

Note: Top is entire model, bottom is zoomed around impoundment. Values listed in legend are for the transient calibration scenario.

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Recharge (ft/d) Array
(Transient Model, Stress Period 1)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-5

Natural Resource Technology
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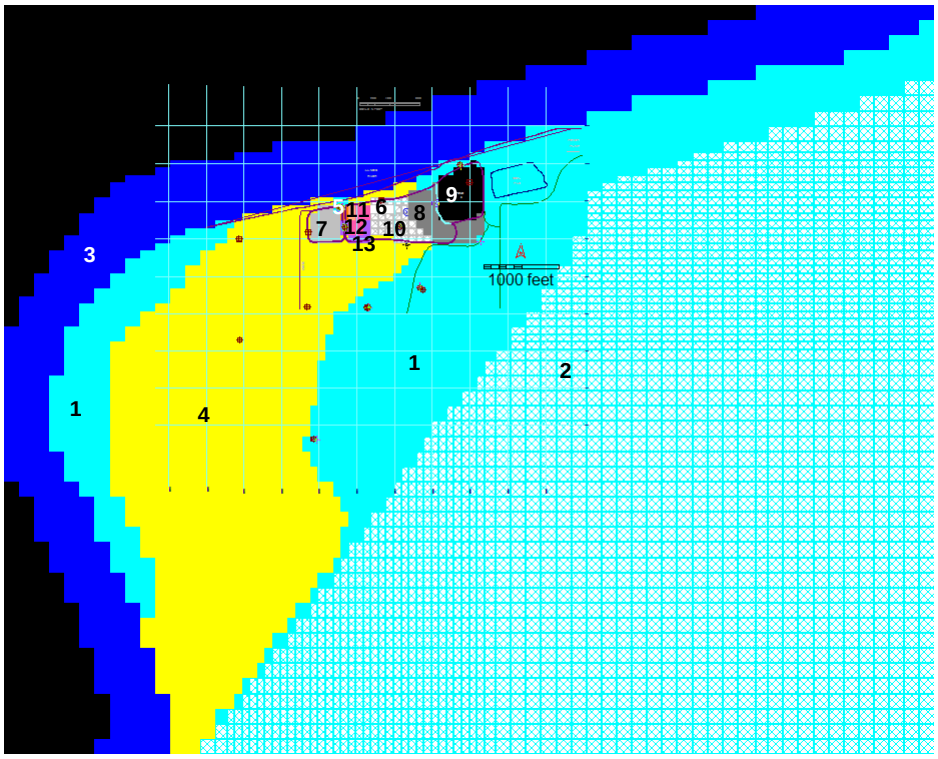
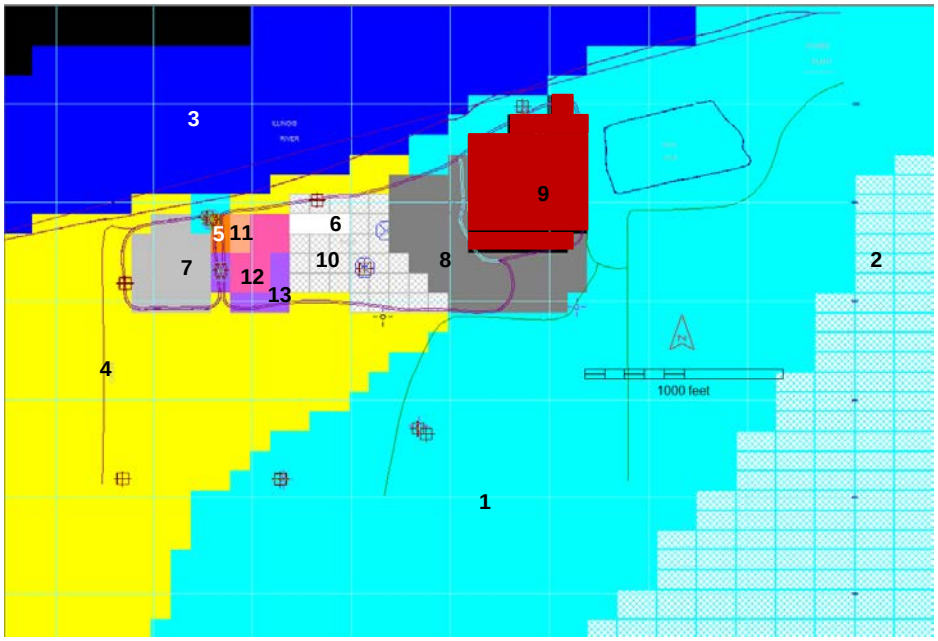


Legend
Recharge (Stress Period 2)

Zone	Value (feet/day)[mg/L]
1	1.100e-003
2	1.100e-003
3	0.000e+000
4	5.000e-004
5	2.960e-003 [7]
6	2.000e-002 [9]
7	2.960e-003 [7]
8	2.960e-003 [9]
9	3.830e-003 [9]
10	2.960e-003 [9]
11	2.000e-002 [7]
12	2.000e-002 [19]
13	2.960e-003 [19]
	No Flow



Legend
Recharge (Stress Period 2)

Zone	Value (feet/day)[mg/L]
1	1.100e-003
2	1.100e-003
3	0.000e+000
4	5.000e-004
5	2.960e-003 [7]
6	2.000e-002 [9]
7	2.960e-003 [7]
8	2.960e-003 [9]
9	3.830e-003 [9]
10	2.960e-003 [9]
11	2.000e-002 [7]
12	2.000e-002 [19]
13	2.960e-003 [19]
	No Flow

Note: Top is entire model, bottom is zoomed around impoundment. Values listed in legend are for the transient calibration scenario.

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Recharge (ft/d) Array
(Transient Model, Stress Period 2)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-5

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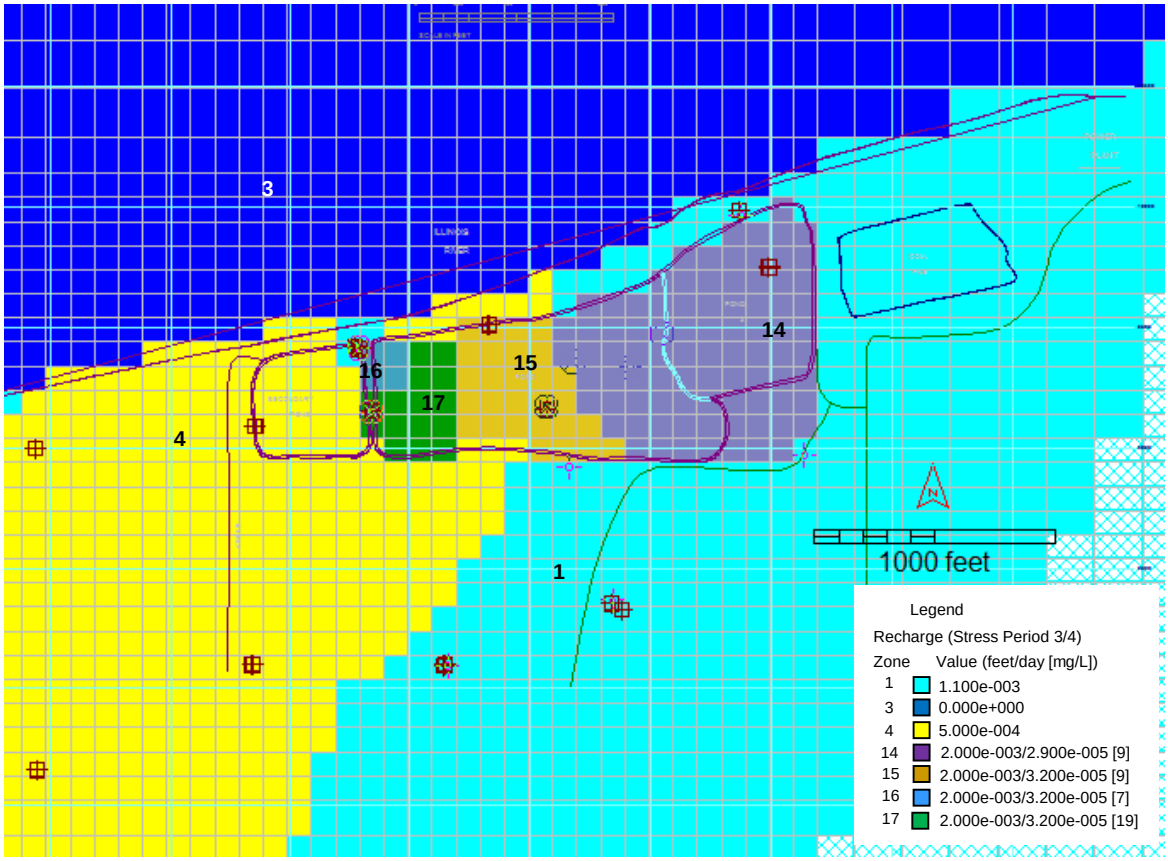

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Recharge (ft/d) Array
(Prediction Model, Stress Periods 3 & 4)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-6

Natural Resource Technology
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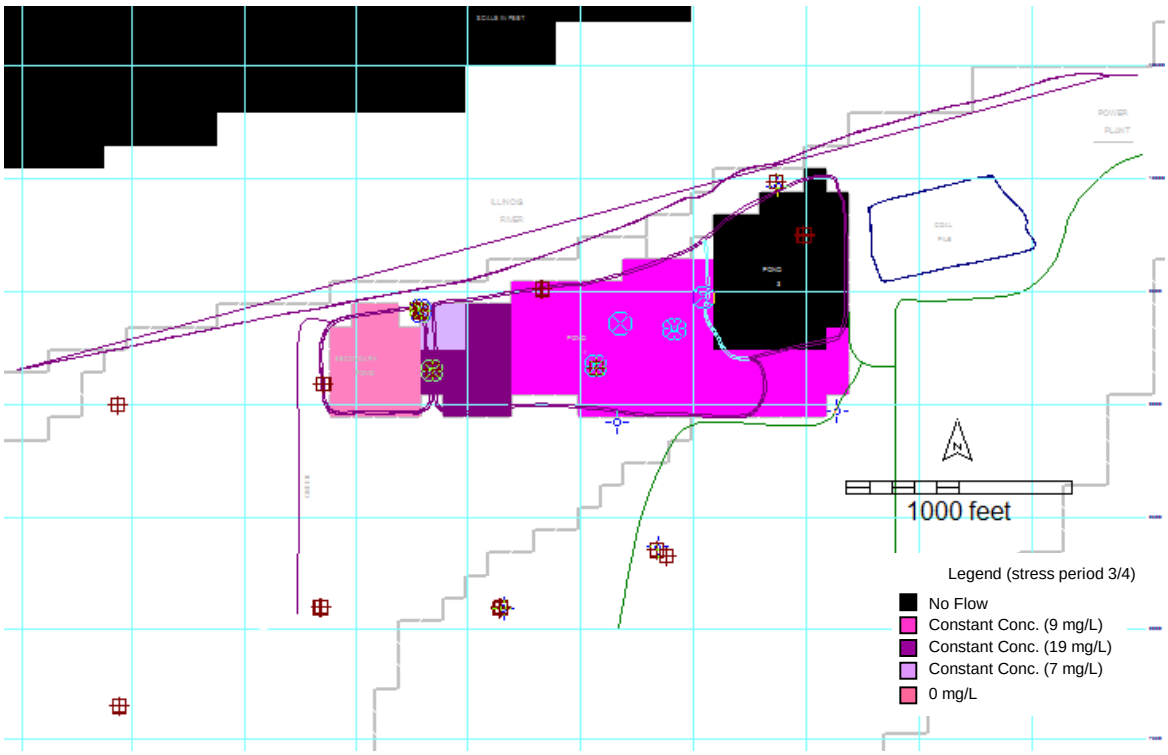

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Constant Concentration Boundary Conditions (Prediction Model, Stress Periods 3 & 4)

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HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-7

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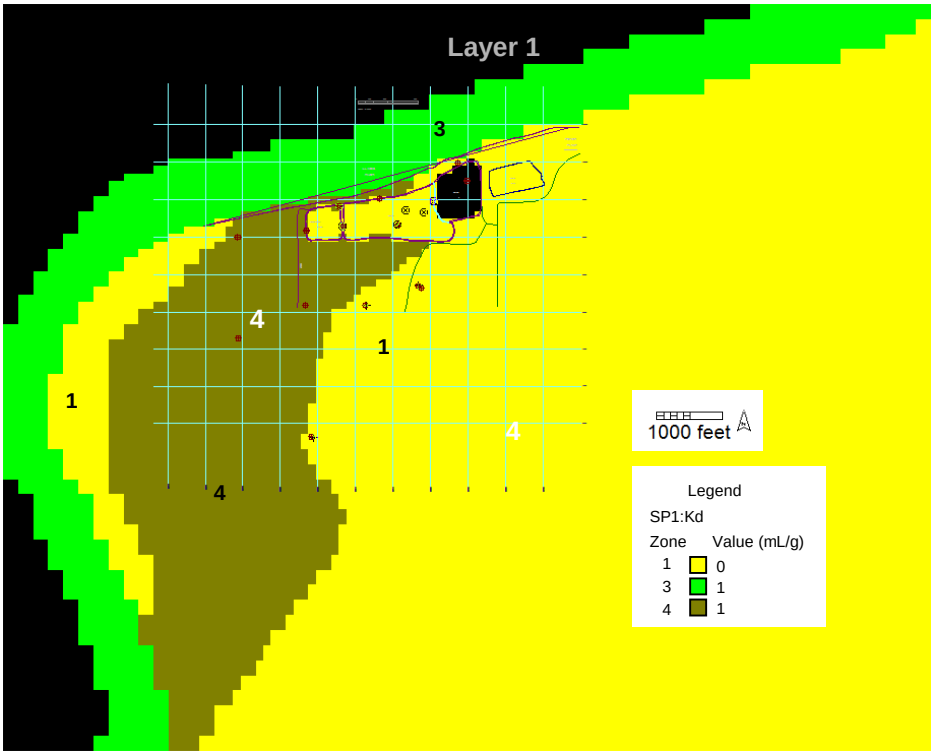

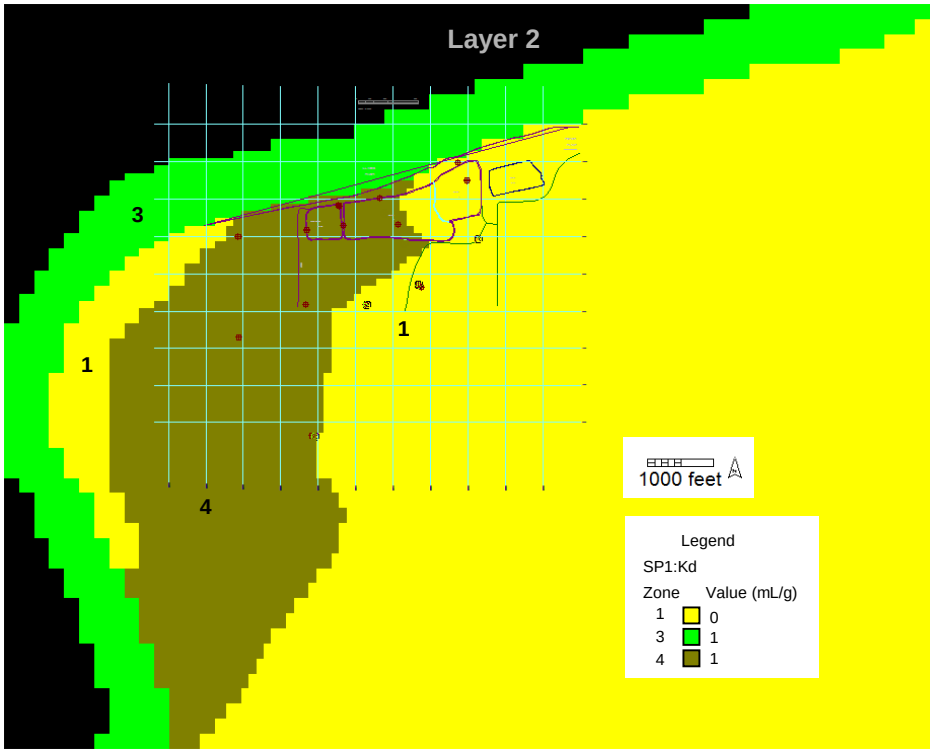

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Distribution Coefficient (mL/g) Array - Layers 1 (top) and 2 (bottom)

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HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-8

Natural Resource Technology
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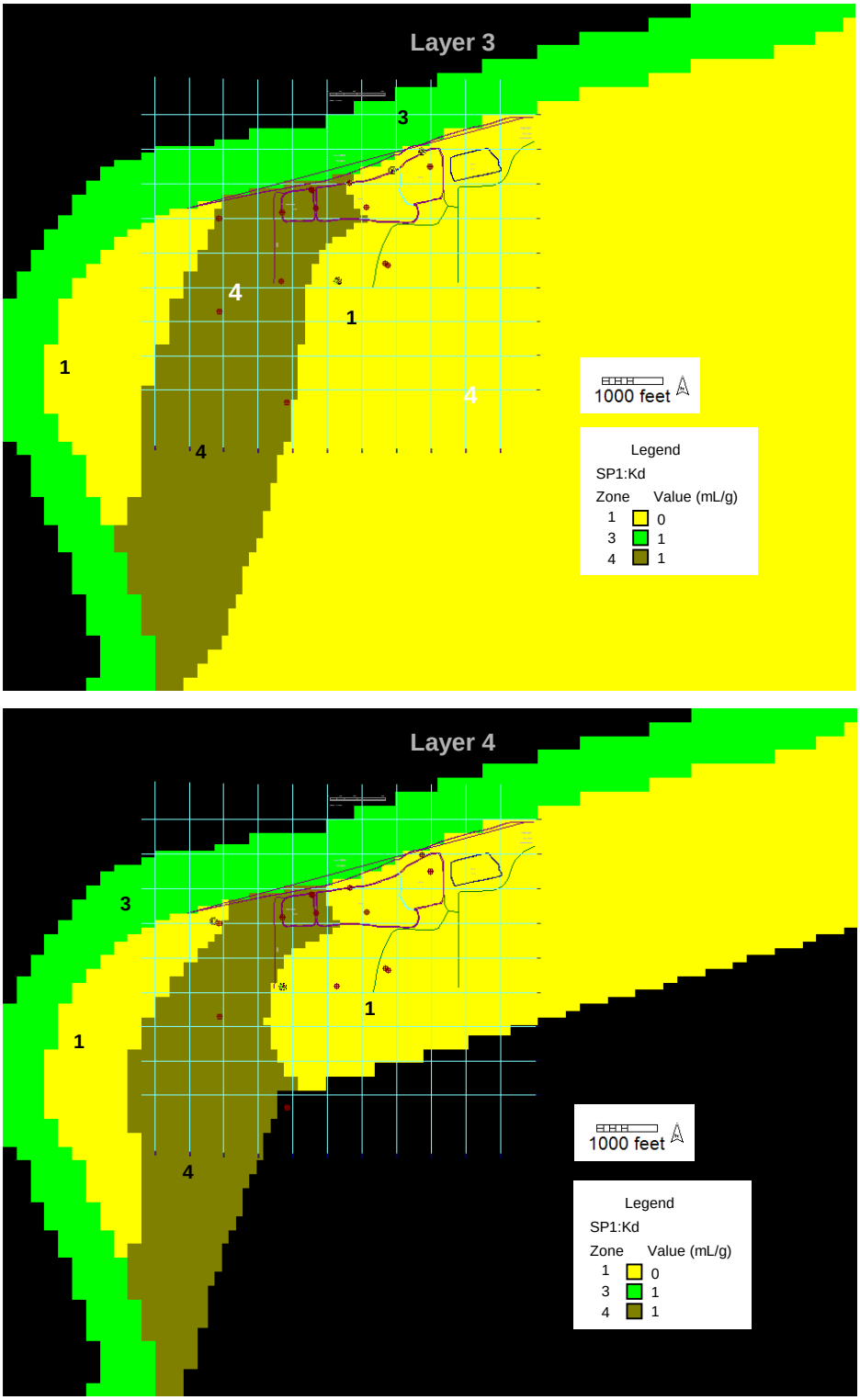

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Distribution Coefficient (mL/g) Array - Layers 3 (top) and 4 (bottom)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-8

Natural Resource Technology
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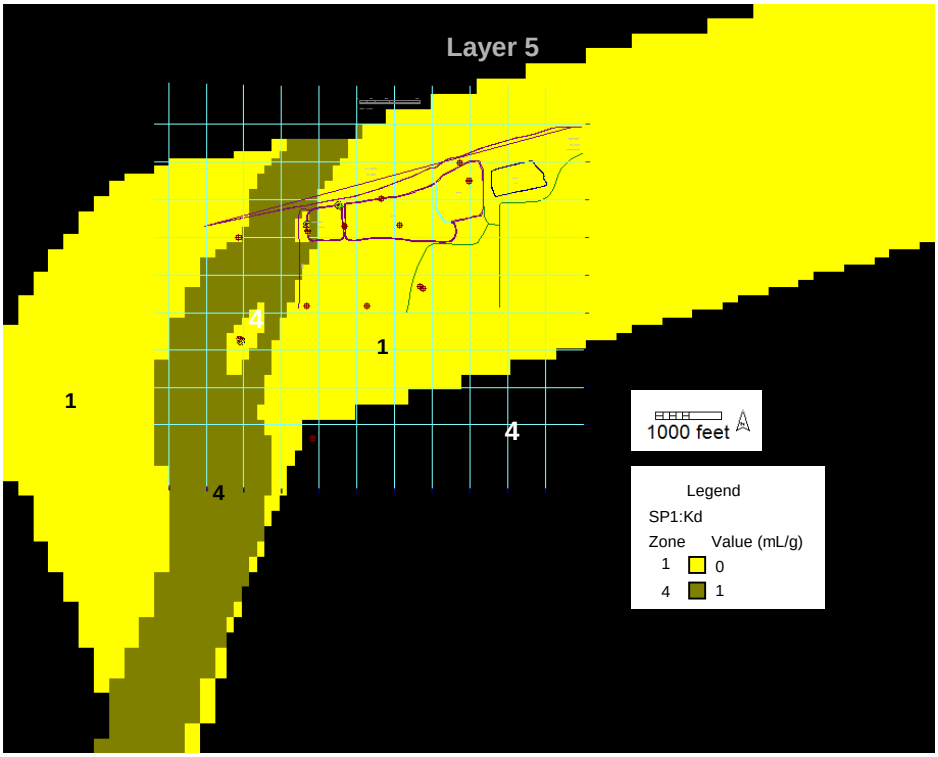

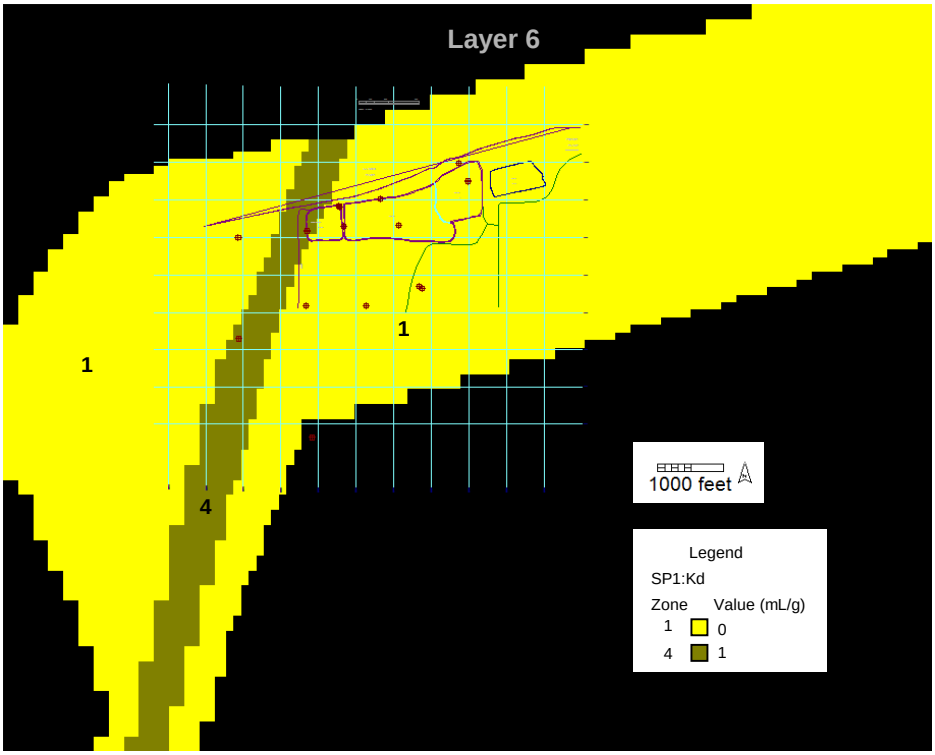

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Distribution Coefficient (mL/g) Array - Layers 5 (top) and 6 (bottom)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 2-8

Natural Resource Technology
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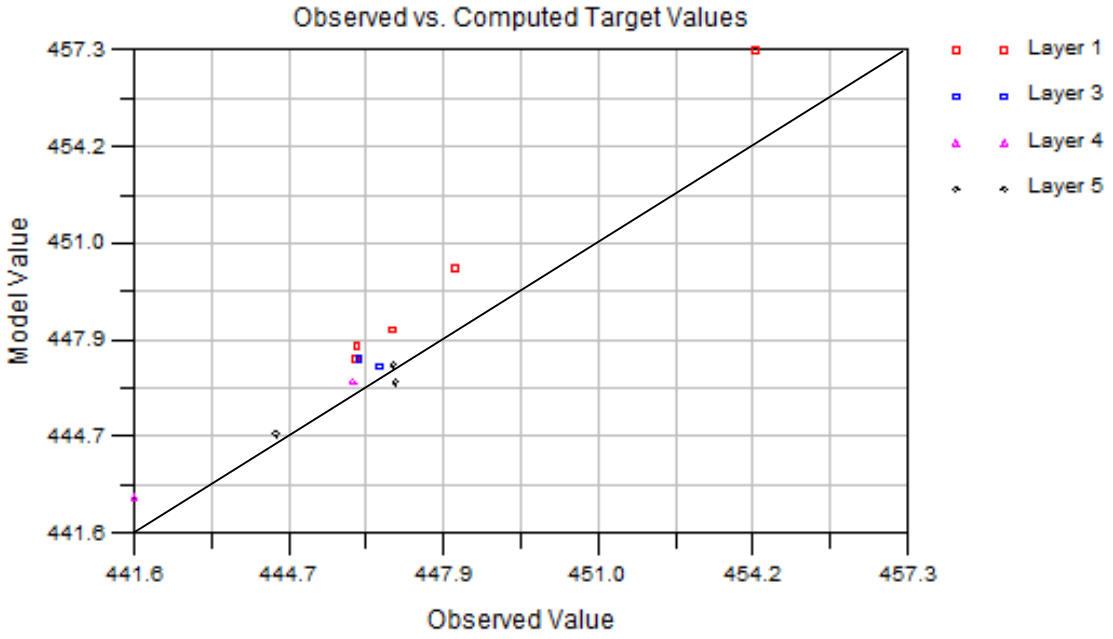

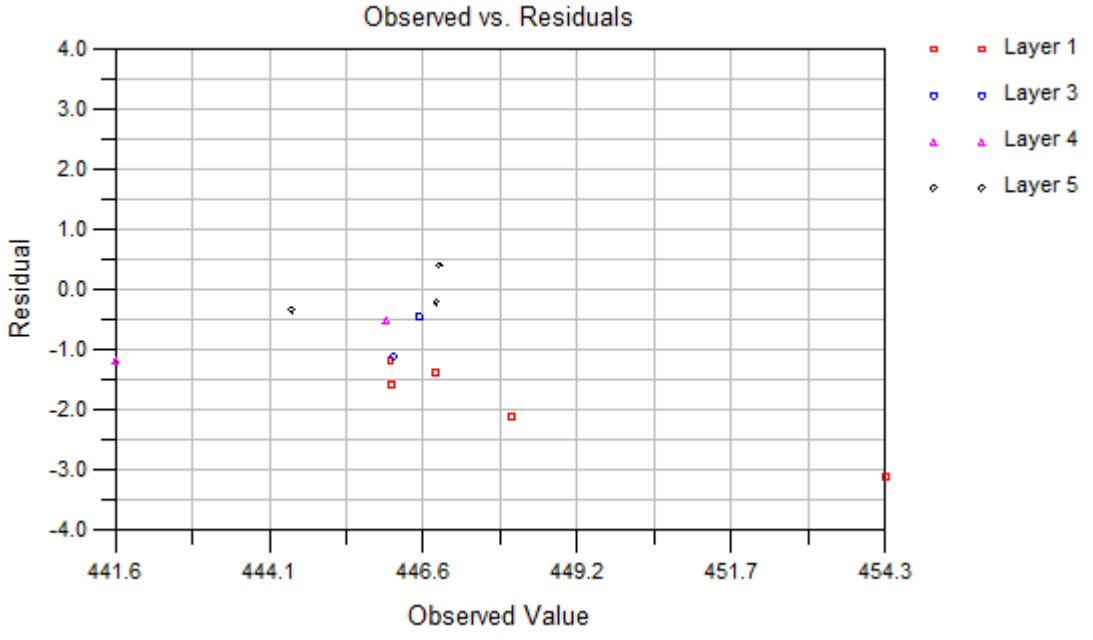

Note: Top plot displays observed heads versus simulated heads, and bottom plots displays observed heads versus residuals.

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Steady-State MODFLOW Model Calibration Results

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-1

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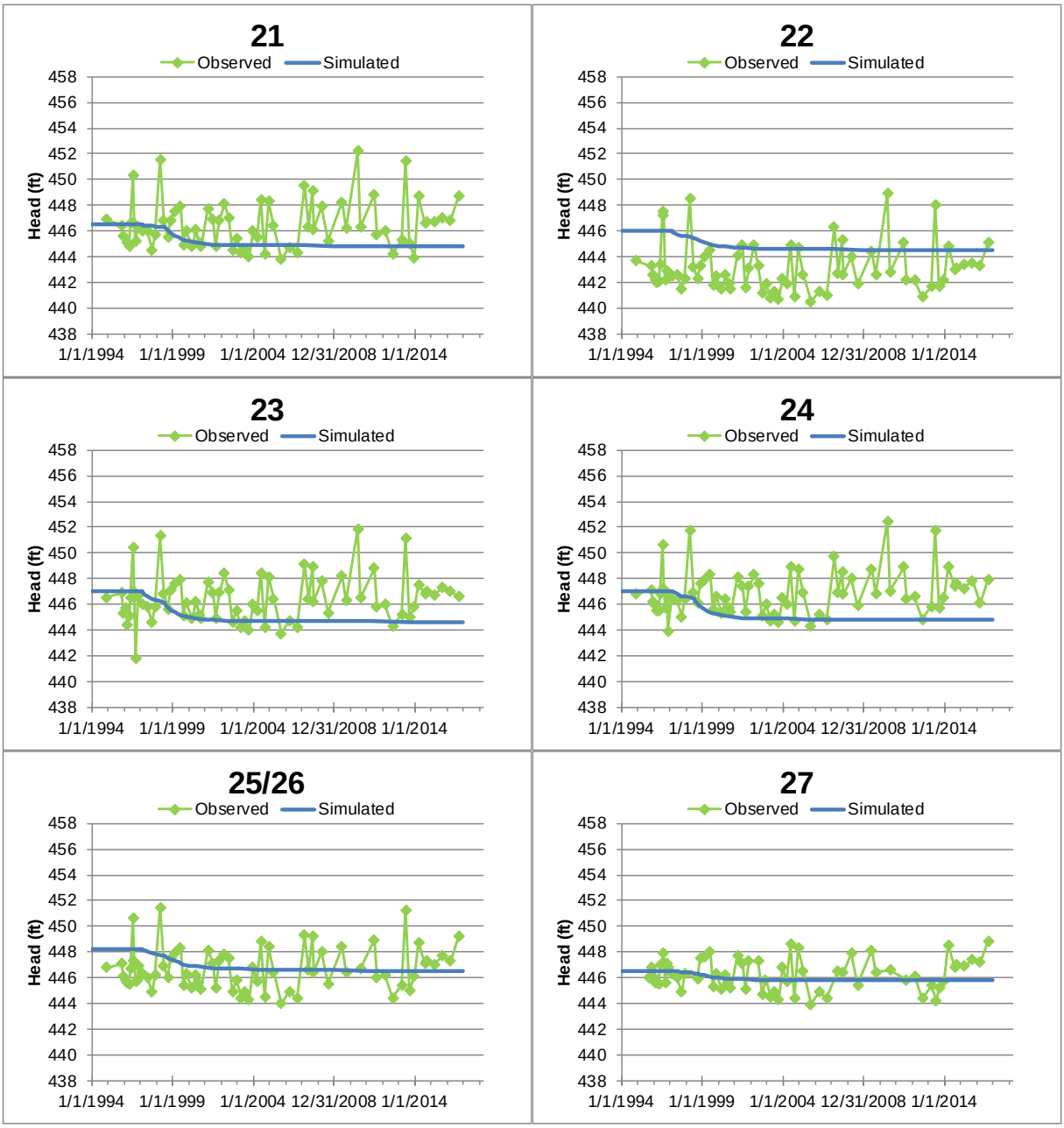

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Comparison of Calibration Heads to Observations from 1994 through 2016

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-2

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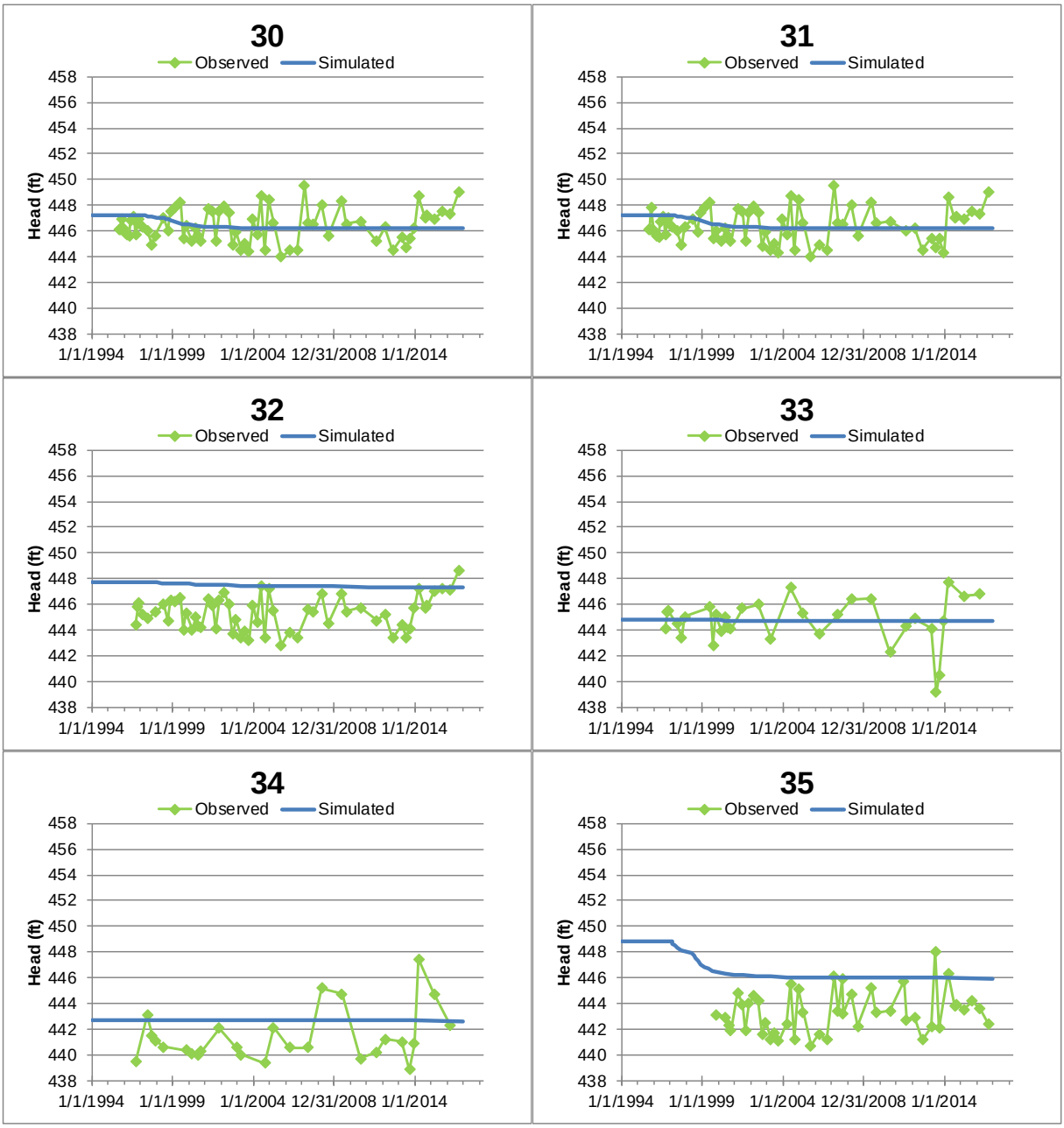

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Comparison of Calibration Heads to Observations from 1994 through 2016

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-2

Natural Resource Technology
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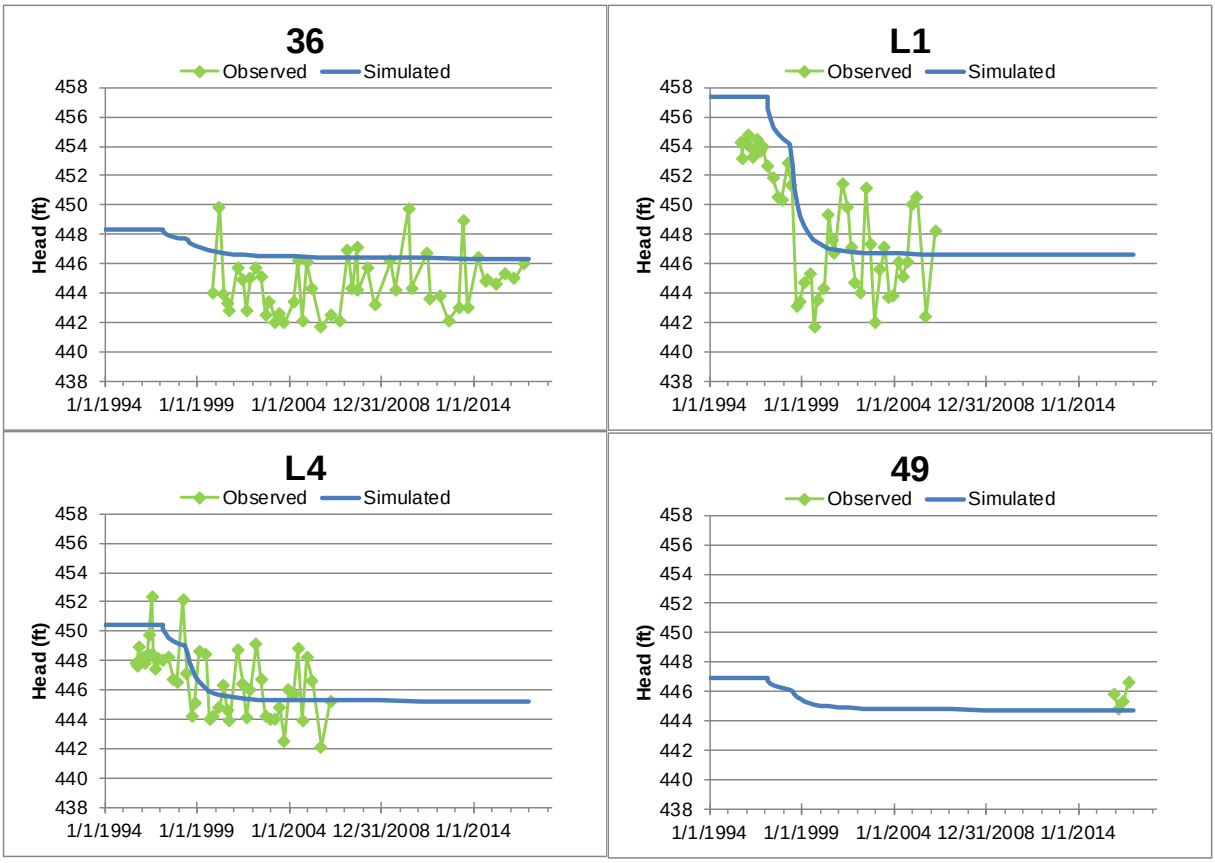
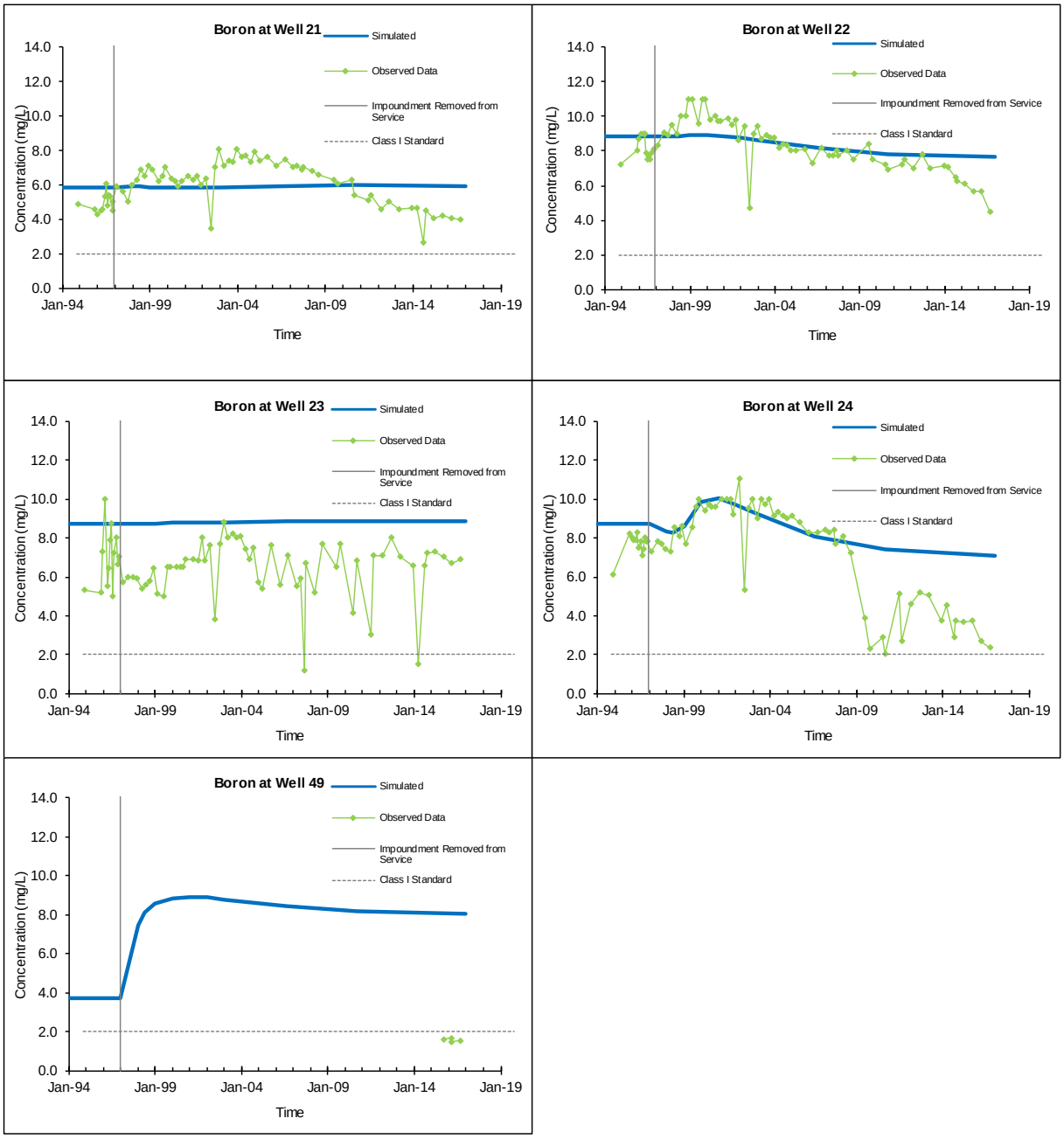


Figure 2-11(Cont'd). Comparison of Calibration Heads to Observations from 1994 through 2013.

PREPARED BY/DATE: M_W /08072017 REVIEWED BY/DATE: BGH /08252017	**Comparison of Calibration Heads to Observations from 1994 through 2016** GROUNDWATER MODEL REPORT HENNEPIN POWER STATION, WEST ASH POND SYSTEM DYNEGY MIDWEST GENERATION, LLC	**PROJECT NO: 2413** **FIGURE NO: 3-2** Natural Resource Technology AN OBG COMPANY



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Comparison of Calibration Boron Concentrations to Observations from 1994 through 2016

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-3

Natural Resource Technology
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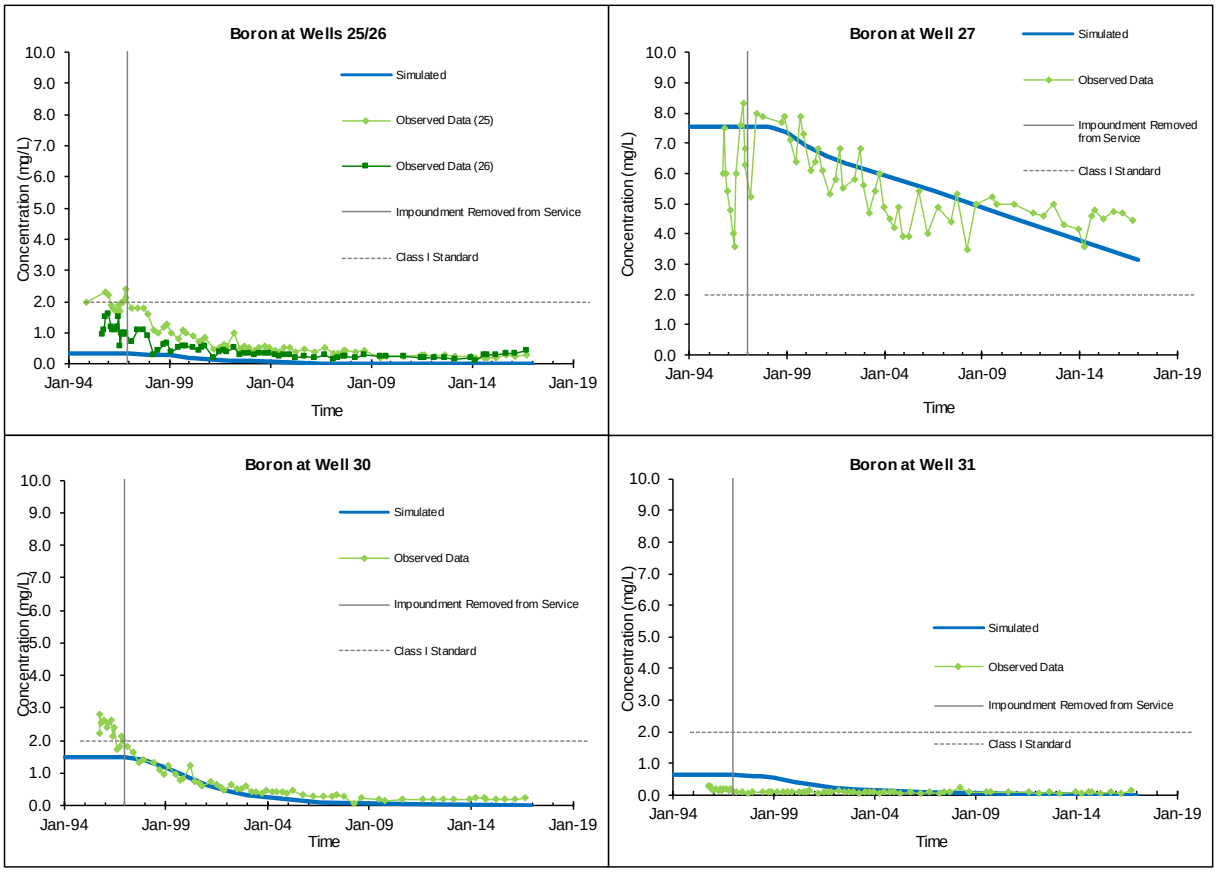

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Comparison of Calibration Boron Concentrations to Observations from 1994 through 2016

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-3

Natural Resource Technology
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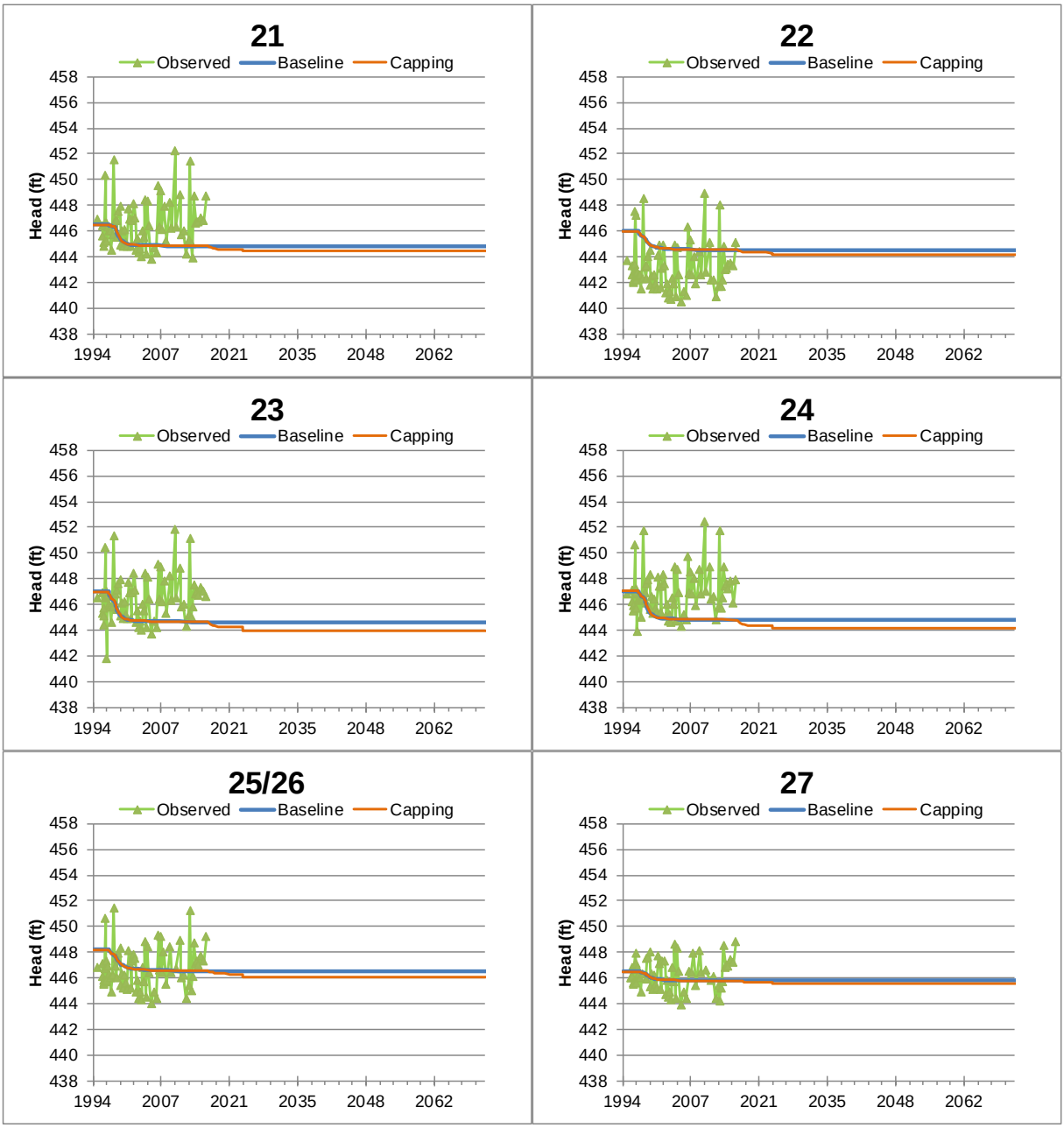

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Comparison of Predicted Heads between Baseline and Capping Scenarios

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-4

Natural Resource Technology
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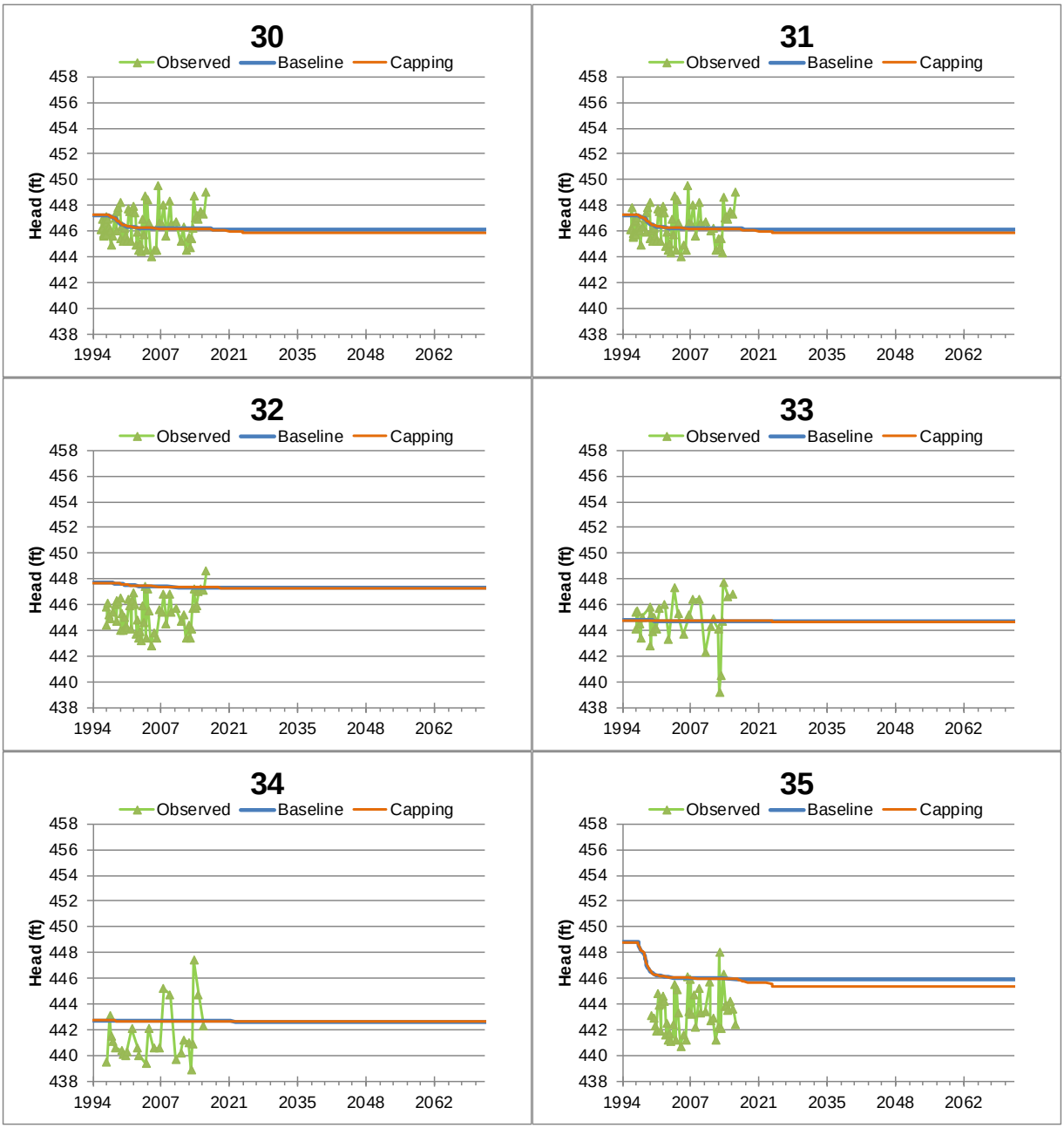

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Comparison of Predicted Heads between Baseline and Capping Scenarios

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-4

Natural Resource Technology
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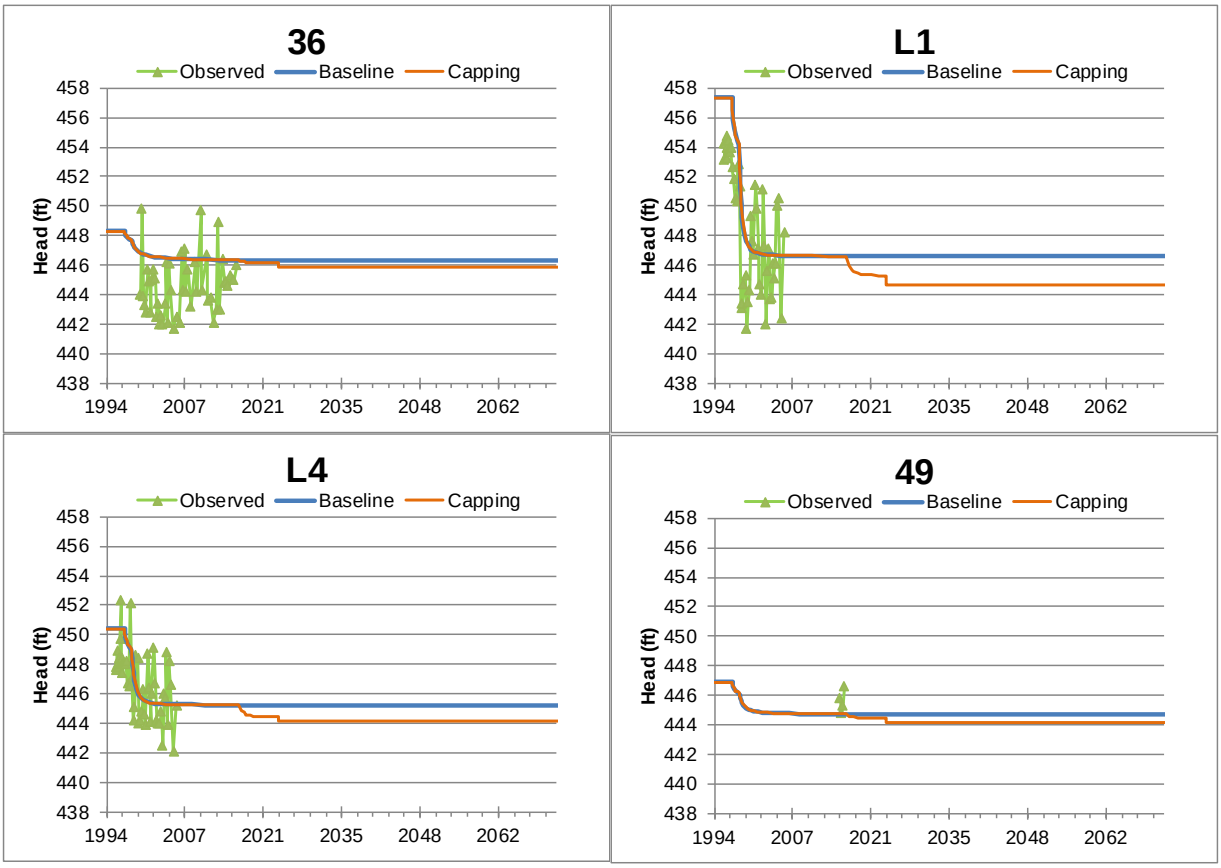

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Comparison of Predicted Heads between Baseline and Capping Scenarios

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-4

Natural Resource Technology
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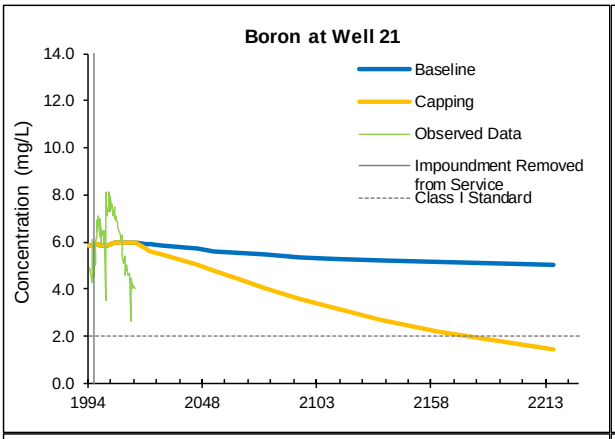

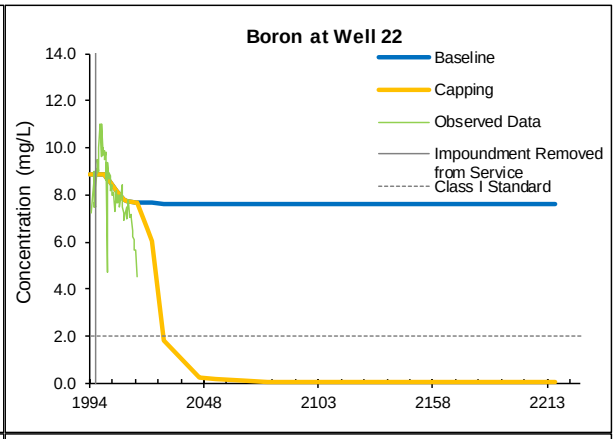

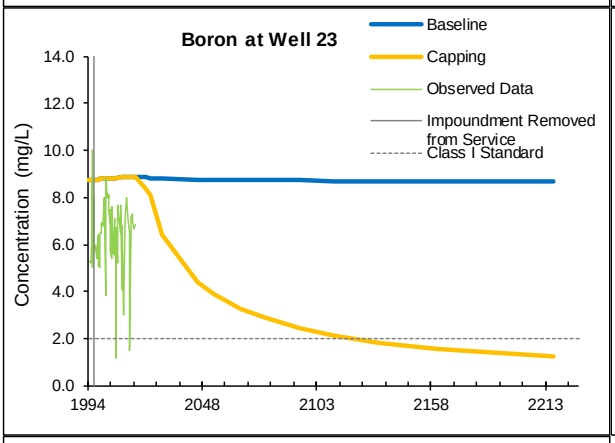

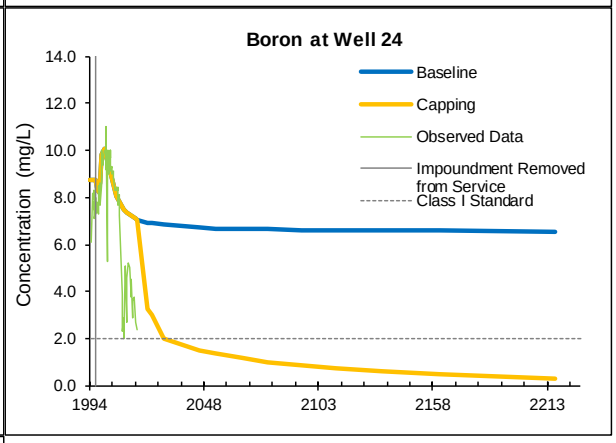

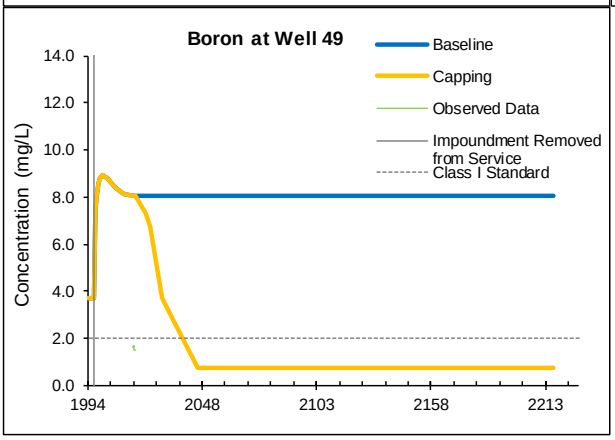

PREPARED BY/DATE:
M_W /08072017
REVIEWED BY/DATE:
BGH /08252017

Comparison of Predicted Boron Concentrations between Baseline and Capping Scenarios

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-5

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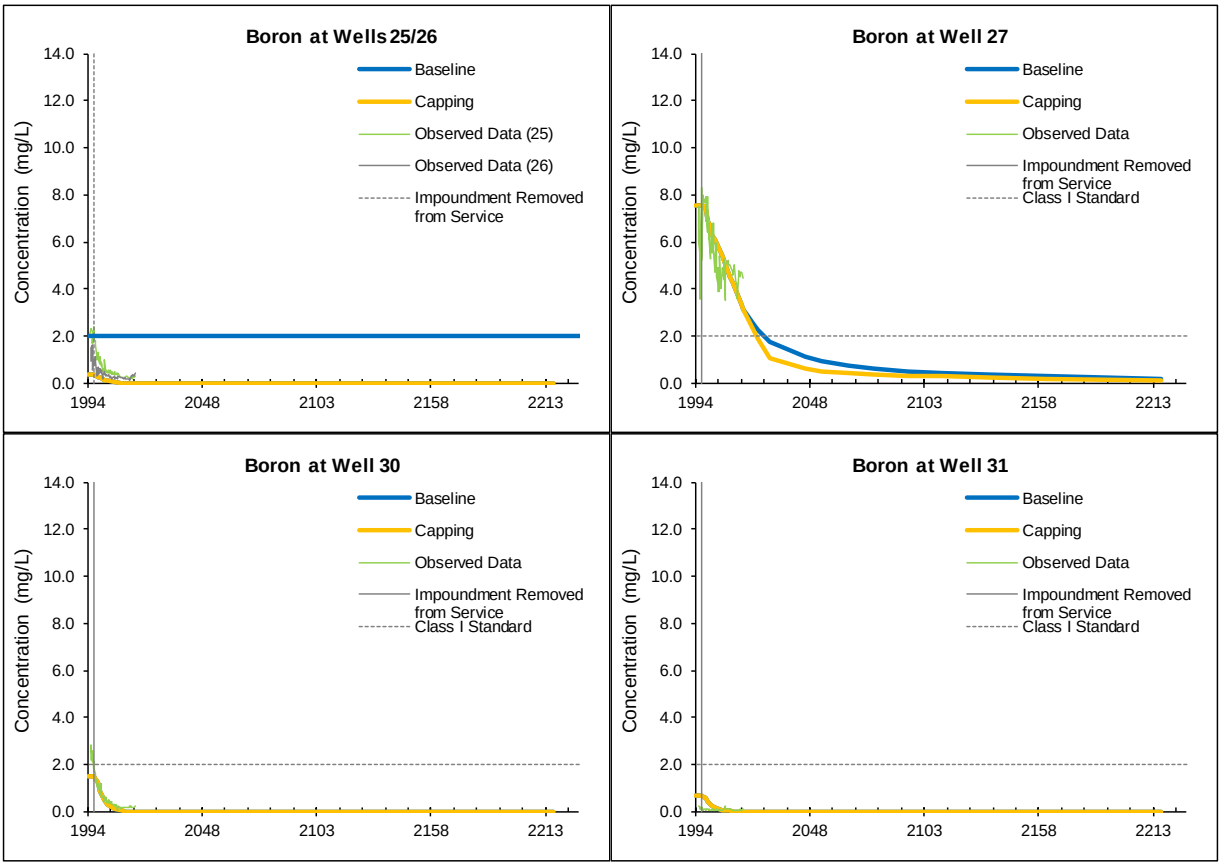

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Comparison of Predicted Boron Concentrations between Baseline and Capping Scenarios

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-5

Natural Resource Technology
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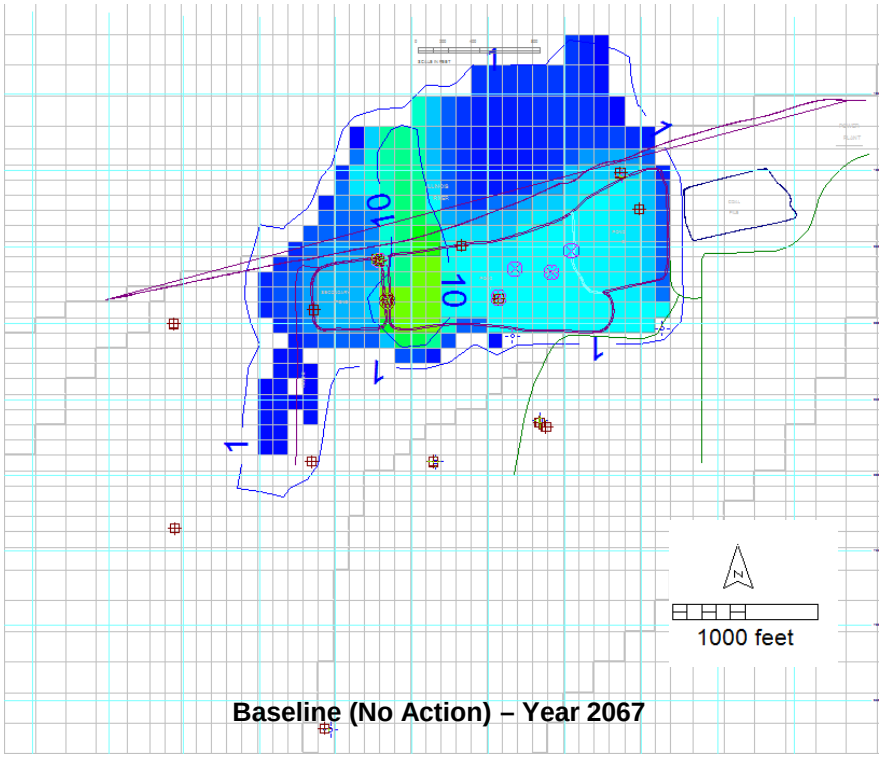
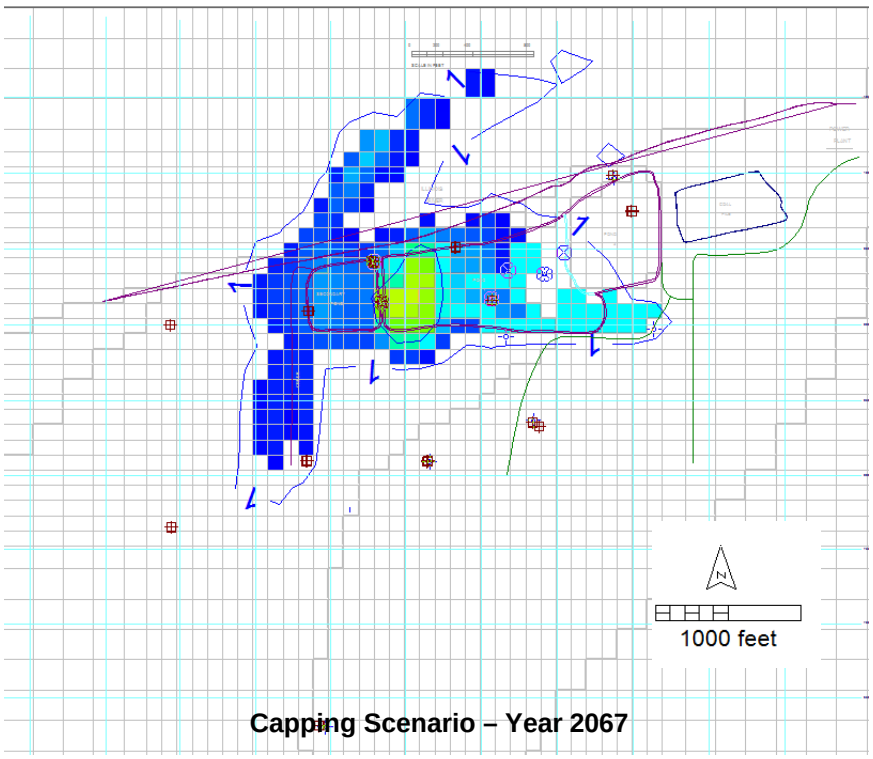


Baseline (No Action) – Year 2067



Capping Scenario – Year 2067

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Footprint of Boron Plume over 2 mg/L in Year 2067

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-6

Natural Resource Technology
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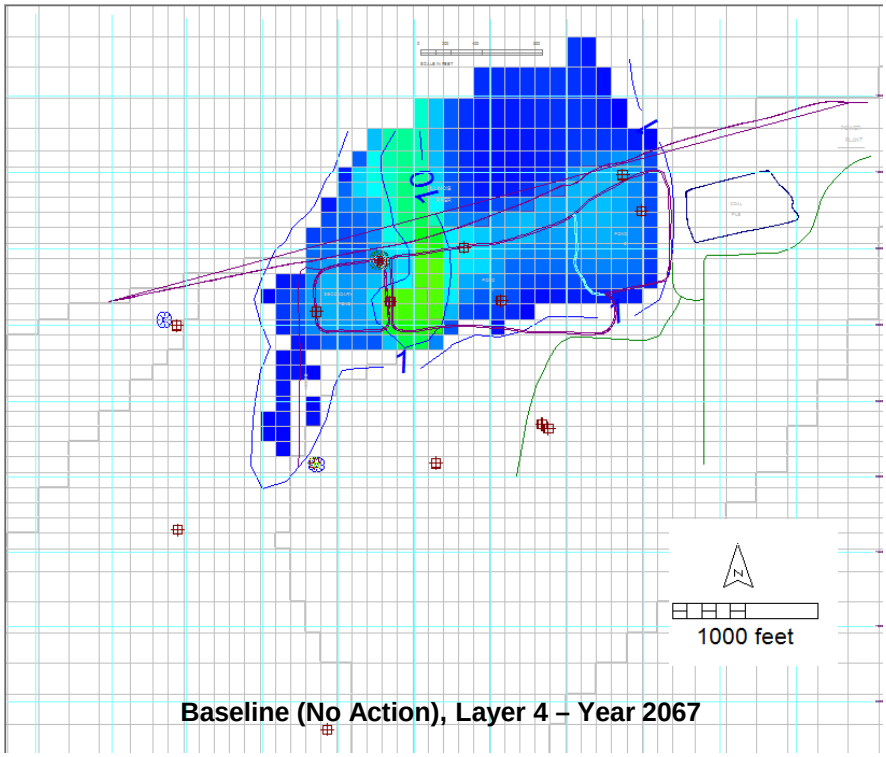
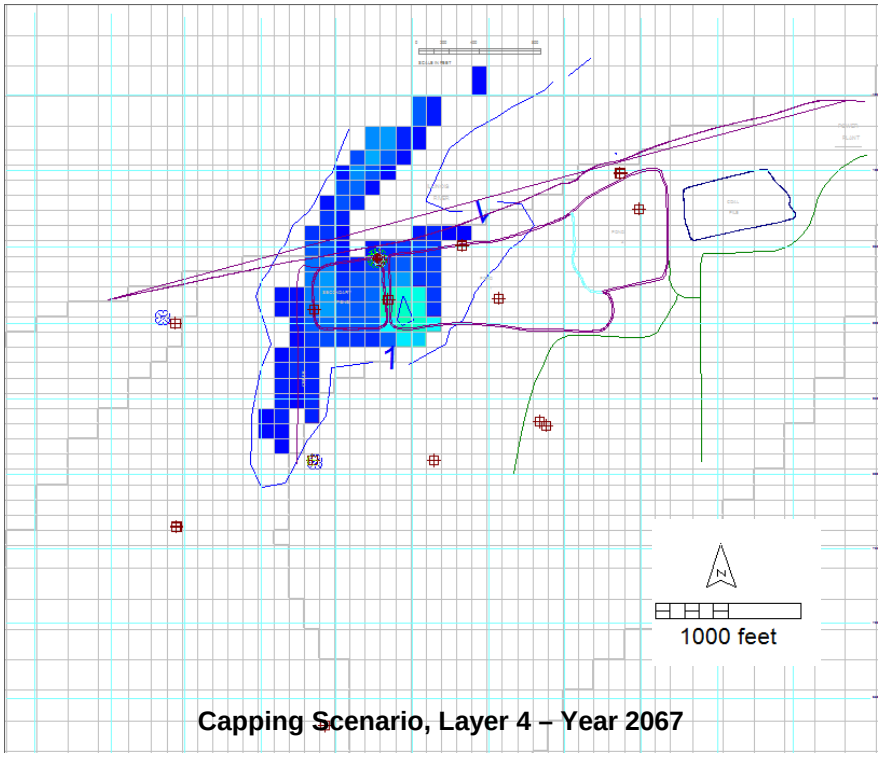


Baseline (No Action), Layer 4 – Year 2067



Capping Scenario, Layer 4 – Year 2067

PREPARED BY/DATE:
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BGH /08252017

Footprint of Boron Plume over 2 mg/L in Year 2067 (Layer 4)

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-7

Natural Resource Technology
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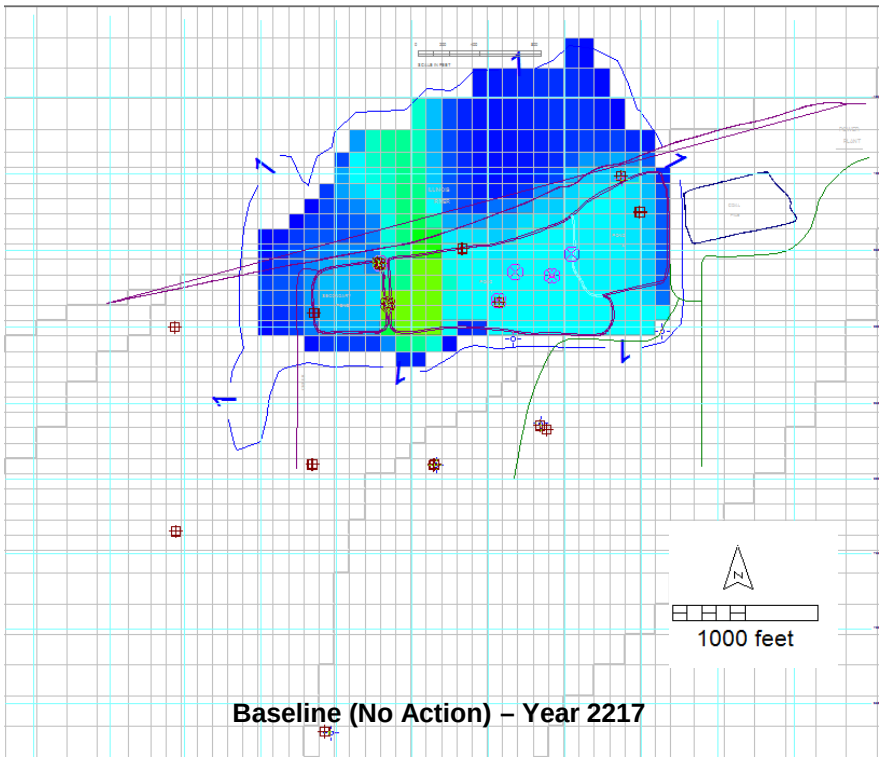
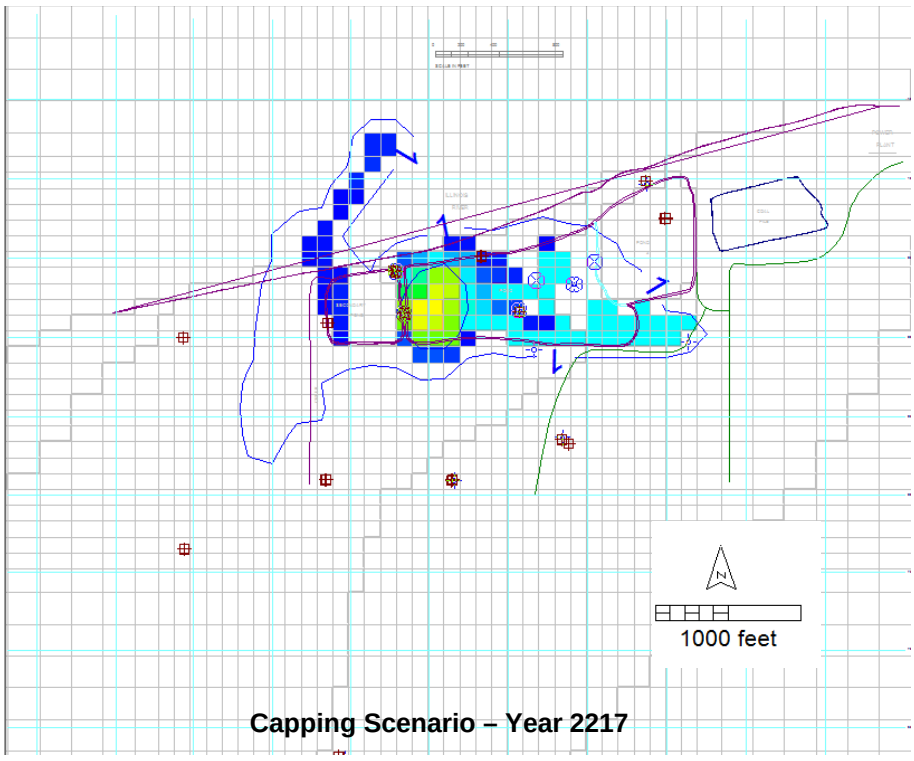


Baseline (No Action) – Year 2217



Capping Scenario – Year 2217

PREPARED BY/DATE:
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REVIEWED BY/DATE:
BGH /08252017

Footprint of Boron Plume over 2 mg/L in Year 2217

GROUNDWATER MODEL REPORT
HENNEPIN POWER STATION, WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2413

FIGURE NO: 3-8

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Appendix A
MODFLOW and MT3DMS Modeling Files (on CD)

OBG

THERE'S A WAY

APPENDIX C
MATERIAL QUANTITY, LABOR, AND MILEAGE ESTIMATES FOR ALTERNATIVE 2 REMEDY

RAMBOLL

DYNEGY MIDWEST GENERATION, LLC - HENNEPIN POWER PLANT
CORRECTIVE ACTION ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT (CAAA-SIR)
ALTERNATIVE 2 - SOURCE CONTROL WITH CONTINUOUS CONTAINMENT SYSTEM[1]

ITEM NO.	ENGINEERING, PRE-CONSTRUCTION, AND CONSTRUCTION SUPPORT TASKS	Units	Quantity	Crew	Daily Output	Labor Hours	Equipment Hours	Notes
1	Engineering Support and CQA During Construction	LS	1	Eng	12	6,240	2,080	Assumed labor and equipment hours based on Ramboll project experience.
	ENGINEERING, PRE-CONSTRUCTION, AND CONSTRUCTION SUPPORT ESTIMATED SUBTOTAL					**6,240**	**2,080**	
ITEM NO.	**SITE PREPARATION**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
2	Staging/Laydown Area Preparation	-	-	-	-	1,295	390	Assumes the general work area associated with the cutoff wall will need to be graded and built-up in order to make way for construction equipment needed for the install.
	Subsurface Stabilization Nonwoven Geotextile	SY	19,400	2 Clab	2500	124	0	313219161550: Geosynthetic soil stabilization, geotextile fabric, non-woven, 120 lb tensile strength includes scarifying and compaction. This assumes stabilization of access roads, staging area, and material handling system.
	Construct Staging/Laydown Areas	SY	15,000	B14	615	1,171	390	015523500100: Temporary, roads, gravel fill, 8" gravel depth, excluding surfacing. Assumes 3-acre staging/laydown area.
3	Construction Soil Erosion & Sediment Controls	-	-	-	-	774	258	Assumes soil erosion and sediment controls will be implemented only during the cutoff wall construction.
	Silt Fence	LF	20,800	B62	650	768	256	312514161000: Synthetic erosion control, silt fence, install and remove, 3' high. Assumes silt fence is installed down both sides of the cutoff wall alignment (5,200 ft total per side) and the silt fence is replaced once during cutoff wall construction. (20,800 ft total)
	Straw Wattles	LF	250	A2	1000	6	2	312514160705: Sediment Log, Filter Sock, 9". Assume straw wattles are needed along perimeter of cutoff wall and staging/laydown area at an occurrence of 1 every 50 feet. Replaced straw wattles once.
4	Construction Facilities	MO - in use	-	-	-	24	-	Assumes office trailer, storage boxes, and portable toilets are required during the construction phase of the alternative.
	Office Trailer	MO - in use	24	B66	-	8	-	015213200350: Office trailer, furnished, no hookups, 32' x 8'. Assume quantity of one (1). Duration is assumed to be 24 months for construction with winter contingency.
	Storage Trailers	MO - in use	24	B66	-	8	-	015213201350: Storage boxes, 40' x 8'. Assume quantity of three (3). Duration is assumed to be 24 months for construction with winter contingency.
	Portable Toilet	MO - in use	24	B66	-	8	-	015433406410: Toilet, portable chemical. Assume quantity of four (4). Duration is assumed to be 24 months for construction with winter contingency.
5	Temporary Contact Stormwater Management System					2,731	710	System to transfer CCR-contact stormwater to the existing onsite settling ponds for treatment prior to discharge
	Install Sump	EA	6	SI	4	24	12	Crew and Daily Output based on experience. Assumed one sump every 5 acres.
	Install 8" HDPE Conveyance Pipe	LF	11,200	B22A	320	1,400	280	331413350300: Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21. Includes labor, materials, and machine for installation and welding of HDPE pipe for conveying extracted water from sumps to EAP.
	Install Transfer Pump and Controller	EA	1	B6	1	52	0	Installation of transfer pump and pump controller to convey water from sumps to discharge outfall based on Ramboll project experience. Assumes inclusion of housing structure. Assume 2 days for installation.
	Install Equilibrium Tank	EA	2	B6	1	180	60	Installation of equalization tank at each trench and associated site preparation and instrumentation. Assumes 2 days for installation.
	Pipe Abandonment	LF	11,200	B6	250	1,075	358	024113380090: Selective demolition of 8" pipe.
6	Cutoff Wall Alignment Preparation Work Pad	-	-	-	-	2,263	754	Construct a temporary gravel work pad along entire cutoff wall alignment.
	Install Crushed Gravel Road (18" Thick) - Right of Way	SY	29,000	B14	615	2,263	754	015523500100: Temporary, roads, gravel fill, 8" gravel depth, excluding surfacing. Spanning 5,200-feet long and 50-feet wide.
	SITE PREPARATION ESTIMATED SUBTOTAL					**7,088**	**2,113**	
ITEM NO.	**CUTOFF WALL CONSTRUCTION**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
7	Temporary Final Cover Removal		-	-	-	482	140	Remove the final cover including cover soil and geosynthetics along the cutoff wall alignment to minimize damage to the final cover system over WAPS.
	Cover Removal	CY	2,300	B10X	575	48	32	312316465570: Excavating, bulk, dozer, open site, bank measure, common earth, 460 HP dozer, 300' haul Assumed 2 feet of thickness over 7 acres, is removed and stockpiled at coal yard.
	Geosynthetic Layers Removal	SF	305,000	B63B	22500	434	108	310519531200: Pond and reservoir liners, membrane lining systems HDPE, 100,000 S.F. or more, 60 mil thick, per S.F. Assumed removal of 7 acres. Also assumed removed geomembranes will be disposed of beneath the repaired final cover system to minimize off-site hauling/disposal.
8	Installation of Cutoff Wall	SF	504,400	-	-	10,761	2,690	Spoils to be temporarily placed in Hennepin Coal Yard and ultimately be placed in WAPS beneath the final cover system. Assumes 5,200-foot wall alignment, 3-foot wall width, and 97-foot wall depth. Assumes 5 feet thick layer that consists of boulders that require the use of hydromill. 312316420550: Excavating, bulk bank measure, 1 C.Y. capacity = 35 C.Y./hour, clamshell, excluding truck loading. This line item was included to quantify labor and equipment hours.
	Contruction Through Layer with Ash, Sand, Silt, and Clay - Heavy Equipment	SF	478,400	B12H	1500	5,103	2,551	Excavation of 92 feet of materials that do not require a hydromill.
	Contruction Through Layer with Ash, Sand, Silt, and Clay - Labor	SF	478,400	2 Clab	1500	5,103	0	Additional laborers to assist excavation
	Contruction Through Layer with Ash, Sand, Silt, and Clay - Heavy Equipment	SF	26,000	B12H	1500	277	139	Excavation of 5-foot layer with boulders that require the use of a hydromill. Assumed a total of 5 feet of the entire cutoff wall may require advancement through boulders or other obstructions.
	Contruction Through Layer with Ash, Sand, Silt, and Clay - Labor	SF	26,000	2 Clab	1500	277	0	Additional laborers to assist excavation
9	Spoils Management	CY - Loose	57,000	-	-	2,846	2,255	Quantity based on surface to surface calculation. Spoils assumed to be temporarily staged in Hennepin Coal Yard Area and then moved to EAP for use as contouring fill.
	Loading	CY - as excavated	114,000	B14B	5000	274	182	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket, 100% fill factor (assume 10% fluff factor from ground to excavated).
	Double Hauling and Placement at Coal Yard area	CY - as excavated	114,000	B34G	850	1,073	1,073	312323206170: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 34 C.Y. off-road, 15 min wait/ld./uld., 15 MPH, cycle 1 mile. Daily output extrapolated down to 10 min wait.
	Spreading/Drying Moisture Conditioning	CY - as excavated	57,000	B10B	1000	684	456	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience. Quantity assumes 50% of volume requires moisture conditioning.
	Spreading Lifts	CY - as excavated	57,000	B10B	1000	684	456	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience.

	Compaction of Material	CY - in place	57,000	B10G	5200	132	88	312323235680: Compaction; Riding, sheepsfoot or wobbly wheel roller, 12" lifts, 2 passes. Assuming material to be compacted will be fine and not coarse.
10	Geotechnical Monitoring	LS	-			1,176	-	Geotechnical monitoring of embankment stability during wall construction
	Installation Fee	LS	1	GM	-	600	-	Assumes installation of inclinometers, survey prisms, and settlement monitoring devices along the WAPS dikes. Assumes a 4-person crew installs the monitoring system over a period of 3 weeks. Based on Ramboll experience
	Monthly O&M Fee	MO	24	Eng	-	576	-	Assumes crew to make two-day visits for monthly calibration, etc for duration of construction.
11	Contact Water Storm Water Management					236	11	Contact storm water will be collected from the sumps and pumped to the Leachate Pond or Secondary Settling Pond near EAP.
	Field Maintenance (O&M)	Event	104	OM	-	208	0	Assumes weekly maintenance visits on pumps and conduits during construction. Each visit assumes 2 staff for 2 days to check, clean, and service all mechanical parts. Assumes 24 months of contruction.
	Generator Charges	Ea	1	R3	1	28	11	263213160300. Gasoline, 3 phase 4 wire, 277/480 V, 11.5 kW generator
	CUTOFF WALL CONSTRUCTION					**15,501**	**5,097**	
ITEM NO.	**SITE RESTORATION**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
12	Replacement of Cover Soils/Vegetation	-	-	-	-	118	99	Assumes restoration of chain link fence along property boundary and restoration of grade surface following cutoff wall installation
	Loading and Spreading Stockpiled Cover Material	CY	2,300	B10B	1000	28	18	312323170011: Fill, dumped material, spread, by dozer, excludes compaction Assumed 2 feet of thickness over 7 acres, returned from stockpile staged at coal yard
	Grading	Ea	1	B62	2	16	5	312213200130: Rough grading sites, 1,100-3,000 S.F., skid steer & labor
	Lime	MSF	455	B66	700	5	5	329113234250: Soil preparation, structural soil mixing, spread soil conditioners, ground limestone, 1#/S.Y., tractor spreader. Assume soils possibly being void of nutrients.
	Fertilizer	MSF	455	B66	700	5	5	329113234150: Soil preparation, structural soil mixing, spread soil conditioners, fertilizer, 0.2#/S.Y., tractor spreader. Assume soils possibly being void of nutrients.
	Grassland Mix	MSF	350	B66	52	54	54	329219142300: Seeding athletic fields, seeding fescue, tall, 5.5 lb. per M.S.F., tractor spreader. Quantity all disturbed areas minus wetland area, pollinator area, and 15-acre pond in consolidated area.
	Mulch	MSF	350	B65	530	11	11	329113160350: Mulching, Hay, 1" deep, power mulcher, large.
13	Replacement of Liner Materials	-	-	-	-	441	0	Assumes replacing damaged liners along the cutoff wall alignment
	Geotextile	SF	310,000	2 Clab	22500	220	0	313219161550: Geotextile soil stabilization; non-woven 120 lb. tensile strength (Assume heavier geotextile based on experience)
	Geomembrane	SF	310,000	2 Clab	22500	220	0	310519531200: Pond and reservoir liners, membrane lining systems HDPE, 100,000 S.F. or more, 60 mil thick, per S.F.
	SITE RESTORATION ESTIMATED SUBTOTAL					**559**	**99**	

	Total Labor Hours	**Total Equipment Hours**
ENGINEERING AND CONSTRUCTION SUBTOTAL	**29,387**	**9,389**
CORRECTIVE ACTION OPERATION AND MAINTENANCE SUBTOTAL	**-**	**-**
ALTERNATIVE 2 SUBTOTAL	**29,400**	**9,400**

NOTES:

1. Alternative 2: Source Control with continous containment system is estimated to take approximately 33 years to achieve groundwater protection standards (GWPS-35 I.A.C Section 845.600) at a majority of perimeter wells associated with the West Ash Pond System (WAPS). The monitoring period has been capped at 30 years total, plus 3 additional years of compliance monitoring.
2. RS Means refers to the 2023 online edition of RS Means Heavy Construction.
3. See crew tab (Alt 2 - Crew) for assumptions regarding crew size, total labor hours and required construction equipment, as needed, for each task.
4. See mileage tab (Alt 2 - Mileage) for assumptions regarding total mileage for tasks outlined in this alternative.

ACRONYMS:

AC = Acre
CY = Cubic Yard
  Bank: Material in natural compacted state
  Loose: Material swelled when removed from compacted state
EAP = East Ash Pond
EA = Each
WAPS = West Ash Pond System
GWPS = groundwater protection standards
LF = Linear Foot
LS = Lump Sum
MSF = square feet divided by 1000
MO = Month

CREW CODES
DYNEGY MIDWEST GENERATION, LLC - HENNEPIN POWER PLANT
CORRECTIVE ACTION ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT (CAAA-SIR)
ALTERNATIVE 2 - SOURCE CONTROL WITH CONTINUOUS CONTAINMENT SYSTEM

Item No.	Crew Code	Labor	Daily Labor Hours	Equipment	Daily Equipment Hours	Crew Size	Onsite Labor Hours	Onsite Heavy Equipment Hours
Construction								
2, 8, 13	2 Clab	Laborer x2	16	None	0	2	5,945	0
3	A2	Laborer x2 Truck Driver x1	24	Flatbed Truck, Gas, 1.5 ton	8	3	6	2
5	B6	Laborer x 2 Operator (light) x 1	24	Backhoe Loader, 48 H.P.	8	3	1,307	418
9, 12	B10B	Operator x1 Laborer x0.5	12	Dozer, 200 H.P.	8	1.5	1,396	930
9	B10G	Operator (med) x1 Laborer x0.5	12	Sheepsfoot Roller, 240 H.P.	8	1.5	132	88
7	B10X	Operator (med) x1 Laborer x0.5	12	Dozer, 105 H.P.	8	1.5	48	32
8	B12H	Laborer x1 Operator x1	16	1 Crawler Crane, 25 Ton 1 Clamshell Bucket, 1 C.Y.	8	2	5,380	2,690
2, 6	B14	Labor Foreman x 1 Operator (light) x1 Laborer x 4	48	Hyd. Excavator, 4.5 C.Y.. Backhoe Loader, 48 H.P.	16	6	3,434	1,145
9	B14B	Operator x1 Laborer x0.5	12	Hyd. Excavator, 6 C.Y.	8	1.5	274	182
5	B22A	Labor Foreman x1 Skilled Worker x1 2 Laborers 1 Equipment Operator, crane	40	1 S.P. Crane 4x4	8	5	1,400	280
9	B34G	Truck Driver x1	8	Dump Truck, Off Hwy., 50 ton	8	1	1,073	1,073
3, 12	B62	Laborer x2 Operator x 1	24	Loader, Skid Steer, 30 H.P.	8	3	784	261
7	B63B	Labor Foreman x1 Laborer x2 Operator x1	32	Loader, Skid Steer, 78 H.P.	8	4	434	108
12	B65	Laborer x1 Truck Driver (light) x1	16	Power Mulcher (large) x1 Flatbed Truck, Gas, 1.5 Ton x1	16	2	11	11
4, 12	B66	Operator (light) x1	8	Flatbed Truck, Gas, 1.5 Ton x1	8	1	88	64
11	R3	1 Electrician Foreman 1 Electrician 0.5 Operator (crane)	20	0.5 S.P. Crane, 4x4, 5 Ton	8	2.5	28	11
10	GM	Engineering Staff x4	40	Service Vehicle X 2	0	4	600	0
1, 10	Eng	Engineering Staff x1.2	10	Side by Side x1	4	1.2	6,816	2,080
5	SI	Laborer x1 Operator x1	16	Hyd. Excavator, 4.5 C.Y.	8	2	24	12
11	OM	Laborer x1	10	None	0	1	208	0
				Construction Subtotals			29,387	9,389
Note: Blue shaded crew codes were created by Ramboll based on experience (not pulled from RS Means).					**Totals**		**29,400**	**9,400**

CONSTRUCTION MILEAGE AND LABOR ESTIMATES
DYNEGY MIDWEST GENERATION, LLC - HENNEPIN POWER PLANT
CORRECTIVE ACTION ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT (CAAA-SIR)
ALTERNATIVE 2 - SOURCE CONTROL WITH CONTINUOUS CONTAINMENT SYSTEM

Construction Mileage and Labor Estimates

Item	Quantity	Assumptions
Labor Total Hours	29,387	Per projected Construction total in cost estimate (does not include contingency)
Duration of Onsite Construction Days	520	Total Days
Average Daily Crew Size	12.3	10 hour days (5 days per week) Assumes 11 workers for site preparation for duration of 2 months, 13 workers for construction for duration of 17 months, 6 workers for site restoration for 2 months
Daily Labor Mobilization Miles	445,900	Inlcudes light and medium commercial vehicles Average of 70 miles round trip per day
Vehicles Miles Onsite	95,550	1 mile per day round trip from gate to parking 5 miles per day for groundwater sampling and well maintenance staff 9 miles per day local trips (Vil. of Hennepin) No contingency Included
Equipment Mobilization Miles - Unloaded	27,040	Average of 260 miles round trip for equipment hauling Average 1 load of equipment per working week
Equipment Mobilization Miles - Loaded	27,040	Average of 260 miles round trip for equipment hauling Average 1 load of equipment per working week
Onsite Haul Truck Miles - Unloaded	1,676	34 CY Off Road Dump Truck 2 mile round trip per load
Onsite Haul Truck Miles - Loaded	1,676	34 CY Off Road Dump Truck 2 mile round trip per load
Offsite Haul Truck Miles - Unloaded	60,417	Assumes 16 CY loads of gravel are delivered to the site from a regional supplier located within 100 miles of the site
Offsite Haul Truck Miles - Loaded	60,417	Assumes truck is returning to the regional supplier located within 100 miles of the site
Material Delivery Miles - Unloaded	105,000	Misc. construction materials (cement, bails, etc) Assumes 200 mile round trip on a daily basis 1 delivery of geomembrane (1,000 miles)
Material Delivery Miles - Loaded	105,000	Misc. construction materials (cement, bails, etc) Assumes 200 mile round trip on a daily basis 1 delivery of geomembrane (1,000 miles)

O&M Mileage and Labor Estimates - Alternative 2: Source Control with Continuous Containment System

Item	Quantity	Assumptions
Labor Total Hours	0	No O&M for Alt 2
Duration of Onsite OMM Days	0	-
Average Daily Crew Size	0	-
Daily Labor Mobilization Miles	0	-
Vehicles Miles Onsite	0	-
Equipment Mobilization Miles - Unloaded	0	-
Equipment Mobilization Miles - Loaded	0	
Onsite Haul Truck Miles - Unloaded	0	-
Onsite Haul Truck Miles - Loaded	0	-
Offsite Haul Truck Miles - Unloaded	0	-
Offsite Haul Truck Miles - Loaded	0	-
Material Delivery Miles - Unloaded	0	-
Material Delivery Miles - Loaded	0	-

Legend:
CAGM = Corrective Action Groundwater Monitoring
O&M = Operation & Maintenance

Appendix C

Corrective Measures Assessment

Intended for
Dynegy Midwest Generation, LLC

Date
May 8, 2024

Project No.
1940103584-005

35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT

HENNEPIN POWER PLANT, WEST ASH POND SYSTEM, IEPA ID: W1550100002-01 AND W1550100002-03

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35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT HENNEPIN POWER PLANT, WEST ASH POND SYSTEM, IEPA ID: W1550100002-01 AND W1550100002-03

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ATTACHMENTS

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ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
ASD	Alternative Source Demonstration
CAAA	corrective action alternatives analysis
CAP	Corrective Action Plan
CBR	closure-by-removal
CCR	coal combustion residuals
CIP	closure-in-place
Closure Plan	Closure and Post-Closure Care Plan
CMA	Corrective Measures Assessment
CSM	conceptual site model
DMG	Dynegy Midwest Generation, LLC
E001	monitoring event 1
E002	monitoring event 2
E003	monitoring event 3
EPRI	Electric Power Research Institute
Geosyntec	Geosyntec Consultants, Inc.
GMP	groundwater monitoring plan
GWPS	groundwater protection standard(s)
HCR	Hydrogeologic Site Characterization Report
HPP	Hennepin Power Plant
ID	identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ISS	In-situ stabilization
ITRC	National Research Council, Interstate Technology & Regulatory Council
IX	ion exchange
NAVD88	North American Vertical Datum of 1988
NID	National Inventory of Dams
No.	number
NPDES	National Pollutant Discharge Elimination System
NRT/OBG	Natural Resource Technology, an OBG Company
OWAP	Old West Ash Pond
OWPP	Old West Polishing Pond
PRB	permeable reactive barrier
psi	pounds per square inch
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SI	surface impoundment
Site	Hennepin Power Plant
TDS	total dissolved solids
UA	uppermost aquifer
USEPA	United States Environmental Protection Agency
WAPS	West Ash Pond System
ZVI	zero-valent iron

1. INTRODUCTION

1.1 Overview

Ramboll Americas Engineering Solutions, Inc. (Ramboll) has developed this assessment of groundwater corrective measures on behalf of the Hennepin Power Plant (HPP), owned and operated by Dynegy Midwest Generation, LLC (DMG), to assist in the compliance with the requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments. This assessment applies specifically to the coal combustion residuals (CCR) surface impoundments (SI) referred to as the West Ash Pond System (WAPS), also referred to as the Old West Ash Pond (OWAP [Illinois Environmental Protection Agency [IEPA] identification [ID] number (No.) W1550100002-01]) and Old West Polishing Pond (OWPP, [IEPA ID No. W1550100002-03]), and CCR Unit ID No. 804, and National Inventory of Dams (NID) No. IL50698. This report addresses content requirements specific to 35 I.A.C. § 845.660 (Assessment of Corrective Measures) for exceedances of arsenic, boron, sulfate, lithium, and total dissolved solids (TDS) at the WAPS.

1.2 Source Control and Residual Plume Management

DMG completed significant source control and residual plume management efforts in 2020 as part of final closure of the WAPS. The final closure was performed in accordance with the Closure and Post-Closure Care Plan (Closure Plan; Geosyntec Consultants, Inc. [Geosyntec], 2017) that was developed in accordance with Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257 and submitted to IEPA for review. IEPA approved the Closure Plan and found "*…the closure and post-closure care plan…to be an adequate corrective action*" (IEPA, 2018). The final closure was addressed in accordance with the IEPA Water Pollution Control permit 2020-EA-65026-1.

The WAPS closure construction included a hybrid consolidate-and-cap approach comprised of closure-by-removal (CBR) of the OWPP and closure-in-place (CIP) of the OWAP. This was accomplished by removing impounded water from within the OWAP and OWPP, excavating CCR and approximately one foot of soil below the CCR, from the OWPP and placing it into the OWAP, and constructing an alternate soil and geosynthetic cover system over the OWAP, in accordance with 40 C.F.R. § 257.102. These source control activities will serve as the primary groundwater corrective measure at the WAPS. The potentially feasible corrective measures presented herein are intended to be supplementary to the primary source control and are intended to serve as management measures to address any residual plumes that remain after completion of source control.

Attachment A includes summary figures (from the final closure plan) showing the final IEPA approved source control and primary corrective action.

1.3 Adaptive Site Management

Adaptive site management strategies will be employed as an integral part of ongoing corrective action at the WAPS. The adaptive site management approach will allow timely incorporation of new site information over the post-closure life cycle of the WAPS to ensure the achievement of the groundwater protection standards (GWPS). The adaptive site management approach is proposed to expedite progress toward meeting the GWPS while acknowledging uncertainties, such as the persistence of current groundwater flow directions and flux quantities and potential related changes in geochemical conditions. A structured decision-making process and explicitly

planned iterations between the implemented corrective measures and monitoring results will ensure that remediation is occurring. System performance and the condition of the residual plume will be monitored as the corrective measure(s) selected through the I.A.C. § 845.710 Corrective Action Plan (CAP) process are implemented to supplement the source control measures described above. If the groundwater concentrations do not decrease consistent with the modeling prediction, the adaptive site management approach will facilitate timely modifications or enhancements to the corrective measure(s), as needed in accordance with 35 I.A.C. §845.680(b). This approach will be employed to provide continuous improvement to the WAPS groundwater remediation in response to new site information and/or the performance of the selected corrective measure(s).

The planned adaptive site management strategies are generally consistent with National Research Council, Interstate Technology & Regulatory Council (ITRC) and United States Environmental Protection Agency (USEPA) methodologies developed to address sites with long remediation times and high levels of uncertainty regarding the remedial actions necessary to achieve final and protective remediation goals (USEPA, 2022). The elements of the proposed adaptive site management strategy at the WAPS will be responsive to the changing conditions associated with pond closure and performance of the selected corrective measure(s) and will include the following:

1. Implementing the groundwater corrective measure(s) selected as part of the CAP for the current conditions at the WAPS. The selected corrective measures may include a combination of the technologies presented in this Corrective Measures Assessment (CMA).
2. Establishing both the absolute remedial objective and functional (interim) goals to monitor progress toward the remedial objective. Achieving the GWPS for 35 I.A.C. § 845.600 constituents at the downgradient waste boundary is the remedial objective for the WAPS. Specific functional goals will be developed as part of the CAP process. The functional goals will be measurable thresholds for future action and may include short-term or technology-specific objectives and triggers. Functional goals may vary for different locations, CCR constituents or other site-specific considerations (ITRC, 2017) and will serve as benchmarks for comparison to ongoing groundwater monitoring at the WAPS.
3. Ongoing groundwater monitoring at the WAPS will continue throughout at least the post-closure care period. Post-closure monitoring will continue for a period of at least 30 years, in accordance I.A.C. § 845.780(c), or until GWPS have been met for at least 3 years, whichever is longer. A comprehensive groundwater monitoring plan (GMP) will be developed as part of the CAP process in accordance with 35 I.A.C. § 845.670 and 35 I.A.C. § 845.220(c)(4). The GMP will include the functional goals and proposed action levels.
4. Groundwater monitoring information will be used to guide decisions regarding whether progress toward the remedial goal is advancing as expected and/or whether additional actions may be needed to achieve the remedial objective, in conjunction with IEPA, as required by 35 I.A.C. § 845.680(b).

2. SITE INFORMATION

The HPP is located in the northwest quarter of Section 26, Township 33 North, Range 2 West, Putnam County, Illinois and approximately 3 miles north-northeast of the Village of Hennepin. The WAPS is located west of the power plant and situated in an area that is a mixture of agricultural and undeveloped land use (**Figure 2-1**). The WAPS is a closed CCR SI consisting of two closed, unlined CCR sub-units including the OWAP (IEPA Unit ID W1550100002-01) and the OWPP (IEPA Unit ID W1550100002-03). The two sub-units formerly comprised the WAPS and were surrounded by a continuous earthen embankment. Prior to closure, the sub-units were divided utilizing an internal splitter dike to support plant operations, where CCR was deposited within the OWAP and the OWPP was utilized as a polishing pond prior to discharging process water to the Illinois River via a National Pollutant Discharge Elimination System (NPDES) outfall. As part of closure, the OWPP, all CCR within the OWPP, and the OWPP perimeter dikes were removed and placed within the WAPS. The pre-closure surface area of the WAPS was approximately 35 acres. The current surface area of the OWAP final cover area is approximately 29 acres (**Figure 2-2**). The Illinois River is connected to the post-closure OWPP by a culvert, allowing for the water level in the OWPP to be similar to the Illinois River. The OWPP functions as post-closure wildlife habitat.

The Closure Plan was submitted to IEPA in 2017 (Geosyntec, 2017). The Closure Plan was approved by IEPA in a letter dated June 19, 2018. The approved Closure Plan summarized the planned closure of the WAPS, which included dewatering the CCR, mechanical excavation of material from the OWPP for use as structural fill in the WAPS, grading within the WAPS, constructing an alternative cover system consisting of geomembrane and vegetated cover soils in direct contract with the graded CCR, and establishment of a vegetative cover. Closure construction was completed by November 17, 2020 (DMG, 2020a; DMG 2020b).

2.1 Conceptual Site Model

Significant site investigation has been completed at the HPP to characterize the geology, hydrogeology, and groundwater quality. Based on extensive investigation and monitoring, the WAPS has been well characterized and detailed in the Hydrogeologic Site Characterization Report (HCR; Natural Resource Technology, an OBG Company [NRT/OBG], 2017c). The conceptual site model (CSM) is presented below.

There are three dominant geomorphic features in the immediate vicinity of the HPP: an upper river terrace at an elevation of about 500 to 550 feet[1], a lower river terrace at an elevation of about 450 to 460 feet, and the current river valley filled with alluvium to an elevation of about 445 feet. The HPP and the eastern portion of the WAPS are on the lower terrace. The western portion of the WAPS overlies alluvium.

The hydrogeological assessment identified that the stratigraphy within and immediately surrounding the WAPS consists of fill, unlithified river alluvium, and Pleistocene-age glacial outwash deposits overlying Pennsylvanian-age shale bedrock. Where undisturbed or partially excavated, the native surficial soil at the site is poorly drained, moderately permeable silty clay loam formed as alluvium in floodplains.

[1] All elevations in this report are refenced to North American Vertical Datum of 1988 (NAVD88) unless otherwise noted.

The Site is characterized by two hydrostratigraphic units:

- **Uppermost Aquifer (UA)**: Includes the unlithified natural geologic materials of the Cahokia Alluvium and Henry Formation extending from the upper saturated zone to the bedrock. The UA contains variable amounts of cobbles and boulders within a sand and gravel matrix. Both the prevalence and size of the cobbles and boulders increase with depth.
- **Bedrock Confining Unit**: Comprised of shales with thin limestone, sandstone, and coal beds. This bedrock confining unit is encountered at elevations ranging from 399.2 to 410.2 feet.

The direction of groundwater flow and hydraulic gradient within the UA varies with the elevation of the Illinois River. During normal river stage the direction of groundwater flow is most often toward the river, but comparison of groundwater and river elevation data indicate reversals in this flow direction during times of high river elevations. The relative duration of these events is short, which leads to the determination of a predominant groundwater flow direction toward the river. Groundwater elevations and contours for the May 2023 monitoring event (Event 1 [E001]) are presented in **Figure 2-3**.

2.2 Groundwater Quality

Groundwater monitoring in accordance with the GMP and sampling methodologies provided in the operating permit application for the WAPS began in the second quarter of 2023. The 35 I.A.C § 845 groundwater monitoring system is displayed on **Figure 2-4** and consists of 11 wells screened in the UA (two background and nine compliance) and one temporary water level only surface water staff gauge. The groundwater samples collected from the 11 wells are used to monitor and evaluate groundwater quality and demonstrate compliance with the groundwater quality standards listed in 35 I.A.C. § 845.600(a). The proposed monitoring wells yield groundwater samples that represent the quality of downgradient groundwater at the CCR boundary (as required by 35 I.A.C. § 845.630(a)(2)).

The E001 sampling event was completed on June 1, 2023. In accordance with 35 I.A.C. § 845.610(b)(3)(C), statistically derived values were compared with the GWPSs summarized in 35 I.A.C. § 845.600 to determine exceedances of the GWPS (Ramboll, 2023a). The statistical determination identified the following GWPS exceedances at compliance groundwater monitoring wells:

- Arsenic at wells 21R and 51
- Boron at wells 21R, 22, 23, and 35
- Cadmium at well 22
- Sulfate at wells 23 and 35
- Lithium at well 22

Subsequent compliance sampling events for Quarter 3 and Quarter 4 2023 (Event 2 [E002] and Event 3 [E003]) were completed in August and November 2023 and groundwater samples were evaluated for exceedances of the GWPS as described in 35 I.A.C. § 845.600 (Ramboll, 2024a; Ramboll, 2024b). The following additional exceedances were identified during the E002 and E003 monitoring events:

- Lithium at well 22
- TDS as well 35

Pursuant to 35 I.A.C. § 845.650(e), an alternative source demonstration (ASD) was prepared and submitted to IEPA that presented evidence demonstrating that sources other than the WAPS were the cause of the cadmium GWPS exceedance listed above (Ramboll, 2023b). The IEPA concurred with the ASD; therefore, arsenic, boron, sulfate, lithium, and TDS exceedances are addressed in this CMA, in accordance with 35 I.A.C. § 845.660.

3. CORRECTIVE MEASURES ASSESSMENT METHODOLOGY

This section describes the CMA methodology initiated in response to the identification of exceedances of the GWPS for 35 I.A.C. § 845.600 constituents at the downgradient waste boundary of the WAPS during the E001 groundwater monitoring event (Ramboll, 2023a). The CMA was initiated on December 10, within 90 days after the detection of exceedance(s) of GWPS. Under 35 I.A.C. § 845, owners and operators of existing CCR SIs must initiate the assessment of corrective measures in accordance with 35 I.A.C. § 845.660 if one or more constituents are detected, and confirmed by an immediate resample, to be in exceedance of a GWPS in 35 I.A.C. § 845.600, and the owner or operator has not demonstrated that: a source other than the CCR SI caused the exceedance, or; that the exceedance of the GWPS resulted from error in sampling, analysis, statistical evaluation, natural variation in groundwater quality or a change in the potentiometric surface and groundwater flow direction (an ASD).

The CMA is the first step in developing a long-term CAP to address the GWPS exceedances at CCR SIs. The process provides a systematic, rational method for evaluating potential corrective measures by first identifying potentially applicable technologies and evaluating them using qualitative information to eliminate from consideration infeasible or otherwise unacceptable remedial technologies (*i.e.,* the 35 I.A.C. § 845.660 CMA). The remaining technologies will be evaluated individually, or assembled into combined alternatives, and further evaluated under the 35 I.A.C. § 845.670 CAP process. The final outcome of the process will be to select an appropriate and protective corrective action(s) for the WAPS.

This CMA identified applicable corrective measure technologies and evaluated them for viability, given the site-specific conditions and considerations at the WAPS, by addressing the following 35 I.A.C § 845.660 evaluation criteria:

- Performance, reliability, ease of implementation and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- Time required to begin and complete the CAP; and
- Institutional requirements, such as State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the CAP.

The evaluation included qualitative and/or semi-quantitative screening of the potential corrective measures (technologies) relative to their general performance, reliability, and ease of implementation characteristics and their potential impacts, timeframes, and institutional requirements to assess the viability of each technology to address the GWPS exceedances at the WAPS. This approach provided a reasoned set of corrective measures that could be used, either individually or in combination, to supplement the source control measures described in **Section 1.2** and achieve GWPSs in the most effective and protective manner. This set of corrective measures will be further evaluated in the Corrective Action Alternatives Analysis (CAAA).

4. DESCRIPTION OF POTENTIAL CORRECTIVE TECHNOLOGIES

The potential groundwater corrective measures summarized below are applicable to the WAPS and were included in the CMA development and analysis. Site-specific considerations regarding the WAPS provided in **Section 2** were used to evaluate potential groundwater corrective measures. Each of the corrective measures evaluated may be capable of satisfying the requirements and objectives, listed in **Section 3**, to varying degrees of effectiveness. The corrective measure review process was intended to yield a set of applicable corrective measures that could be used to supplement the completed source control activities described in **Section 1.2** (CBR of the OWPP and CIP with a geosynthetic cap at the OWAP). The completed source control has significantly reduced infiltration rates relative to pre-closure conditions. Ongoing monitoring will be an integral part of all corrective measures to verify and document the remedial process. The corrective measures ultimately advanced to the CAAA and selected in the CAP will be used to enhance the effectiveness of the source control and may be used independently or may be combined into specific remedial alternatives to leverage the advantages of multiple corrective measures to attain GWPSs.

Source control measures were completed in 2020 for the WAPS, as described in **Section 1.2**; all of the evaluated corrective technologies are proposed to be supplemental and complementary to source control activities. The following potential corrective measures, commonly used to mitigate groundwater impacts, were considered as a part of the CMA process:

- Source Control with Groundwater Polishing;
- Source Control with In-Situ Stabilization (ISS);
- Source Control with Groundwater Extraction (groundwater pumping wells or collection trenches);
- Source Control with a Cutoff Wall; and
- Source Control with In-Situ Chemical Treatment (permeable reactive barrier [PRB]).

4.1 Source Control with Groundwater Polishing

Both federal and state regulators have long recognized that natural geochemical processes can be an acceptable component of a remedial action when it can achieve remedial action objectives in a reasonable timeframe. In 1999, USEPA published a final policy directive for groundwater remediation and described the process as follows:

- *"The reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants."* (USEPA, 1999).

The USEPA has stated that source control is the most effective means of ensuring the timely attainment of remediation objectives (USEPA, 1999). Natural geochemical processes may be appropriate as a "finishing step" after effective source control implementation (*i.e.*, groundwater polishing), to reduce the residual mass remaining in the groundwater after closure, if there are no risks to receptors and/or the contaminant plume is not expanding. Thus, groundwater polishing would be used in conjunction with the significant planned source control effort at the site, which will consist of a hybrid consolidate-and-cap approach with a final cover system described in **Section 1.2**.

In 2015, USEPA addressed remediation of inorganic compounds in groundwater and noted that the use of natural geochemical processes to address inorganic contaminants: (1) is not intended to constitute a treatment process for inorganic contaminants; (2) when appropriately implemented, can help to restore an aquifer to beneficial uses by immobilizing contaminants onto aquifer solids and providing the primary means for attenuation of contaminants in groundwater; and (3) is not intended to be a "do nothing" response (USEPA, 2015). Rather, documenting the applicability of natural geochemical processes for groundwater remediation should be thoroughly and adequately supported with site-specific characterization data and analysis (USEPA, 1999; USEPA, 2007; USEPA, 2015):

Both physical and chemical processes can contribute to the reduction of the small amount of residual mass remaining after closure of the WAPS, and the toxicity, mobility, volume, or concentration of contaminants in groundwater. Physical processes applicable to CCR include dilution, dispersion, and flushing. Chemical processes applicable to CCR include precipitation and coprecipitation (*e.g.,* incorporation into sulfide minerals) and sorption (*e.g.,* to iron, manganese, aluminum; to other metal oxides or oxyhydroxides; or to sulfide minerals or organic matter), and ion exchange (IX).

All inorganic compounds are subject to physical processes and under typical environmental conditions, physical mechanisms most often exert the dominant control on the CCR constituents of interest. Chemical mechanisms are also likely to be active, though not often dominant, such as adsorption, IX, and organic complexation. In combination with source control, these natural controls can provide an effective means to polish residual loading and achieve the GWPS in a reasonable timeframe. Additional data collection and analysis may be required to support the USEPA's evaluation framework (USEPA, 2015) and obtain regulatory approval.

4.2 Source Control with In-Situ Stabilization

ISS is a technology to treat impacted material using large diameter augers or other equipment to mix a slurry of pozzolanic additives, or reagents, into soils to solidify them in-situ. As the augers are advanced into the subsurface, the slurried reagent is blended with the soil, resulting in a subsurface mixture of soil and reagent. ISS results in a solidified mass with similar unit weights but with greater strength, lower permeability, and reduced contaminant mobility. ISS results in a column of mixed material which cures to a desired unconfined compressive strength of approximately 50 to 200 pounds per square inch (psi) after 28 days. Mixed columns typically cure relatively quickly, generally able to support construction equipment within 24 to 48 hours. Typically mixing sequencing will call for allowing mixed columns to cure for 24 to 48 hours before mixing a directly adjacent column. To treat all soil within a targeted area, adjacent columns are overlapped.

Typical ISS construction uses using large diameter rotary augers or hydraulic excavators to solidify/stabilize soil in place by mixing a cementitious grout with impacted soil. ISS implementation creates a stable and relatively impermeable, continuous, monolith having an unconfined compressive strength of greater than 50 psi. Full-scale ISS construction will result in volumetric expansion of the treated soil. The expansion, often referred to as "swell," is a result of blending reagent mixtures with the soil.

Typical ISS column diameters range from 3 to 12 feet. Various diameter columns may be used depending on the subsurface soil conditions, site constraints or layout, or project schedule. ISS columns will overlap forming a continuous solidified monolith. Columns will be spaced and overlapped to ensure all soils within the targeted area are thoroughly mixed. Each ISS column will include continuous application of reagent from the ISS platform surface (*i.e.,* base of excavation) to the design depth. There may be some limited areas where a shallower mixing profile is designed and mixing using a backhoe/excavator, commonly referred to as bucket mixing, may prove to be more efficient than vertical rotary mixing system. Bucket mixing operations consist of using the excavator to mix the soils to the design depth. Grout is pumped into the excavation from the grout plant via hoses. The soil is mixed with the grout from the base to the top of the treatment cell until the material appears adequately homogenized.

ISS is not widely used as a corrective measure for CCR applications but has been successfully implemented at power stations for other (*i.e.,* structural) applications. A combination of factors, including geologic heterogeneities and potential subsurface obstructions in the ash could limit the effectiveness of implementation.

4.3 Source Control with Groundwater Extraction

Groundwater extraction is one of the most widely used groundwater corrective technologies and has a long history of performance. This corrective measure includes installation of one or more groundwater pumping wells or trenches to control and extract impacted groundwater. Groundwater extraction captures and contains impacted groundwater and can limit plume expansion and/or off-site migration. Construction of a groundwater extraction system typically includes, but is not limited to, the following primary components:

- Designing and constructing a groundwater extraction system consisting of one or more extraction wells and operating at a rate to allow capture of CCR impacted groundwater within the UA.
- Management of extracted groundwater, which may include modification to the existing NPDES permit.
- Ongoing inspection and maintenance of the groundwater extraction system.

Remediation of inorganics by groundwater extraction can be effective, but systems do not always perform as expected. A combination of factors, including geologic heterogeneities, difficulty in flushing low-permeability zones, and rates of contaminant desorption from aquifer solids can limit effectiveness. Groundwater extraction systems require ongoing operation and maintenance to address issues such as iron bacteria and well fouling and to ensure optimal performance. The extracted groundwater must be managed, either by ex-situ treatment or disposal.

Groundwater extraction may reduce the timeframe to achieve GWPS and contain the groundwater constituents that exceed the GWPS. Extraction could be accomplished using a groundwater pumping well system or an extraction trench.

4.4 Source Control with a Cutoff Wall

Since the late 1970s and early 1980s, vertical cutoff walls have been used to control and/or isolate impacted groundwater. Low-permeability cutoff walls can be used to prevent horizontal off-site migration of potentially impacted groundwater. Cutoff walls act as barriers to transport of impacted groundwater and can isolate soils that have been impacted by CCR to prevent contact with unimpacted groundwater. Cutoff walls are often used in conjunction with an interior pumping system to establish an inward gradient within the cutoff wall. The gradient imparted by the pumping system maintains an inward flow through the wall, keeping it from acting as a groundwater dam and controlling potential end-around or breakout flow of contaminated groundwater. Constructing the cutoff wall such that it intersects a low-permeability material at its base, referred to as "keying", greatly increases its effectiveness.

A commonly used cutoff wall construction technology is the slurry trench method, which consists of excavating a trench and backfilling it with a soil-bentonite mixture, often created with the excavated soils, or, for deeper walls, a cement-bentonite mixture that is produced at an onsite batch plant. The trench is temporarily supported with bentonite slurry pumped into the trench during excavation (D'Appolonia & Ryan, 1979). Cutoff wall excavation uses conventional hydraulic excavators, hydraulic excavators equipped with specialized booms to extend their reach (*i.e.,* long-stick excavators), clamshells, or more specialized equipment such as hydromills or secant-pile drill rigs, depending upon trench depth, material excavated, and type of material that the wall is keyed into.

Cutoff walls are a widely accepted technology for containing impacted groundwater. Combining groundwater polishing with a limited cutoff wall and groundwater extraction in specific areas may provide advantages over independent use of these potential corrective technologies. Cutoff walls can be used in combination with groundwater extraction or as part of a PRB system (as the "funnel" in a funnel-and-gate system; **Section 4.5**).

4.5 Source Control with In-Situ Chemical Treatment

The use of in-situ treatment, either by injection or PRBs is a widely used technology for treating impacted groundwater. However, in-situ treatment techniques for arsenic, boron, lithium, and sulfate are not well established; therefore, performance is unknown.

Chemical treatment could consist of injection of reactive materials into the subsurface to treat contaminants at specific, targeted locations. Alternately, treatment via PRB, where reactive materials are placed in the subsurface at locations designed to direct the contaminant plume along a flow path through the reactive media. In either system, the contaminants are transformed or otherwise rendered into environmentally acceptable forms to attain remediation concentration goals downgradient of the barrier (Electric Power Research Institute [EPRI], 2006).

As groundwater passes through the PRB under natural gradients, dissolved constituents in the groundwater react with the media and are transformed or immobilized. A variety of media have been used or proposed for use in PRBs. Zero-valent iron (ZVI) has been shown to effectively immobilize some CCR constituents, including arsenic, chromium, cobalt, molybdenum, selenium,

and sulfate. Use of a combination media consisting of ZVI and a boron-selective IX resin to treat boron has been documented in a pilot-scale test (EPRI, 2006).

System configurations include continuous PRBs, in which the reactive media extends across the entire path of the contaminant plume; and funnel-and-gate systems, where low-permeability barriers are installed to control groundwater flow through a permeable gate containing the reactive media. Continuous PRBs intersect the entire contaminant plume and do not materially impact the groundwater flow system. Design may or may not include keying the PRB into a low-permeability unit at depth. Funnel-and-gate systems utilize a system of barriers to groundwater flow (funnels) to direct the contaminant plume through the reactive gate. The barriers, typically some form of cutoff wall, are keyed into a low-permeability unit at depth to prevent short circuiting of the plume. Funnel-and-gate design must consider the residence time to allow chemical reactions to occur. Directing the contaminant plume through the reactive gate can significantly increase the flow velocity, thus reducing residence time.

Design of in-situ treatment systems requires rigorous site investigation to characterize the site hydrogeology and to delineate the contaminant plume. A thorough understanding of the geochemical and redox characteristics of the plume is critical to assess the feasibility of the process and select appropriate reactive media. Laboratory studies, including batch studies and column studies using samples of site groundwater, are needed to determine the effectiveness of the selected reactive media at the site (EPRI, 2006). The main considerations in selecting reactive media are as follows (Gavaskar et al., 1998 as cited by EPRI, 2006):

- Reactivity - The media should be of adequate reactivity to immobilize a contaminant within the residence time of the design.
- Hydraulic performance - The media should provide adequate flow through the PRB, meaning a greater particle size than the surrounding aquifer materials. Alternatively, gravel beds have been emplaced in front of barriers to direct flow through the barrier.
- Stability - The media should remain reactive for an amount of time that makes its use economically advantageous over other technologies.
- Environmentally compatible by-products - Any by-products of media reaction should be environmentally acceptable. For example, iron released by zero-valent iron corrosion should not occur at levels exceeding regulatory acceptance levels. Availability and price: The media should be easy to obtain in large quantities at a price that does not negate the economic feasibility of using a PRB.
- Availability and price: The media should be easy to obtain in large quantities at a price that does not negate the economic feasibility of using a PRB.

5. ASSESSMENT OF CORRECTIVE MEASURE TECHNOLOGIES

This CMA was initiated to address exceedances of the 35 I.A.C. § 845.600 GWPS at the downgradient waste boundary of the WAPS identified during the E001 groundwater monitoring event (**Section 2.2**).

5.1 Requirements

The potential groundwater corrective technologies described in the previous section were evaluated relative to the requirements presented in **Section 3** and reiterated below:

- Performance, reliability, ease of implementation and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- Time required to begin and complete the CAP; and
- Institutional requirements, such as State or local permit requirement or other environmental or public health requirements that may substantially affect implementation of the CAP.

Table 5-1 presents the qualitative CMA evaluations of the of each groundwater technology against these requirements, as well as their ability to address GWPS exceedances. The following sections provide a summary of these evaluations and a discussion of the potential groundwater corrective measure technologies that may be viable, either independently or in combination, to address GWPS exceedances. This section also provides a summary of corrective measure technologies that have been retained and advanced for evaluation as part of the CAAA process for selecting the final remedy for the WAPS per 35 I.A.C. § 845.670.

5.2 Groundwater Corrective Technology Assessment

Source control, consisting of a hybrid consolidate-and-cap approach comprised of CBR of the OWPP and CIP of the OWAP, will be the primary groundwater corrective measure for the WAPS. Closure was completed in 2020 and each of the potential groundwater corrective measure technologies would supplement the positive impact of prior closure activities. The following sections evaluate groundwater corrective measure technologies that, when combined with site closure, may be viable to address GWPS exceedances. Technologies that are not viable for addressing the GWPS at the WAPS will be eliminated from further evaluation and viable technologies will be advanced for further evaluation as part of the CAAA process per 35 I.A.C. § 845.600.

5.2.1 Source Control with Groundwater Polishing

Source control construction (**Section 1.2**) has reduced the mass loading to the groundwater system to the extent that aquifer polishing process could act upon CCR constituents in the UA. Hydrostatic modeling and groundwater flow and fate and transport modeling indicated that source control construction would reduce the hydraulic head to near-zero level (equilibrium condition) within seven years after completion of cap construction and decrease transport of CCR constituents off-site. Ongoing groundwater modeling, which is expected to be completed in 2025, indicates that GWPS will be met approximately 30 years after the remedy implementation for the wells currently included in the compliance well network.

Groundwater polishing by natural geochemical processes is a widely accepted component of groundwater remediation and is routinely approved by the IEPA when paired with source control. The performance of groundwater polishing as a groundwater corrective measure varies based on site-specific conditions and additional data collection may be needed to support the design and regulatory approval. The sandy nature of the UA suggests good performance by physical processes in addressing the arsenic, boron, sulfate, lithium, and TDS in the UA.

Naturally occurring geochemical processes are ongoing at the WAPS and will continue to affect groundwater constituent concentrations. Ongoing monitoring of groundwater conditions is needed to better understand the mechanisms and efficacy of the groundwater polishing process and to confirm the effectiveness over time. Thus, additional groundwater sample collection and analyses would be required to characterize potential mechanisms, as discussed above, and to provide long term monitoring of the remedial progress. Enhancements to the groundwater monitoring system may be required to ensure that the aquifer polishing is occurring as predicted, consistent with the adaptive site management approach. The reliability of aquifer polishing as a groundwater corrective measure is high because operation and maintenance requirements are limited. However, the reliability can also vary based on site-specific hydrogeologic and geochemical conditions.

Following characterization and approval of the CAP, monitoring of the groundwater polishing processes and comparison to functional goals established to monitor progress toward the remedial objective could begin as quickly as within a few months of CAP approval.

No potential safety impacts or exposure to human health or environmental receptors are expected to result from the groundwater polishing processes. Timeframes to achieve GWPS are dependent on site-specific conditions, which require detailed technical analysis (ongoing at this time). Selecting groundwater polishing as a corrective measure for the WAPS will require approval of the CAP permits by the IEPA.

Monitoring the groundwater polishing to track progress toward achievement of the GWPS after the 2020 completion of source control construction at the WAPS would require long-term maintenance and monitoring of the groundwater monitoring system to confirm source control and verify the effectiveness in reducing groundwater concentrations to levels below the GWPS. Monitoring activities could be initiated immediately after approval of the CAP permit.

Groundwater polishing processes will continue to occur naturally at the FAPS. It may be a viable corrective measure for the arsenic, boron, sulfate, lithium, and TDS exceedances at the WAPS. Therefore, these processes are being advanced to the CAAA for further evaluation.

5.2.2 Source Control with In-Situ Stabilization

Source control will reduce the mass loading to the groundwater system and ISS was considered as a method of supplementing the completed source control. ISS is typically infeasible for large site and/or deep CCR; however, it was considered at the WAPS due to the limited size of the impoundment and limited depth to CCR. Implementing additional groundwater corrective measures may reduce the time required to attain the GWPS in the UA. Targeting zones of the CCR in the WAPS using ISS to solidify/stabilize CCR that is present at and below the groundwater level observed in surrounding monitoring wells at normal conditions could reduce or prevent the continued migration of CCR-related constituents away from the WAPS. When combined with groundwater polishing, ISS may reduce the time required to attain GWPS.

ISS is not a common corrective measure for CCR impacted groundwater, but it is a widely accepted corrective measure used to control and/or isolate impacted groundwater and it is routinely approved by regulatory agencies. ISS have a long history of reliable performance as a groundwater remediation technique.

ISS construction may be challenging due to the presence of potential obstructions in the CCR (*i.e.,* debris in the ash) which could impede advancement of the large diameter augers used to construct the ISS monolith. ISS construction in the already closed WAPS would be complicated and would likely require removal and reconstruction of the final cover system, which could cause a temporary reversal of some of the completed source control activities.

Construction could be completed within 2 to 3 years. Time of implementation is approximately 4 to 5 years, including characterization, design, permitting and construction. ISS would be used to supplement the completed source control and may require additional corrective measures, such as groundwater polishing, to attain GWPS.

Completing ISS in the WAPS would require IEPA approval of the CAP permit and, depending on the location, an IDNR dam safety modification permit may be required.

Supplementing source control using ISS could be used to reduce or prevent the continued migration of CCR-related constituents away from the WAPS. When combined with groundwater polishing, ISS may reduce the time required to attain GWPS. Therefore, ISS is being advanced to the CAAA for further evaluation.

5.2.3 Source Control with Groundwater Extraction

The completed source control is reducing the mass loading to the groundwater system and implementing additional groundwater corrective measures may reduce the time required to attain the GWPS in the UA.

Groundwater extraction is a widely accepted corrective measure with a long track record of performance and reliability. It is routinely approved by the IEPA. For a corrective measure using groundwater extraction to effectively control off-site flow and/or to remove potentially contaminated groundwater, horizontal and vertical capture zone(s) must be created. The performance of a groundwater extraction system would be expected to be effective in the high permeability UA. However, the proximity and influence of the Illinois River to the impacted area of the UA would potentially result in large volumes of extracted groundwater and river water. Cutoff walls (**Section 4.4**) could be used in conjunction with a pumping system to control potential groundwater movement from the river.

Implementation of a groundwater extraction system presents design challenges due to the proximity to the Illinois River. An extraction system in the UA would have to consider the potential for extracting unimpacted river water. Construction of an extraction system may be challenging due to the presence of cobbles and potentially large boulders in the UA. Specialty drilling methods may be required to construct the extraction system. Extracted groundwater (and potentially river water) would need to be managed, which may include modification to the existing NPDES permit and treatment prior to discharge, if necessary. Specialized treatment equipment may be required, and ongoing operations and maintenance activities would be necessary.

There could be some impacts associated with constructing and operating a groundwater extraction system, including some limited exposure to extracted groundwater. Additional data collection and analyses would be required to design an extraction system. Construction could be completed within 1 year following completion of a final design. Time of implementation is approximately 3 to 4 years after approval of the CAP permit, including characterization, design, permitting, and construction. Timeframes to achieve GWPS are dependent on site-specific conditions. An extraction system may reduce the time to attain GWPS in the UA relative to the post-closure timeframe predicted by the groundwater modeling. However, the relatively long expected GWPS attainment times may result in operations and maintenance of a groundwater extraction system for decades of years or more.

Implementing a groundwater extraction system at the WAPS would require IEPA approval of the CAP permit, and discharge of extracted groundwater may require a modification to the NPDES permit, as well as possibly permitting and construction of a new outfall. Depending upon the location of the extraction system an Illinois Department of Natural Resources (IDNR) dam safety modification permit may also be required to construct an extraction system.

Groundwater extraction could be viable corrective measure for the arsenic, boron, sulfate, lithium, and TDS exceedances at the WAPS. Implementation of groundwater extraction would require combining an extraction system with a cutoff wall to prevent very high inflow volumes from the Illinois River. Therefore, groundwater extraction is not being advanced to the CAAA for further evaluation.

5.2.4 Source Control with Groundwater Cutoff Wall

The completed source control is reducing the mass loading to the groundwater system and implementing additional groundwater corrective measures may reduce the time required to attain the GWPS in the UA. A low permeability cutoff wall could provide long-term, maintenance-free physical barrier to significantly reduce or prevent horizontal migration of CCR-impacted groundwater away from the WAPS. A cutoff wall could be used in combination with a groundwater extraction system in the UA to reduce the potentially high volumes of extracted groundwater that would be captured by and extraction system between the WAPS and the Illinois River. A cutoff wall could reduce the water management and treatment requirements for an extraction system.

Groundwater cutoff walls are a widely accepted corrective measure used to control and/or isolate impacted groundwater and are routinely approved by the IEPA. Cutoff walls have a long history of reliable performance as hydraulic barriers, provided they are properly designed and constructed. However, if not coupled with a groundwater extraction system, a cutoff wall will provide directional groundwater control only and may result in redistribution of contaminants and potentially GWPS exceedances at new locations.

Cutoff walls are designed to act as hydraulic barriers; as a result, cutoff walls inherently alter the existing groundwater flow system. Changes to the existing groundwater flow system may need to be controlled to maximize the effectiveness of the remedy by, for example, combining a cutoff wall with groundwater extraction to control build-up of hydraulic head upgradient and around the cutoff walls. Construction of a cutoff wall extending into the UA would be challenging, if it is possible, and would require specialized and highly experienced contractors with non-standard construction equipment due to the presence of subsurface cobbles and boulders.

Constructing a cutoff wall may also be challenging due to the physical site constraints (limited construction area due to the proximity of the Illinois River), particularly if used in combination with an extraction system. In that case, both the extraction system and the cutoff wall would need to be located between the WAPS and the river, which would increase the construction complexity and could result in structural impacts to the embankment dikes, depending on the location of the wall.

Additional data collection and analyses would be required to design a cutoff wall. Construction could be completed within 2 to 3 years. Time of implementation is approximately 5 to 8 years, including characterization, design, permitting, and construction. To attain GWPS, cutoff walls require a separate groundwater corrective measure to operate in concert with the cutoff wall(s). Cutoff walls are commonly coupled with aquifer polishing and/or groundwater extraction as groundwater corrective measures. The time to attain GWPS is dependent on the selected groundwater corrective measure or measures that are coupled with the cutoff walls.

Constructing a cutoff wall at the WAPS would require IEPA approval of the CAP permit and, depending on the location, an IDNR dam safety modification permit may be required.

A cutoff wall alone would not be a viable corrective measure for the arsenic, boron, sulfate, lithium, and TDS exceedances at the WAPS. Cutoff walls are commonly coupled with groundwater polishing and/or groundwater extraction as groundwater corrective measures. However, a cutoff wall could provide long-term, maintenance-free physical barrier to significantly reduce or prevent horizontal migration of CCR-impacted groundwater away from the WAPS. Therefore, the cutoff wall is being advanced to the CAAA for further evaluation.

5.2.5 Source Control with In-Situ Chemical Treatment

Source control will reduce the mass loading to the groundwater system and implementing additional groundwater corrective measures may reduce the time required to attain the GWPS in the UA. Use of in-situ treatment, either through targeted injection of reactive media or in PRB systems, to transform contaminants into environmentally acceptable forms to attain the GWPS was considered.

In-situ treatment using IX to address arsenic, boron, lithium, sulfate, and TDS exceedances in groundwater is not an established or widely accepted groundwater corrective measure; therefore, its performance and reliability are unknown. Regulatory acceptance of this innovative approach to achieving the GWPS is uncertain.

In-situ treatment in the granular UA is expected to be relatively straightforward using targeted reactive media delivery via injection, however use of a PRB would present design and construction challenges similar to the challenges with constructing a cutoff wall discussed above due to the presence of cobbles and boulders. Depending upon the location of the PRB system, construction may affect the WAPS embankment and/or final cover system and periodic change-outs of IX resin media may be required.

Additional data collection and analyses would be required to design an in-situ treatment system and bench scale and/or pilot scale testing may be required to demonstrate performance and reliability. Time of implementation is approximately 4 to 6 years after approval of the CAP permit, including characterization, design, permitting, and construction. Timeframes to achieve GWPS are dependent on demonstrations of performance and reliability and on ultimate regulatory

acceptance. It is not known whether in-situ treatment would reduce the time to attain GWPS in the UA relative to the post-closure timeframe predicted by the groundwater modeling.

Due to the uncertain performance, reliability and potential for regulatory acceptance, in-situ chemical treatment is not a viable corrective measure for the arsenic, boron, sulfate, lithium, and TDS exceedances at the WAPS and is not being advanced to the CAAA for further evaluation.

5.3 Technologies Advanced to CAAA

Based on the evaluations presented above, the following potential corrective technologies are being advanced to the CAAA for more detailed evaluations, individually or in combination, and cost estimation:

- Source control with groundwater polishing;
- Source control and with ISS; and
- Source control with a groundwater cutoff wall.

6. REFERENCES

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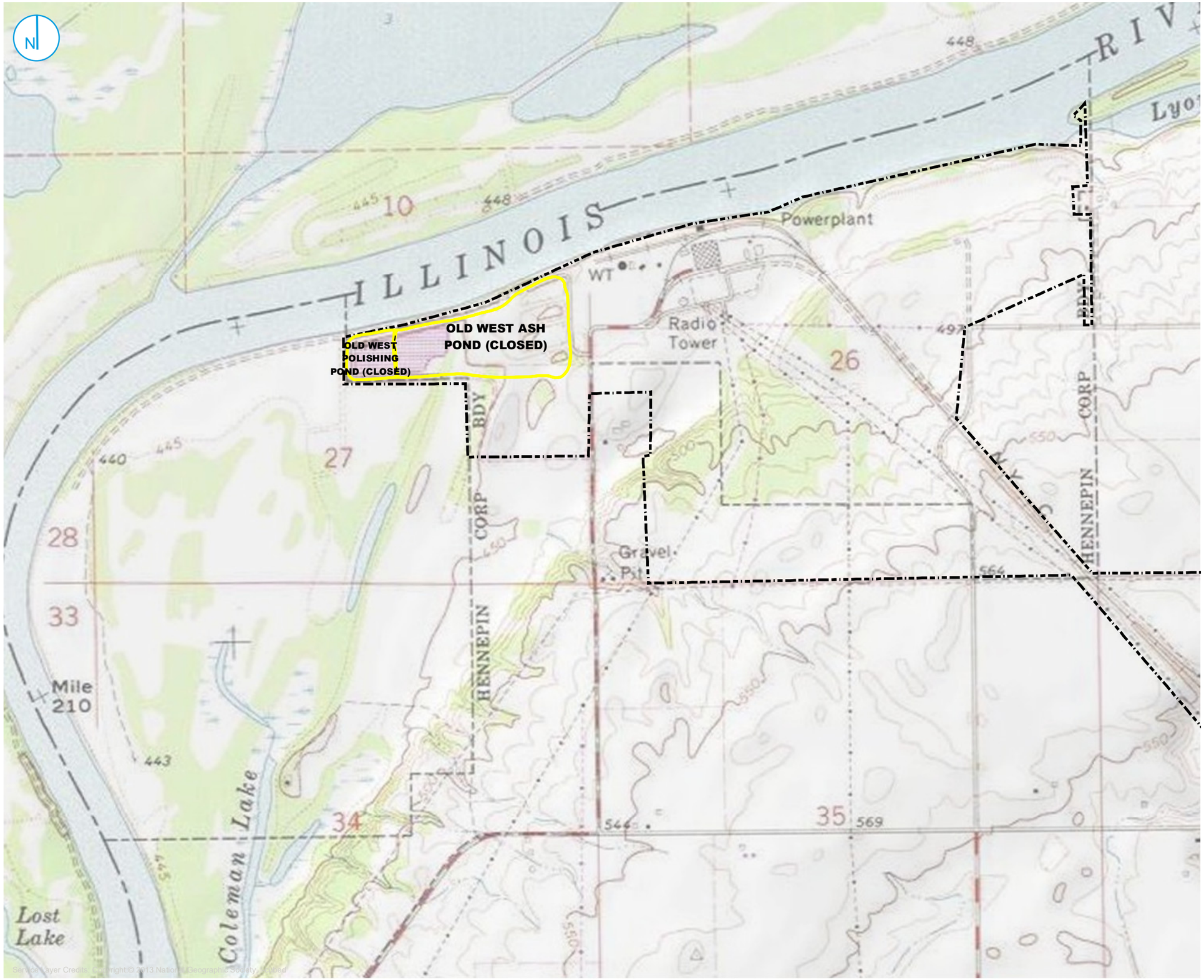
Tables

TABLE 5-1.
Corrective Measures Assessment Matrix
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS
5/8/2024

Remedy	Evaluation Factors						
	Performance	**Reliability**	**Ease of Implementation**	**Potential Impacts of Remedy (safety impacts, cross-media impacts, control of exposure to any residual contamination)**	**Time Required to Begin and Implement Remedy[1]**	**Time to Attain Groundwater Protection Standards**	**Institutional Requirements (state/local permit requirements, environmental/public health requirements that affect implementation of remedy)**
Source Control with Groundwater Polishing	Performs best paired with source control which was completed in 2020.	Ongoing analysis will evaluate if the attenuation mechanism has low reversibility, if the aquifer has sufficient capacity, and if the hydrogeology is favorable for arsenic, boron, sulfate and/or lithium physical processes. Arsenic in the uppermost aquifer conditions may be more amenable to physical processes.	Evaluation is underway and is expected to be completed in 2024. Long-term monitoring would be required. Implementing would not require extensive specialized equipment or contractors	None identified.	Approximately 90 days after CAP permit approval.	Dependent on site-specific conditions. Ongoing analysis will evaluate attenuation rate and capacity.	IEPA approval of the CAP permit is required. No institutional requirements are anticipated. The approved the Closure Plan for source control included a Groundwater Management Zone application for locations and identified parameters.
Source Control with In-Situ Stabilization	Supplement source control using in-situ stabilization within targeted zones of the CCR, combined with groundwater polishing for impacts beyond the CCR.	Not widely used as a corrective measure for CCR applications but has been successfully implemented at power stations for other (*i.e.,* structural) applications.	Presence of potential obstructions (*i.e.,* debris) in the ash could inhibit implementation.	Would require temporarily disturbing and reconstructing the existing final cover system; this may temporarily reverse some of the completed source control effects.	Design, permitting and construction is expected to take 4 to 5 years after CAP approval.	Would likely reduce the time to less than the post closure timeframe predicted by the groundwater model for source control and groundwater polishing only.	IEPA approval of the CAP permit is required. A IDNR dam safety modification permit might also be required, depending on the location of the ISS installation.
Source Control with Groundwater Extraction	A widely accepted, routinely approved technology. Performance is generally good in granular aquifers, however the highly permeable nature of the Uppermost Aquifer would likely require high flow rates. May be uncertainty in expected performance due to the proximity to the river and potential for flood events.	Reliable if properly designed, constructed and maintained. Likely not reliable without cutoff wall due to the high permeability of the Uppermost Aquifer and proximity to the river.	Specialized drilling techniques (*i.e.,* sonic) may necessary for groundwater extraction system construction due to the presence of cobbles/boulders. Extracted groundwater flow rates could be very high and would require management, possibly including treatment, which may also require specialized equipment/contractors.	Alters groundwater flow system. Potential for some limited exposure to extracted groundwater. Groundwater extraction may induce settlement, which could cause structural impacts to the embankments, final cover system and/or adjacent structures. High flow rates may increase the difficulty in water management/treatment requirements.	Design, permitting and construction is expected to take 3 to 4 years after CAP permit approval.	Dependent on site-specific conditions. Less than the post-closure timeframe predicted by the groundwater model for source control and groundwater polishing.	IEPA approval of the CAP permit is required. IEPA approval is anticipated to be required for discharge of extracted groundwater via a NPDES discharge permit. An IDNR dam safety modification permit might also be required, depending on location of wells and settlement potential.
Source Control with Groundwater Cutoff Wall	Widely accepted, routinely approved, good performance if properly designed and constructed. May need to be combined with another groundwater corrective measure, such as groundwater polishing or extraction, to achieve GWPS.	Reliable for groundwater directional control if properly designed and constructed.	Widely used, established technology. Due to the depth to the uppermost aquifer and presence of cobbles/boulders, construction would likely require specialized, highly experienced contractors with non-standard construction equipment. Space limitations may be challenging for installing the wall and relocating compliance well system.	Alters groundwater flow system but does not provide any treatment. Can result in unintended consequences resulting from redirecting contaminants to areas where they are not currently present. May cause structural impacts to the embankment dikes, depending on the location of the wall. May require disturbing and reconstructing portions of the existing final cover system and other aspects of the completed closure, depending on the location of the wall; this may temporarily reverse some of the completed source control effects.	Design, permitting and construction is expected to take 5 to 8 years after CAP permit approval. Uncertainty in implementation time due to need for specialty contractors and expected difficult installation conditions.	Needs to be combined with other groundwater corrective measure(s). Time required to attain GWPS dependent on combined measures.	IEPA approval of the CAP permit is required. An IDNR dam safety permit may also be required depending on the location of the cutoff wall.
Source Control with In-Situ Chemical Treatment	In-Situ treatment not well established for boron, sulfate or lithium, therefore performance is unknown. In-situ treatment of arsenic is feasible. Performance would be poor because it would be limited to a single constituent.	Unknown reliability for arsenic, boron, sulfate, and/or lithium.	The granular nature of uppermost aquifer would likely be amenable to in-situ chemical delivery.	May require disturbing and reconstructing portions of the existing final cover system and other aspects of the completed closure, depending on the type and delivery method for the treatment. This may temporarily reverse some of the completed source control effects.	May require bench scale and/or pilot scale testing as part of design. Design, permitting and construction is expected to take 4 to 6 years after CAP approval.	There is uncertainty regarding whether a in-situ treatment would reduce arsenic, boron, sulfate, or lithium concentrations to achieve the GWPS. Dependent on conditions specific to the reactive media used and the site. Treatment technology is not well understood.	IEPA approval of the CAP permit is required. IEPA approval of this innovative and relatively unproved solution may be challenging. A IDNR dam safety permit may also be required if a PRB is used, depending on the location.

Notes:
[1] Time required to begin and implement remedy includes design, permitting, and construction.
CAP - Corrective Action Plan
CCR - coal combustion residuals
GWPS - Groundwater Protection Standards
IDNR - Illinois Department of Natural Resources
IEPA - Illinois Environmental Protection Agency
ISS - In-Situ Stabilization
NPDES - National Pollutant Discharge Elimination System
PRB - Permeable Reactive Barrier

Figures



REGULATED UNIT (SUBJECT UNIT)

PROPERTY BOUNDARY

0 500 1,000 Feet

SITE LOCATION MAP

35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

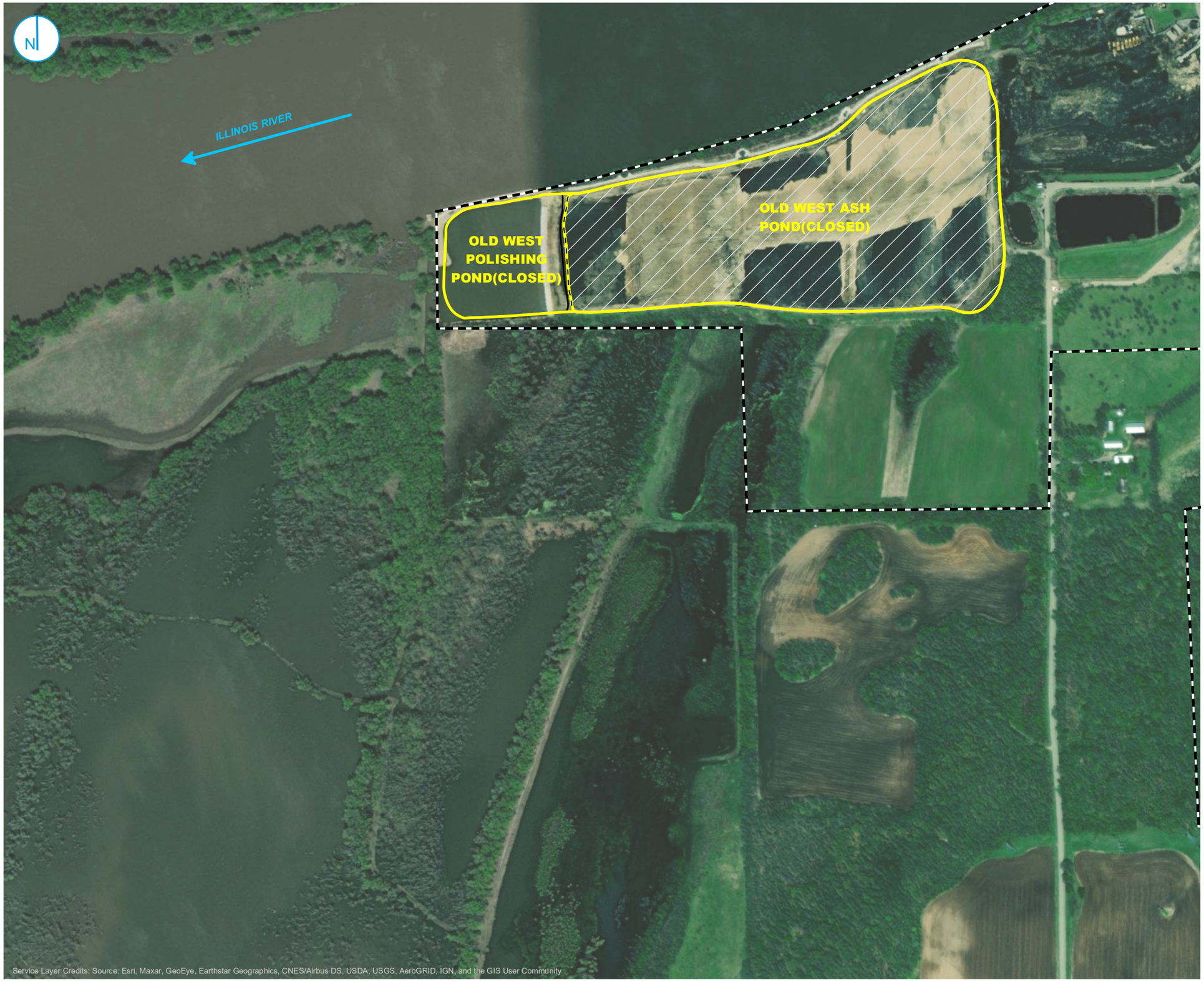
FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\222285\MXD\645_Operating_Permit\Hennepin\GMP_804\Figure 1-1_Site Location Map.mxd

PROJECT: 169000XXXX | DATED: 9/29/2021 | DESIGNER: STOLZSD



REGULATED UNIT (SUBJECT UNIT)

LIMITS OF FINAL COVER

PROPERTY BOUNDARY

0 200 400
Feet

SITE MAP

35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\22285\MXD\845_Operating_Permit\Hennepin\GMP_804\Figure 1-2_Site Map.mxd
PROJECT: 169000XXXX | DATED: 9/29/2021 | DESIGNER: STOLZSD

COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
MONITORING WELL
GROUNDWATER ELEVATION CONTOUR (1 FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

NOTES:

1.ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.

2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

*ILLINOIS RIVER ELEVATION OBTAINED FROM STAFF GAGE SG02, LOCATED AT THE HENNEPIN POWER PLANT

0 200 400 Feet

UPPERMOST AQUIFER POTENTIOMETRIC SURFACE MAP MAY 30, 2023

35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 7/6/2023 | DESIGNER: GALARNMC

Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_2023\Hennepin\OWAP_804\HEN 804 OWAP Pot Surface 20230530.mxd

COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
MONITORING WELL
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
SITE FEATURE
PROPERTY BOUNDARY

0 200 400
Feet

MONITORING WELL LOCATION MAP

35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-4

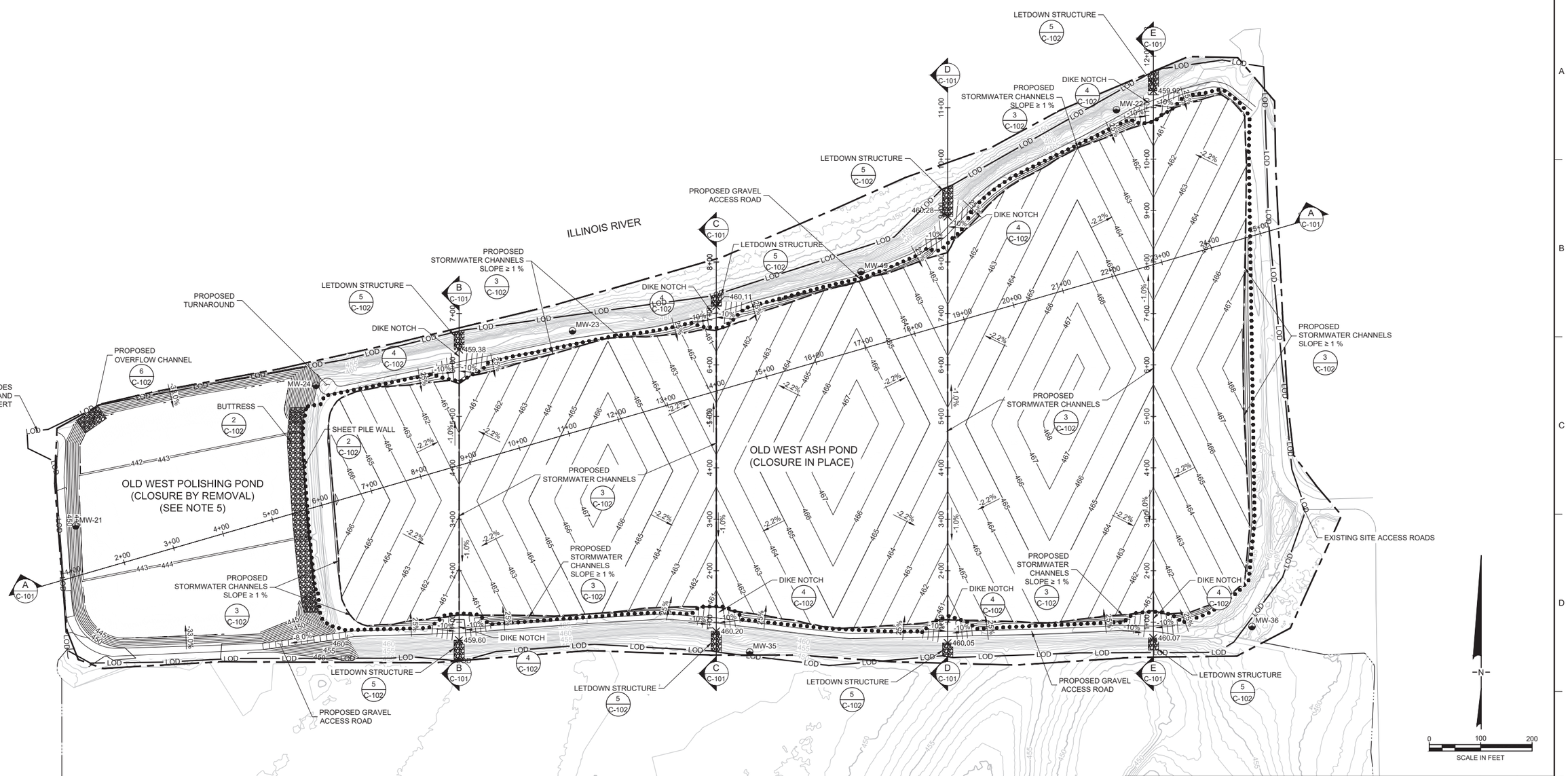
RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\22851\MXD\2021_Annual\GWM_CAR\Hennepin\OWAP_804\Figure 1 HEN OWAP MW Location Map.mxd

PROJECT: 169000XXXX | DATED: 1/5/2022 | DESIGNER: galarmmc

Attachment A – Selected Closure Plan Drawings



NOTES:

1. WEST ASH BASIN TOPOGRAPHIC SURVEY PROVIDED BY DYNEGY, TITLED "HENNEPIN 2015 AERIAL TOPOGRAPHY EXISTING SITE CONDITIONS", SURVEYED BY WEAVER CONSULTANTS GROUP, DATED DECEMBER 1, 2015.
2. TOPOGRAPHIC SURVEY SOUTH OF THE OLD WEST ASH POND AND OLD WEST POLISHING POND WAS PROVIDED BY INGENAE, TITLED "2017 TOPOGRAPHY", DATED JUNE 15, 2017.
3. COORDINATES AND DIRECTIONS SHOWN ON THIS DRAWING ARE BASED ON ILLINOIS STATE PLANE COORDINATE SYSTEM (NAD83) (US FEET). ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) (US FEET).
4. GRADING SHOWN ON THIS PLAN IS THE TOP OF FINAL COVER, WHICH IS TWO FEET ABOVE TOP OF SUBGRADE.
5. THE OLD WEST POLISHING POND WILL BE CLOSED BY REMOVAL OF CCR. AFTER CLOSURE, THE FORMER OLD WEST POLISHING POND WILL BE VEGETATED AND FUNCTION AS SHALLOW POND. THE ONLY INFLOW INTO THE FORMER OLD WEST POLISHING POND WILL BE PRECIPITATION THAT FALLS DIRECTLY INTO THE POND AND WATER FROM THE ADJACENT ILLINOIS RIVER THAT WILL FLOW INTO THE POND DURING HIGH-WATER EVENTS.
6. ALL DENSE, WOODY VEGETATION (I.E. TREES, SHRUBS) INSIDE THE LIMITS OF DISTURBANCE WILL BE REMOVED AS PART OF CLOSURE CONSTRUCTION. THE DISTURBED AREAS WILL BE RE-VEGETATED WITH GRASSES AS PART OF CLOSURE CONSTRUCTION.

EARTHWORK VOLUMES TO REACH DESIGN SUBGRADES			
CUT (PRE-COMPACTION)		FILL (POST COMPACTION)	
OLD WEST POLISHING POND	61,000 CY	OLD WEST POLISHING POND	0 CY
OLD WEST ASH POND	36,000 CY	OLD WEST ASH POND	80,000 CY
TOTAL	97,000 CY	TOTAL	80,000 CY

NOTES:

1. CUT MATERIAL IS ASSUMED TO REDUCE IN VOLUME BY 18% DUE TO COMPACTION. THEREFORE, THE TOTAL VOLUME OF CUT MATERIAL AVAILABLE FOR COMPACTED FILL IS 80,000 CY, RESULTING IN BALANCED CUT AND FILL QUANTITIES.
2. CUT AND FILL QUANTITIES ARE ONLY THOSE REQUIRED TO REACH DESIGN SUBGRADES. OTHER EARTHWORK QUANTITIES, SUCH COVER SOIL, BUTTRESS FILL, AND LETDOWN STRUCTURES ARE NOT INCLUDED IN THESE QUANTITIES.

BASE MAP LEGEND

- 460 — EXISTING GROUND SURFACE ELEVATION (MAJOR) (5-FT INTERVAL)
- EXISTING GROUND SURFACE ELEVATION (MINOR) (1-FT INTERVAL)
- WEAVER SURVEY LIMITS
- INGENAE SURVEY LIMITS
- LOD — LIMITS OF DISTURBANCE
- MW-23 — EXISTING MONITORING WELL

PROPOSED CONDITION LEGEND

- 465 — TOP OF FINAL COVER ELEVATION ELEVATION (MAJOR) (5-FT INTERVAL)
- 465 — TOP OF FINAL COVER ELEVATION (MINOR) (1-FT INTERVAL)
- APPROXIMATE LIMITS OF FINAL COVER AND ANCHOR TRENCH
- PROPOSED STORMWATER CHANNELS

CLOSURE PLAN SUBMITTAL
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REV	DATE	DESCRIPTION	DRN	APP

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DYNERGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZE DRIVE
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TITLE: OVERALL GRADING PLAN

PROJECT: SWPPP DRAWINGS FOR CLOSURE OF THE OLD WEST ASH POND AND OLD WEST POLISHING POND

SITE: HENNEPIN POWER STATION
HENNEPIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	LPC	DATE:	DECEMBER 2017
DRAWN BY:	CT/MK	PROJECT NO.:	CHE8356
CHECKED BY:	SH	FILE:	CHE8356-003
REVIEWED BY:	PA	DRAWING NO.:	C-100
APPROVED BY:	JPC		

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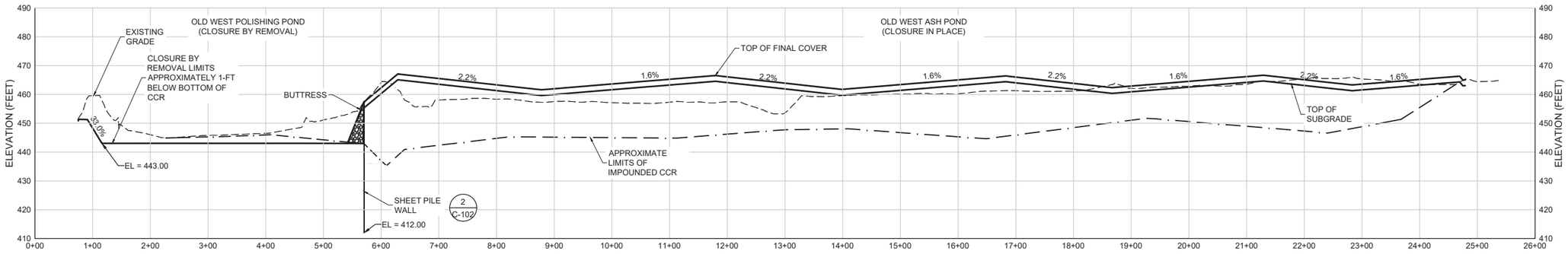
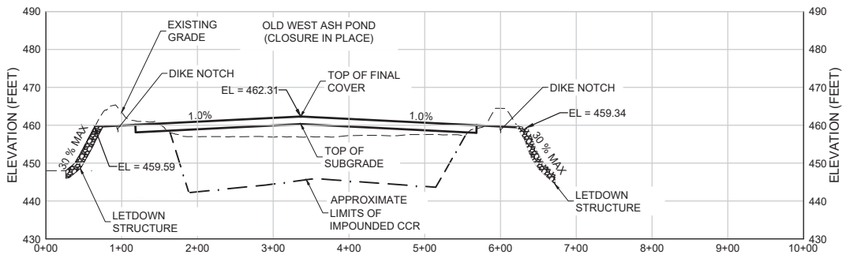


A C-100 SECTION

PROPOSED DESIGH GRADING SECTION A-A

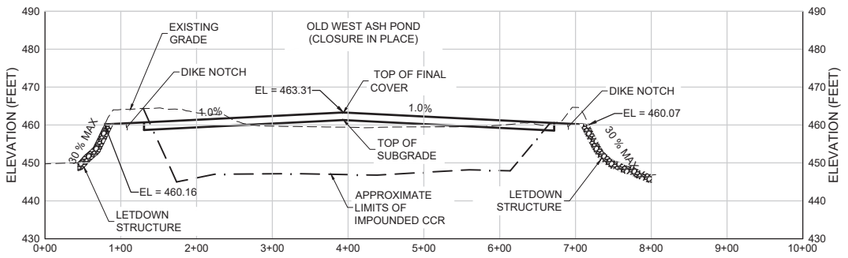
HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 20'



B C-100 SECTION

CHANNEL SECTION B-B

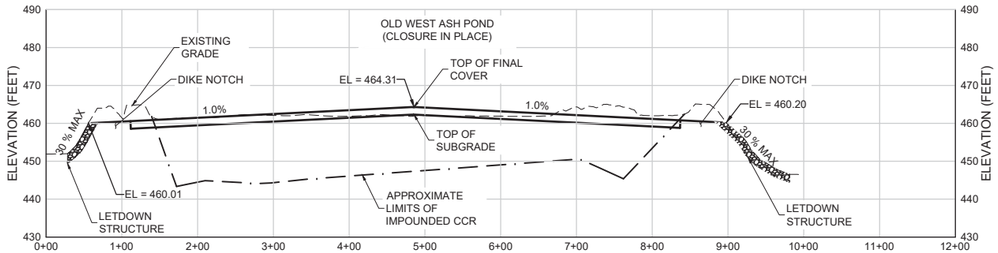
HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 20'



C C-100 SECTION

CHANNEL SECTION C-C

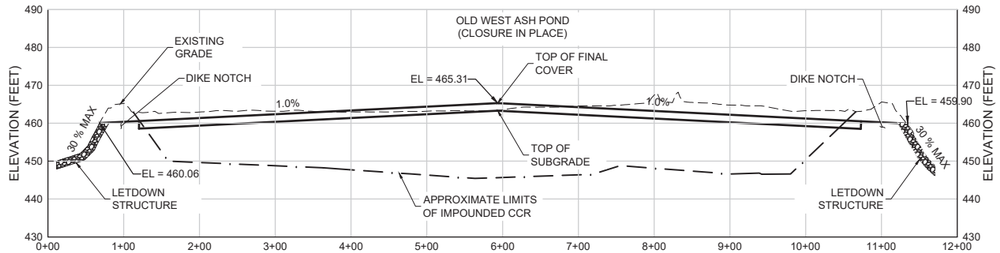
HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 20'



D C-100 SECTION

CHANNEL SECTION D-D

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 20'



E C-100 SECTION

CHANNEL SECTION E-E

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 20'

NOTE:

1. APPROXIMATE LIMITS OF IMPOUNDED CCR DEVELOPED USING AVAILABLE BORING DATA FROM THE 2016 AECOM, 2016 CEC, AND 2017 CEC GEOTECHNICAL EXPLORATIONS. CCR LIMITS BETWEEN BORINGS WERE INTERPOLATED USING AUTOCAD CIVIL3D SOFTWARE AND IMPOUNDMENT DESIGN AND CONSTRUCTION INFORMATION FROM THE CCR RULE HISTORY OF CONSTRUCTION REPORT FOR THE HENNEPIN POWER STATION (AECOM, 2016).

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TITLE: SECTIONS

PROJECT: SWPPP DRAWINGS FOR CLOSURE OF THE OLD WEST ASH POND AND OLD WEST POLISHING POND

SITE: HENNEPIN POWER STATION
HENNEPIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

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REVIEWED BY:	PA	DRAWING NO.:	C-101
APPROVED BY:	JPC		

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Appendix D

Nature and Extent Report

Intended for
Dynegy Midwest Generation , LLC
13498 E 800th St.
Hennepin, Illinois, 61327

Date
May 8, 2024

Project No.
1940103584-005

NATURE AND EXTENT REPORT

HENNEPIN POWER PLANT, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

RAMBOLL Bright ideas. Sustainable change.

NATURE AND EXTENT REPORT
HENNEPIN POWER PLANT, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

Project name	**Hennepin Power Plant West Ash Pond System**
Project no.	**1940103584-005**
Recipient	**Dynegy Midwest Generation, LLC**
Document type	**Nature and Extent Report**
Revision	**FINAL**
Date	**May 8, 2024**
Prepared by	**Nathaniel Keller, Bryan Donaldson**
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ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
ASD	Alternative Source Demonstration
CCR	coal combustion residuals
Closure Plan	Closure and Post-Closure Care Plan
CMA	Corrective Measures Assessment
cm/s	centimeters per second
COC	chemicals of concern
CSM	conceptual site model
DMG	Dynegy Midwest Generation, LLC
E001	Event 1
E002	Event 2
E003	Event 3
GCSM	geochemical conceptual site model
GWPS	groundwater protection standard
HELP	Hydrologic Evaluation of Landfill Performance
HPP	Hennepin Power Plant
HCR	Hydrogeologic Site Characterization Report
ID	Identification
IEPA	Illinois Environmental Protection Agency
LCL	lower confidence limit
mg/L	milligrams per liter
NAVD88	North American Vertical Datum 1988
No.	Number
OWAP	Old West Ash Pond (Pond No. 1 and Pond No. 3)
OWPP	Old West Polishing Pond
SI	surface impoundment
TDS	total dissolved solids
UA	uppermost aquifer
WAPS	West Ash Pond System

EXECUTIVE SUMMARY

Groundwater samples collected at the Hennepin Power Plant (HPP) West Ash Pond System (WAPS) during May and June 2023 for the Quarter 2, 2023 compliance sampling event (Event 1 [E001]) were evaluated for exceedances of the groundwater protection standards (GWPS) described in Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.600. Exceedances were identified in the following wells in the uppermost aquifer (UA):

- Arsenic at 21R and 51
- Boron at 21R, 22, 23, and 35
- Cadmium at 22
- Sulfate at 23 and 35

In accordance with 35 I.A.C. § 845.650(e), an Alternative Source Demonstration (ASD) was completed for the cadmium exceedance at well 22 and received concurrence in a letter from the Illinois Environmental Protection Agency (IEPA) dated December 11, 2023 [1, 2]. A Corrective Measures Assessment (CMA) was initiated on December 10, 2023 and submitted on May 8, 2024 in accordance with 35 I.A.C. § 845.660 for the remaining E001 exceedances [3].

The subsequent compliance sampling events for the Quarter 3 and Quarter 4, 2023 sampling events (Event 2 [E002] and Event 3 [E003]) were completed in August and November 2023 and groundwater samples were evaluated for exceedances of the GWPS as described in 35 I.A.C. § 845.600. Additional exceedances were identified in the following wells in the UA during the E002 and E003 events:

- Lithium at 22
- Total Dissolved Solids (TDS) at 35

The E002 and E003 exceedances of lithium at well 22 and TDS at well 35 were evaluated with respect to the groundwater model, potentially feasible corrective measures, and remedy extents and were determined not to substantially affect the findings and conclusions of the previously initiated CMA evaluation and therefore have been incorporated into the CMA and this report.

As required by 35 I.A.C. § 845.650(d)(1) this report characterizes the nature and extent of arsenic, boron, lithium, sulfate, and TDS and relevant site conditions to determine how they may affect the corrective measures ultimately selected for the WAPS and documents the additional measures taken in accordance with 35 I.A.C. § 845.650(d).

All of the aforementioned chemicals of concern (COCs) were detected above the GWPS within the UA. The lateral and downgradient extent of these COCs in the UA is adequately defined by sampling of existing monitoring wells and surface water samples. The vertical migration of these COCs above the GWPS in the UA is limited by low hydraulic conductivity of the Bedrock Confining Unit (Carbondale Formation) underlying the UA [4]. The concentrations of arsenic, boron, lithium, sulfate and TDS within the UA are attenuated physically through dilution and dispersion; and may be geochemically attenuated by surface complexation reactions with metal oxyhydroxides and clays. Concentrations of exceedance parameters in the Illinois River were evaluated and they do not exceed their respective GWPS.

1. INTRODUCTION

35 I.A.C. § 845.650(d)(1) requires the owner or operator of a coal combustion residuals (CCR) surface impoundment (SI) to characterize the nature and extent of a release and relevant site conditions that may affect the remedy ultimately selected for a CCR SI if any constituent regulated under 35 I.A.C. § 845 is found to exceed the GWPS. This report documents the nature and extent of constituents detected above the GWPS that are attributable to the HPP WAPS.

The groundwater data and analysis in this report includes results from historical sampling (initiated in 2015) through E003, which was completed on November 15, 2023. Results of the events E001, E002, and E003 were submitted and placed in the facility's operating record within 60 days of receiving final laboratory analytical data [5, 6, 7] as required by 35 I.A.C. § 845.800(d)(15). The statistical determination presented in these reports identified the following exceedances of the GWPS at compliance groundwater wells in the UA:

- Arsenic at 21R and 51
- Boron at 21R (E001 only), 22, 23, and 35
- Cadmium at 22
- Lithium at 22
- Sulfate at 23 and 35
- TDS at 35

An ASD, as allowed by 35 I.A.C. § 845.650(e), was completed for the cadmium exceedance at UA monitoring well 22 [2]. The IEPA concurred with the ASD in a letter dated December 11, 2023 [1]. Therefore, the nature and extent of cadmium is not discussed in this document. This Nature and Extent Report discusses in detail the extent of arsenic, boron, lithium, sulfate, and TDS exceedances as well as a geochemical conceptual site model (GCSM) describing the nature of these exceedances.

2. UNIT BACKGROUND

2.1 Site Location and Description

The HPP is an approximately 504-acre property consisting of 19 parcels positioned adjacent to the Illinois River, including a retired coal-fired power plant, CCR landfill and SIs, and farmland, located approximately 3 miles north-northeast of the Village of Hennepin, Illinois, in Putnam County. The HPP construction history includes construction of Unit 1 in 1953 and Unit 2 in 1969, with capacities of 70 megawatts (MW) and 210 MW, respectively. The plant initially burned high-sulfur Illinois coal and switched to sub-bituminous Powder River Basin coal in 1999 [8]. The HPP ceased operations in 2019 when the power plant was retired.

The WAPS is one of three CCR units at the HPP regulated under 35 I.A.C. § 845. The other two CCR units regulated under 35 I.A.C. § 845 (Ash Pond Number [No.] 2 and No. 4 multi-unit [AP2/AP4] and the East Ash Pond) are located adjacent to each other and the Landfill, east of the HPP. The WAPS is located west of the HPP. Areas surrounding the WAPS include agricultural land, with scattered groupings or rows of trees to the southeast, and low-lying floodplains of the Donnelley Wildlife Management Area to the southwest and west. The WAPS and surrounding properties are shown on **Figure 2-1**.

2.2 Description of CCR Unit

Dynegy Midwest Generation, LLC (DMG) operated the WAPS from 1952 through 1996. It consists of two closed units, the Old West Ash Pond (OWAP; IEPA Unit Identification [ID] W1550100002-01) and the Old West Polishing Pond (OWPP; IEPA Unit ID W1550100002-03) (**Figure 2-2**). The OWAP consists of the 9.3-acre Pond No. 1 at the eastern end of the impoundment and the 16.4-acre Pond No. 3 within the central portion of the impoundment. The 4.7-acre OWPP is situated at the western end of the impoundment. All ponds were previously bermed to approximately 15 feet above grade primarily using locally occurring soils. The OWPP berms were excavated and removed to obtain access to CCR material used within and below them during closure construction of this unit in 2020.

During operation, water was used to sluice fly ash, bottom ash, and low-volume wastes to the WAPS. At the time it was removed from service in late 1996, there was no surface water discharge. Coal ash sluiced to the WAPS was a by-product of the combustion of high-sulfur Illinois coal. CCR fill, consisting primarily of fly ash, bottom ash, and boiler slag is present from approximately 460 feet[1] to a minimum elevation of approximately 440 feet along the west side of the OWAP (**Figure 2-3**). The unit is encompassed by fill deposits of predominantly sand, clay, and silt materials from on-site excavations that were used to construct berms and roads surrounding the various impoundments across the Site.

Water that may come into contact with CCR within the footprint of the WAPS becomes CCR source water. CCR source water samples, collected from the porewater monitoring wells (**Figure 2-4**) screened within the CCR materials at the WAPS were used to provide information for ASDs

[1] All elevations in this report are referenced to North American Vertical Datum of 1988 (NAVD88) unless otherwise noted.

and groundwater transport modeling[2]. As a result of declining water levels within the unit post-closure, the remaining porewater monitoring wells have become dry, thus preventing further sample collection.

The Closure and Post-Closure Care Plan, Old West Ash Pond, Old West Polishing Pond at DMG, Hennepin Power Station (Closure Plan) was submitted to IEPA in 2017 [9] and approved by IEPA in a letter dated June 19, 2018. The approved Closure Plan summarized the planned closure of the WAPS, which included dewatering the CCR, if needed, mechanical excavation of material from the OWPP for use as structural fill in the WAPS, grading within the WAPS, constructing an alternate cover system consisting of geomembrane and vegetated cover soils in direct contact with the graded CCR, and establishment of a vegetative cover. Closure construction was completed on November 17, 2020 [10].

2.3 Geology and Hydrogeology

Significant site investigation has been completed at the HPP to characterize the geology, hydrogeology, and groundwater quality. Based on extensive investigation and monitoring, the WAPS has been well characterized and detailed in the October 25, 2021 operating permit application and the Hydrogeologic Site Characterization Report (HCR) submitted as part of the Closure Plan [4, 11, 9]. Those materials, in addition to data collected from the nearby East Ash Pond System, where representative of Site conditions, are incorporated herein.

2.3.1 Hydrostratigraphic Units

In addition to CCR, materials at the site have been categorized into two hydrostratigraphic units at the WAPS based on stratigraphic relationships, geologic composition, and common hydrogeologic properties. Cross-sections developed for the HCR are included in **Appendix A**. The units, listed from surface downward, are summarized as follows:

- **Uppermost Aquifer (UA)**: Includes the Cahokia Alluvium which consists of fine-grained river deposits comprised of silts and clays (upper UA), fine-medium sands (middle UA), and highly permeable glacial outwash sands and gravels of the Henry Formation (lower UA). The UA contains variable amounts of cobbles and boulders within a sand and gravel matrix. Both the prevalence and size of the cobbles and boulders increase with depth.

- **Bedrock Confining Unit**: Comprised of interbedded layers of shales with thin limestone, sandstone, and coal beds. Representative hydraulic conductivity for shale ranges from 5×10^{-6} to 5×10^{-10} centimeters per second (cm/s) and this unit defines the lower boundary of the UA. Borings along the perimeter of the nearby East Ash Pond System confirm the presence of shale bedrock between elevations ranging from 399.2 to 410.2 feet [12].

2.3.2 Uppermost Aquifer

The unlithified geologic deposits of the UA surrounding the WAPS are derived from recent river deposition, glacial outwash, and glacial tills. The WAPS overlies both glacial outwash deposits (Henry Formation) and alluvium (Cahokia Alluvium). OWAP Pond No. 1 rests on top of lower terrace glacial deposits, and the eastern portion of Pond No. 3 overlies alluvial sand. Whereas the

[2] Per Federal Register 80 (21302), which promulgated the final C.F.R. 40 § 257 rule, porewater concentrations should be used to characterize potential leaching from impoundments. As discussed further in USEPA's risk assessment of CCR surface impoundments (USEPA 2014), porewater is "collected from the interstitial water between waste particles in surface impoundments as it occurs in the field," and concentrations within the porewater are "the most representative data available for impoundments because these data are field-measured concentrations of leachate." Therefore, CCR source water collected from porewater wells screened near the base of ash within the unit represents the CCR source term.

western portion of Pond No. 3 and the OPP overlies silty clay alluvial channel fill deposits (**Figure 2-3**). The total thickness of the UA varies in thickness ranging from 50 to 200 feet. Groundwater monitoring for the UA is focused on the sand and gravel zone because it is continuous, exhibits high groundwater velocities, and is most likely to indicate potential migration of impacts from the WAPS. The top of the sand and gravel portion of the UA is shown on **Figure 2-5**. The sand and gravel is present at the surface at an approximate elevation of 450 feet (no overlying clay/silt) near wells 25, 26, and within 5 feet of the surface at wells 30, 31, 35, and 36. CCR is also near the top of the sand and gravel in eastern areas of the WAPS. From the topographic highs, the top of the sand and gravel slopes downward toward the river to approximately 410 feet near well 21/21R and 51. The direction of groundwater flow and hydraulic gradient is contingent on the elevation of the Illinois River which is directly adjacent to the WAPS.

2.3.3 Regional Bedrock Geology

The bedrock geology near the Hennepin Power Station is primarily comprised of the Pennsylvanian Carbondale Formation, which is characterized by shale with thin limestone, sandstone, and coal beds. The bedrock surface elevation ranges from 400 to 450 feet, with shale bedrock confirmed between elevations of 400 and 410 feet in the vicinity of the WAPS. The thickness of Pennsylvanian rocks varies from 150 to 525 feet across Putnam County and is estimated to be around 300 to 400 feet near the site. Beneath the Pennsylvanian rocks lie Mississippian and Devonian-age interbedded layers of limestone and shale over Silurian-age dolomite, with aquifer depths ranging from less than 1,000 feet to over 1,800 feet. [4].

2.3.4 Water Table Elevation and Groundwater Flow Direction

Measured water table elevations in the UA during the quarterly sampling events in 2023 ranged from approximately 440 feet in the northwest portion of the site (well 34) to approximately 449 feet south of the WAPs in well 26 (**Table 2-1**; **Figure 2-6** to **Figure 2-9**). Increased groundwater elevations measured near the river in wells 22, 34, and 50 during periods of flooding (**Figure 2-5**) indicate there is a potential connection between the river and the sand and gravel of the UA in this area. Groundwater elevations following closure have been relatively stable, generally varying less than approximately 2 feet.

The primary groundwater flow direction within the UA is generally northwest from areas where the sand and gravel in the UA is closest to the surface (wells 25, 26, 30, 31, 35, and 36) toward the river and locations where the UA potentially interacts with the base of the river (*i.e.,* wells 22, 34, and 50).

2.3.4.1 Impact of Surface Water Bodies on Groundwater Flow

Under normal river stage conditions, the Illinois River serves as the primary local and regional receiving body of water for groundwater in the area, with its lowest stage typically occurring between August and October [4]. Historically during this period, a groundwater divide becomes apparent beneath the WAPS, directing flow north towards the river and southwestward, eventually migrating west of the WAPS. Surface water elevations in the Donnelley Wildlife Management Area (DWMA) are expected to be similar to elevations measured in wells 32, 33, and 34. Groundwater flow patterns are depicted in potentiometric surface maps for quarters 1 through 4 of 2023 (**Figures 2-6 through 2-9**), which align with historical observations.

During annual spring flooding from March to June, and sporadic flood events, river stages exceed adjacent groundwater levels, resulting in temporary aquifer recharge and a reversal of groundwater flow direction. Horizontal gradients across the site flatten during these events. A representative potentiometric surface map for February 28 and March 1, 2023 (**Figure 2-6**), illustrates groundwater flow conditions during flood stage, with an approximate river elevation of 449.50 feet. These reversals are temporary and limited in duration and extent. Horizontal hydraulic gradients from the WAPS to off-site areas vary from 0.001 during Illinois River flood stage to about 0.005 during normal river stage.

2.3.5 Hydraulic Conductivities

2.3.5.1 Field Hydraulic Conductivities

Hydraulic conductivity was calculated based on field tests at seven wells in proximity to the WAPS. Hydraulic conductivity ranged from 1.2×10^{-2} cm/s in the Henry Formation (deep UA) to 1.3×10^{-4} cm/s in the Cahokia Alluvium silt (shallowest UA). The geometric mean hydraulic conductivity for the sand and gravel portion of the UA is 6×10^{-3} cm/s. The geometric mean for wells finished in the glacial outwash gravels of the Henry Formation is 1.7×10^{-2} cm/s [4].

A pump test was also performed in the Henry Formation using a "fire well" which resulted in a reported hydraulic conductivity of 1.3×10^{-1} cm/s. The well is located in proximity to the southwest corner of the HPP, east of the WAPS [4].

2.3.5.2 Laboratory Hydraulic Conductivities

Hydraulic conductivity laboratory tests were performed for two samples collected in boring HEN-B010 (fly ash with sand and gravel) near the south berm of Old West Pond 3 and HEN-B017 (gray lean clay with sand) near the west berm of the OWPP. Hydraulic conductivities were calculated to be 1.2×10^{-5} cm/s and 6.8×10^{-7} cm/s, respectively [4].

2.3.5.3 Groundwater Velocity and Vertical Gradients

Hydraulic gradients were calculated from water-level elevations at wells 21 to 34 and wells 27 to 33 in June and September 2013 [4] as representative gradients for the predominant direction of lateral flow at the WAPS. Hydraulic gradients ranged from 0.005 (21 to 34) to 0.001 (27 to 37) during both periods of measurement [4].

Groundwater velocities were calculated using geometric means of the field calculated hydraulic conductivities of 1.7×10^{-2} cm/s (glacial outwash gravels) and 6.0×10^{-3} cm/s (sand and gravel), an effective porosity of 0.22 and the hydraulic gradients listed above. Groundwater velocities calculated in proximity to the WAPS, between wells 21 to 34 and wells 27 to 33, range from 0.03 meters per day (m/day) to 0.34 m/day [4].

Vertical gradients evaluated in wells 22 and 22D in 2023 indicate groundwater generally has an upward gradient in this area, which is consistent with the Illinois River being the receiving water body for regional groundwater. Downward gradients observed in February and November are potentially a result of delayed response to changes in river stage in the deeper well, and a measurement anomaly, respectively (**Figure 2-10**).

2.4 Groundwater Monitoring

The monitoring system for the WAPS is shown on **Figure 2-11** and consists of two background monitoring wells (32 and 34) and nine compliance monitoring wells (21R, 22, 22D, 23, 27, 35, 49, 50, and 51). These monitoring wells are screened within the UA along the perimeter of the WAPS to monitor potential impacts from the SI [13]. During remedial construction performed in February 2020, wells 21 and 24 were abandoned and replaced with wells 21R and 51, respectively. Discussion of historical groundwater data from wells 21 and 24 is presented in **Section 3** of this report and will refer to their respective replacement wells.

2.5 Hydrogeologic Conceptual Site Model

The overall groundwater flow regime within the unlithified materials is consistent with topographically-controlled flow patterns, where infiltration of precipitation recharges groundwater and flows north and west near the site towards the Illinois River. Flow patterns within the site hydrostratigraphic units are typically horizontal, with components of converging vertical (upward) flow near and underneath the river. Under typical post-closure conditions, groundwater flow directions at the OWAP are north, towards the river. During the operation of the impoundments, high local recharge to groundwater from sluicing of CCR created radial flow conditions near the impoundment; while groundwater flow was still predominantly towards the river, some of the groundwater beneath the impoundment flowed towards the adjacent wetlands located south and west of the OWAP.

After sluicing was halted, recharge continued to infiltrate the CCR in the WAPS. The recharge in the footprint of the OWAP migrated within the CCR into the OWPP (through ash within the former western separator berm), and downward into the UA at a reduced rate (since sluice water was no longer present). During closure the OWPP was dewatered, a temporary sheet pile wall was constructed along its eastern side to facilitate the excavation of ash in the OWPP, and a solid clay berm along the west side of the OWAP was constructed. The unit was then closed with a geomembrane cover system to significantly reduce and control infiltration into the CCR material. The sheet pile was left in place at the completion of the construction.

Currently, little to no precipitation enters the remaining CCR in the WAPS due to the geomembrane cover system; however, during high river stage the heads within the UA may become elevated and potentially intersect the base of the CCR. The extent and magnitude of these events is based on the stage of the Illinois River and the duration of the elevated levels.

Conceptually, source water from the WAPS, if present, migrates downward into the materials of the UA, either sand or silt/clay, and mixes with groundwater. Groundwater continues to migrate vertically in the low permeability materials until it encounters the sand and gravel portions of the UA. In the sand and gravel, groundwater migrates horizontally to the north towards the Illinois River, and depending on elevations, may also have a component to the southwest/west which eventually intersects the Illinois River.

Based on the conceptual model discussed above, the compliance wells at the WAPS have been grouped into the following categories based on their location within the flow system (**Figure 2-5**):

- Unconfined UA wells: Monitoring wells located in areas where the sand and gravel unit is near the land surface (wells 22, 22D, 32, 35, 36, 49, and 50). These wells are located on the

eastern half of the unit or southeast of the WAPS. The bottom of the screened intervals are at an elevation greater than 420 feet (except 22D) and the sand and gravel is overlain by less than 8 feet of fine-grained material.

- Transitional UA wells: Monitoring wells within sand and gravel that is overlain by 15 to 25 feet of fine-grained material (wells 23, 27, and 34). The base of the screens are at an elevation between 410 and 420 feet and the wells are located in a "U" shape around the former OWPP.
- Confined UA wells: Wells within sand and gravel at depth below 30 to 40 feet of fine-grained material (wells 21R and 51). These wells are located on the west and northeast side of the OWPP, and the base of the wells are at an elevation below 405 feet.

3. OCCURRENCE AND DISTRIBUTION OF GROUNDWATER EXCEEDANCES (EXTENT)

As described in Section 1, exceedances from sampling events E001, E002, and E003 include the following parameters and wells within the UA:

- Arsenic at 21R and 51
- Boron at 21R, 22, 23, and 35
- Sulfate at 23 and 35
- Lithium at 22
- TDS at 35

The extents of exceedances discussed below were defined using existing monitoring wells, including wells present onsite (**Table 3-1**) that may not be included in the 35 I.A.C. § 845 monitoring program.

3.1 Additional Investigation to Further Evaluate Nature and Extent

Solid phase data were collected and evaluated to assess potential geological sources of exceedance parameters and to inform the GCSM (discussed further in **Section 4**). Solid phase data were not collected from the CCR source material prior to completion of closure of the unit in 2020. A total of three borings were advanced adjacent to locations with potential exceedances (wells 22 and 51), and background well (34). Four solids samples were collected and analyzed for the following:

- EPA 6010B for 7-step sequential extraction (iron, aluminum, arsenic, manganese, lithium, and boron);
- EPA 6010B for Total Metals (35 I.A.C. § 845.600 parameters [minus radium] plus aluminum, bismuth, copper, iron, magnesium, manganese, nickel, potassium, silver, strontium, tin, titanium, uranium, vanadium, yttrium, and zinc) via Bulk Characterization;
- Bulk Mineralogy by Reitveld x-ray diffraction analysis;
- Sulfate and Sulfide Analysis via anion chromatography;
- Total Organic Carbon Analysis; and,
- Loss on Ignition Analysis.

In addition, fifteen surface water samples were collected to characterize the water quality in the Illinois River upgradient and adjacent to the WAPS (**Figure 3-1**). Surface water samples were analyzed for dissolved (*i.e.*, filtered) fractions of arsenic, lithium, and boron, and total (*i.e.*, unfiltered) sulfate. Data from this investigation is presented in **Table 3-2** and has been incorporated into this report where applicable.

3.2 Extents in the Uppermost Aquifer

Exceedances are identified quarterly following comparison of lower confidence limits (LCLs) to the GWPSs described in 35 I.A.C. § 845.600. The LCLs vary as the dataset is updated to include additional quarterly events (**Table 3-3**). The discussion below includes ranges of concentrations

measured in wells with exceedances, because there is no single value for LCLs. The statistical results from the three compliance monitoring events are presented in **Table 3-3** and all data evaluated has been summarized in **Table 3-4**.

3.2.1 Arsenic

Arsenic concentrations in monitoring wells 21R and 51 resulted in exceedances of the GWPS (0.010 milligrams per liter [mg/L], **Figure 3-2**). The concentrations and extent of arsenic exceedances at the WAPS are summarized as follows:

- 21R and 51 – Exceedances were reported in all three compliance sampling events. Data collected between 2015 and 2023 reported arsenic concentrations ranging from 0.0024 to 0.0345 mg/L in well 21/21R and from 0.0102 to 0.038 mg/L in well 24/51 (**Table 3-4**). The lateral extent of elevated arsenic concentrations are defined by adjacent monitoring wells 34 (non-detect to 0.0005 mg/L) located west of 21R, and 23 (non-detect to 0.0005 mg/L), located east of 51 (**Figure 2-11**, **Table 3-4**). The downgradient extent is defined by the Illinois River, where arsenic concentrations measured in 2020 at sample locations IR04-C/L/R and IR05-C/L/R were all less than 0.0031 mg/L (**Table 3-2).** Surface water samples of the Illinois River upgradient, midgradient, and downgradient of the HPP were indistinguishable for arsenic concentrations, indicating that there is no measurable impact to the Illinois River from groundwater relative to the WAP or HPP. Downward vertical migration of arsenic concentrations above the GWPS is limited by regional upward gradients to the Illinois river, as observed in wells 22/22D.

3.2.2 Boron

Boron concentrations in monitoring wells 21R (E001 only), 22, 23, and 35 resulted in exceedances of the GWPS (2 mg/L, **Figure 3-2**). The concentrations and extent of boron exceedances at the WAPS are summarized as follows:

- 21R (E001 only) – The concentrations of boron in 21/21R ranged from 1.25 to 4.60 mg/L (**Table 3-4**) and LCLs have declined between events E001 and E003. The lateral extent of elevated boron concentrations are defined by adjacent monitoring wells 34 (0.075 to 0.206 mg/L) located west of 21R, and 24/51 (1.3 to 3.84 mg/L), located east of 21R (**Figure 2-11**, **Table 3-4**).
- 22 – Concentrations of boron in monitoring well 22 range from 0.13 to 6.72 mg/L (**Table 3-4**) and LCLs have declined between events E001 and E003. Concentrations above the GWPS are defined laterally by well 49 (0.68 to 1.70 mg/L) located west of 22, and by well 50 (0.59 to 1.43 mg/L) located east of well 22 (**Table 3-4**). Vertical extent of boron concentrations above the GWPS is defined by nested well 22D (1.63 to 2.68 mg/L).
- 23 – Concentrations of boron range in well 23 from 5.63 to 12.8 mg/L (**Table 3-4**) and LCLs are variable during events E001 through E003. The extent of boron concentrations above the GWPS is defined laterally by well 51 (1.30 to 3.14 mg/L) to the west and well 49 (0.68 to 1.70 mg/L) to the east.
- 35 – Concentrations of boron in well 35 range from 4.98 to 18.1 mg/L (**Table 3-4**) and LCLs have declined during events E001 through E003. The extent of elevated boron concentrations is defined in the downgradient direction of flow (towards both 23 and 27) by concentrations measured in well 27 (2.00 to 4.31 mg/L) and the Illinois River (discussed below).

The extent of boron concentrations above the GWPS downgradient from all locations is defined by the results of surface water sampling from the Illinois River completed in 2020 (**Figure 3-1**). Concentrations of boron measured at sample locations IR04-C/L/R and IR05-C/L/R were all less than 0.14 mg/L. Surface water samples of the Illinois River upgradient, midgradient, and downgradient of the HPP were indistinguishable for boron concentrations, indicating that there is no measurable impact to the Illinois River from groundwater relative to the WAP or HPP. Downward migration of boron concentrations within the UA is limited by the presence of regional upward gradients to the Illinois River, as observed in wells 22/22D.

3.2.3 Lithium

Lithium concentrations in monitoring well 22 resulted in the only exceedance of the GWPS (0.04 mg/L, **Figure 3-2**). The concentrations of lithium within well 22 range from 0.0090 to 0.0764 mg/L (**Table 3-4**) and LCLs have increased during events E001 through E003 as concentrations stabilize. The extent of lithium concentrations above the GWPS is defined laterally by well 50 (0.0071 to 0.0300 mg/L) to the east and well 49 (0.0202 to 0.0297 mg/L) to the west. Surface water samples collected from the Illinois River in 2020 (**Figure 3-1**) at sample locations IR04-C/L/R and IR05-C/L/R had lithium concentrations below 0.008 mg/L. Surface water samples of the Illinois River upgradient, midgradient, and downgradient of the HPP were indistinguishable for lithium concentrations, indicating that there is no measurable impact to the Illinois River from groundwater relative to WAP or HPP. The vertical extent of lithium is defined by concentrations measured in well 22D which are below the GWPS, ranging from 0.0123 to 0.0190 mg/L (**Table 3-4**).

3.2.4 Sulfate

Sulfate concentrations in monitoring wells 23 and 35 resulted in exceedances of the GWPS (400 mg/L, **Figure 3-2**). The concentrations and extent of sulfate exceedances at the WAPS are summarized as follows:

- 23 – Concentrations of sulfate range from 323 to 554 mg/L and LCLs exhibit no trend during events E001 through E003. The extent of sulfate concentrations above the GWPS, like boron, is defined by well 24/51 (87.0 to 162 mg/L) to the west and well 49 (71.0 to 114 mg/L) to the east (**Table 3-4**).
- 35 – Concentrations of sulfate in well 35 range from 255 to 1,190 mg/L and LCLs have increased during events E001 through E003. The extent of elevated sulfate concentrations is defined in the downgradient direction of flow (towards both 23 and 27) by well 27 (104 to 228 mg/L) and the Illinois River.

Surface water samples collected from the Illinois River in 2020 (**Figure 3-1**) at sample locations IR04-C/L/R and IR05-C/L/R had sulfate concentrations ranging from 73 to 75 mg/L. Surface water samples of the Illinois River upgradient, midgradient, and downgradient of the HPP were indistinguishable for sulfate concentrations, indicating that there is no measurable impact to the Illinois River from groundwater relative to WAP or HPP. The vertical migration of sulfate is limited by the regional upward gradients near the Illinois River, as observed onsite in wells 22 and 22D.

3.2.5 Total Dissolved Solids

TDS results indicate the mass of dissolved material in groundwater and is a representation of multiple constituents present in the groundwater. Typically, major ions (such as sulfate) represent the primary contributors to TDS. TDS detected in monitoring well 35 resulted in an

exceedance of the GWPS (1200 mg/L, **Figure 3-2**). This TDS exceedance is coincident with the sulfate exceedance observed at well 35. The concentrations and extent of TDS exceedances at the WAPS are defined downgradient of well 35 by wells 23, 27, 49, and 51 (**Table 3-4**).

The vertical migration of TDS is limited by the regional upward gradients near the Illinois River, as observed onsite in wells 22 and 22D.

4. GEOCHEMICAL CONCEPTUAL SITE MODEL (NATURE)

A GCSM was developed to describe the conditions of the groundwater in the vicinity of the HPP WAPS and is summarized here (full analysis presented in **Appendix B**). The GCSM describes the geochemical processes that contribute to the mobilization, distribution, and attenuation of chemicals in the environment. Only parameters that have exceeded the GWPS in WAPS groundwater, to be addressed in the corrective action plan, are included in the GCSM. As discussed in previous sections the exceedances observed at the WAPS include arsenic, boron, lithium, sulfate, and TDS.

The CCR materials are the primary source of constituent loading to the CCR porewater (*i.e.*, CCR source water). Over an extended period (*e.g.*, months to years), the CCR source water (*i.e.*, water contained within the interstitial pore spaces of the CCR that can be sampled by low-flow groundwater sampling methods) reaches equilibrium with the CCR materials. The porewater is therefore representative of the mobile phase constituents capable of migrating into the underlying materials and potentially downgradient in groundwater. The WAPS CCR source water is therefore the primary indicator of constituents *available* to the groundwater and is considered as the primary source term for environmental investigation and fate and transport modeling.

Arsenic, boron, lithium, and sulfate are naturally present in coal deposits and are concentrated in CCR. TDS is a measure of inorganic and organic substances in solution and, as such, TDS trends are generally consistent with those of major ions in the WAPS groundwater system. Arsenic, boron, and lithium were identified in UA solids adjacent to downgradient and background wells, which suggests that aquifer solids could provide a secondary natural geogenic source of arsenic, boron, and lithium to the groundwater. Redox conditions vary across the site, with more oxidizing conditions on the east side of the WAPS and more reducing conditions on the west. Reducing conditions may be enhancing arsenic mobility and thus aqueous arsenic concentrations at select wells on the west of the WAPS. The principal source of arsenic, boron, lithium, sulfate, and TDS exceedances to groundwater of the UA is currently expected to be the WAPS CCR porewater.

Arsenic, boron, lithium, and sulfate in the groundwater system may be attenuated via surface complexation reactions with metal (*i.e.*, aluminum, iron, and manganese) oxyhydroxides. Iron oxides were detected in aquifer solids and are generally predicted to be stable at monitoring wells across the monitoring system. Clay minerals were also identified in aquifer solids and may provide an additional attenuation mechanism for arsenic, boron, lithium, and sulfate in groundwater. At the limited locations across the monitoring system where reducing conditions are present, microbial sulfate reduction may also contribute to decreased sulfate concentrations in the groundwater. Attenuation of the constituents contributing to TDS, such as sulfate, will reduce TDS concentrations as well.

5. COMBINED GEOCHEMICAL AND HYDROGEOLOGIC CONCEPTUAL SITE MODELS

5.1 Arsenic Conceptual Site Model

The conceptual site model (CSM) describing current conditions at the WAPS combining the hydrogeologic and geochemical CSMs for arsenic is as follows. Water that may come into contact with CCR in the WAPS becomes porewater within the unlined CCR unit. During operations, sluicing of CCR with elevated heads in the unit resulted in radial flow, likely causing porewater, potentially impacted with arsenic, to migrate downward into the UA. In the UA, porewater mixes with groundwater and the resulting geochemical conditions influence the mobility of arsenic and concentrations observed in compliance wells. In the unconfined/oxidizing portions of the UA, arsenic concentrations do not exceed the GWPS, while in the deeper confined portions of the UA, reducing concentrations result in elevated arsenic concentrations that exceed the GWPS. In addition to physical attenuation mechanisms of dilution and dispersion, elevated arsenic concentrations may be attenuated via surface complexation reactions with metal (*i.e.,* aluminum, iron, and manganese) oxyhydroxides or reactions with clay minerals.

5.2 Boron Conceptual Site Model

The CSM describing current conditions at the WAPS combining the hydrogeologic and geochemical CSMs for boron is as follows. Water that may come into contact with CCR in the WAPS becomes porewater within the unlined CCR unit. During operations, sluicing of CCR with elevated heads in the unit resulted in radial flow, likely causing porewater, impacted with boron, to migrate downward and outward into the UA. In the UA, porewater mixes with groundwater and migrates toward the Illinois River. After sluicing operations ceased in 1996 boron concentrations began to decline in all wells (except 23 and 35) and continued on that trajectory following closure of the unit in 2020. The reduction in infiltration has generally resulted in lower boron concentrations and small shifts in groundwater flow directions (*i.e.,* boron concentrations in well 27 have declined and no longer exceed the GWPS). At well 35 (and 23, which is downgradient of 35), localized flow conditions following closure appear to be influencing boron concentrations at this location while head within the WAPS approaches equilibrium. The Hydrologic Evaluation of Landfill Performance (HELP) model completed for closure indicated that hydrostatic equilibrium would be achieved in approximately 7 years following closure (or approximately 2027) [14]. In addition to physical attenuation mechanisms of dilution and dispersion, elevated boron concentrations may be attenuated via surface complexation reactions with metal (*i.e.,* aluminum, iron, and manganese) oxyhydroxides or reactions with clay minerals.

5.3 Lithium Conceptual Site Model

Similar to arsenic and boron CSMs, water that may come into contact with CCR in the WAPS becomes porewater within the unlined CCR unit. During operations, sluicing of CCR with elevated heads in the unit resulted in radial flow, likely causing porewater, potentially impacted with lithium, to migrate downward into the UA. In the UA, porewater mixes with groundwater and the resulting geochemical conditions influence the concentrations observed in compliance wells. Lithium concentrations are above the GWPS only in well 22 at the WAPS. The well is located north of the CCR unit and is the only compliance location directly downgradient of the CCR unit without a clay/silt layer above the well screen. In addition to physical attenuation mechanisms of dilution and dispersion, elevated lithium concentrations may be attenuated via surface

complexation reactions with metal (*i.e.,* aluminum, iron, and manganese) oxyhydroxides or reactions with clay minerals. The lack of clay at this location may have resulted in migration of lithium to this location and observations following closure indicate concentrations are declining.

5.4 Sulfate and TDS Conceptual Site Model

Consistent with the other CSMs, water that may come into contact with CCR in the WAPS becomes porewater within the unlined CCR unit. During operations, sluicing of CCR with elevated heads in the unit resulted in radial flow, likely causing porewater, impacted with sulfate, to migrate downward and outward into the UA. In the UA, porewater mixes with groundwater and migrates toward the Illinois River with concentrations attenuating due to physical mechanisms (dilution and dispersion), and potentially through surface complexation reactions with metal (*i.e.*, aluminum, iron, and manganese) oxyhydroxides or reactions with clay minerals. Under sufficient reducing conditions, microbial sulfate reduction may also contribute to decreased sulfate concentrations in the groundwater. After sluicing operations ceased in 1996 sulfate concentrations began to decline in all wells (except 23 and 35) and continued on that trajectory following closure of the unit in 2020. The reduction in infiltration has generally resulted in lower sulfate concentrations and small shifts in groundwater flow directions. At well 35 (and 23, which is downgradient of 35), localized flow conditions following closure appear to be influencing sulfate concentrations at this location while head within the WAPS approaches equilibrium. The HELP model completed for closure indicated that hydrostatic equilibrium would be achieved in approximately 7 years following closure (or approximately 2027) [14] . Lack of elevated sulfate (while boron persists) at UA well 21R provides evidence that sulfate reduction may be occurring.

6. CONCLUSIONS AND FUTURE ACTIVITIES

In accordance with 35 I.A.C. § 845.650(d)(1), the nature and extent of GWPS exceedances of arsenic, boron, lithium, sulfate, and TDS have been described in sufficient detail to support a complete and accurate assessment of the corrective measures necessary to effectively clean up all releases from the WAPS. As discussed in Sections 3.3.1 and 3.3.2, the horizontal delineation of all constituents has been defined by a combination of results at existing wells and surface water results that indicate concentrations are below the GWPS.

Following closure, groundwater monitoring results are generally consistent with the conclusions in the Closure Plan [9] and site conditions are improving as follows:

- Water levels within the CCR are declining. Porewater monitoring wells have gone dry, indicating the level in the unit has declined.
- Trends for boron and sulfate (**Appendix B** [GCSM]), which are conservative indicators of CCR impacts, indicate concentrations are declining in all wells except wells 23 and 35. Concentrations at these two locations are potentially related to localized flow conditions that originated as a result of closure, but are expected to dissipate as the unit reaches equilibrium (predicted to occur in 2027).

These observations are consistent with the conceptual site models and constituent extents provided in **Section 5.**

Boron was selected for modeling source control presented in the Final Closure Plan, as described in the Groundwater Model Report (GMR) [14]. Boron is considered a surrogate parameter for arsenic, lithium, sulfate and TDS because it is the constituent at the site that will likely require the longest time to achieve the GWPS. Further modeling selected constituents is a common industry approach for evaluation of environmental systems and is sufficient to achieve the modeling objectives in support of the closure alternatives analysis [15]. Ongoing groundwater modeling, which includes recent data following closure and is expected to be completed in 2025, indicates that the GWPS will be met approximately 30 years after the initiation of groundwater polishing (which starts when the Corrective Action Plan permit is issued). Additional geochemical modeling will be completed to evaluate how surface complexation reactions with metal oxyhydroxides and clay minerals or changes in redox conditions may affect arsenic, boron, lithium, and sulfate mobility or in the case and therefore the time to reach the GWPS for these parameters.

7. REFERENCES

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TABLES

Table 2-1. Groundwater Elevation Data
Nature and Extent Report
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
21R	Compliance	UA	4/30/2023	5.16	446.88
21R	Compliance	UA	5/30/2023	5.92	446.13
21R	Compliance	UA	6/21/2023	6.36	445.68
21R	Compliance	UA	7/21/2023	6.11	445.93
21R	Compliance	UA	8/21/2023	6.36	445.68
21R	Compliance	UA	9/30/2023	6.52	445.53
21R	Compliance	UA	10/31/2023	5.67	446.38
21R	Compliance	UA	11/13/2023	5.77	446.28
21R	Compliance	UA	12/21/2023	6.18	445.87
22	Compliance	UA	4/30/2023	17.85	446.59
22	Compliance	UA	5/30/2023	18.45	446.00
22	Compliance	UA	6/21/2023	18.73	445.71
22	Compliance	UA	7/21/2023	18.52	445.92
22	Compliance	UA	8/21/2023	18.68	445.76
22	Compliance	UA	9/30/2023	19.54	444.91
22	Compliance	UA	10/31/2023	18.87	445.58
22	Compliance	UA	11/13/2023	18.43	446.02
22	Compliance	UA	12/21/2023	18.84	445.61
22D	Compliance	UA	4/30/2023	18.43	446.99
22D	Compliance	UA	5/30/2023	19.10	446.33
22D	Compliance	UA	6/21/2023	19.42	446.00
22D	Compliance	UA	7/21/2023	19.19	446.23
22D	Compliance	UA	8/21/2023	19.40	446.02
22D	Compliance	UA	10/31/2023	18.90	446.53
22D	Compliance	UA	11/13/2023	22.10	443.33
22D	Compliance	UA	12/21/2023	19.54	445.89
23	Compliance	UA	4/30/2023	15.90	447.48
23	Compliance	UA	5/30/2023	16.72	446.67
23	Compliance	UA	6/21/2023	17.08	446.30
23	Compliance	UA	7/21/2023	16.83	446.55
23	Compliance	UA	8/21/2023	17.08	446.30
23	Compliance	UA	9/30/2023	17.38	446.01
23	Compliance	UA	10/31/2023	16.45	446.94
23	Compliance	UA	11/13/2023	17.64	445.75
23	Compliance	UA	12/21/2023	17.18	446.21

Table 2-1. Groundwater Elevation Data
Nature and Extent Report
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
27	Compliance	UA	4/30/2023	3.33	447.24
27	Compliance	UA	5/30/2023	4.14	446.44
27	Compliance	UA	6/21/2023	4.53	446.04
27	Compliance	UA	7/21/2023	4.31	446.27
27	Compliance	UA	8/21/2023	4.56	446.02
27	Compliance	UA	10/31/2023	3.72	446.86
27	Compliance	UA	11/13/2023	3.91	446.67
27	Compliance	UA	12/21/2023	4.38	446.20
32	Background	UA	4/30/2023	4.36	447.02
32	Background	UA	5/30/2023	5.22	446.16
32	Background	UA	6/21/2023	5.63	445.75
32	Background	UA	7/21/2023	5.42	445.96
32	Background	UA	8/21/2023	5.60	445.78
32	Background	UA	9/30/2023	5.74	445.64
32	Background	UA	10/31/2023	4.62	446.76
32	Background	UA	11/13/2023	4.79	446.59
32	Background	UA	12/21/2023	5.20	446.18
34	Background	UA	4/30/2023	7.69	441.86
34	Background	UA	5/30/2023	8.66	440.90
34	Background	UA	6/21/2023	9.16	440.39
34	Background	UA	8/25/2023	NA	440.58
34	Background	UA	10/31/2023	7.74	441.82
34	Background	UA	11/13/2023	8.37	441.19
34	Background	UA	12/21/2023	7.76	441.80
35	Compliance	UA	4/30/2023	7.69	447.13
35	Compliance	UA	5/30/2023	8.30	446.53
35	Compliance	UA	6/21/2023	8.84	445.98
35	Compliance	UA	7/21/2023	8.58	446.24
35	Compliance	UA	8/21/2023	8.87	445.96
35	Compliance	UA	9/30/2023	9.05	445.78
35	Compliance	UA	10/31/2023	7.97	446.86
35	Compliance	UA	11/13/2023	8.15	446.68
35	Compliance	UA	12/21/2023	8.70	446.13

Table 2-1. Groundwater Elevation Data
Nature and Extent Report
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
49	Compliance	UA	5/30/2023	21.54	446.63
49	Compliance	UA	8/25/2023	19.65	448.52
49	Compliance	UA	9/30/2023	22.16	446.01
49	Compliance	UA	10/31/2023	21.33	446.84
49	Compliance	UA	11/13/2023	21.49	446.68
49	Compliance	UA	12/21/2023	22.02	446.15
50	Compliance	UA	5/30/2023	18.25	445.69
50	Compliance	UA	10/31/2023	18.06	445.88
50	Compliance	UA	11/13/2023	18.24	445.70
50	Compliance	UA	12/21/2023	18.61	445.33
51	Compliance	UA	4/30/2023	17.74	447.05
51	Compliance	UA	5/30/2023	18.50	446.30
51	Compliance	UA	6/21/2023	18.94	445.85
51	Compliance	UA	7/21/2023	18.69	446.10
51	Compliance	UA	8/21/2023	18.92	445.87
51	Compliance	UA	9/30/2023	19.17	445.63
51	Compliance	UA	10/31/2023	18.22	446.58
51	Compliance	UA	11/13/2023	18.59	446.21
51	Compliance	UA	12/21/2023	18.84	445.96
SG02	Water Level	SW	4/30/2023	NA	448.50
SG02	Water Level	SW	5/30/2023	NA	440.50
SG02	Water Level	SW	6/21/2023	NA	440.50
SG02	Water Level	SW	7/21/2023	NA	441.75
SG02	Water Level	SW	8/21/2023	NA	440.75
SG02	Water Level	SW	9/30/2023	NA	440.75
SG02	Water Level	SW	10/31/2023	NA	441.50
SG02	Water Level	SW	11/13/2023	NA	441.00
SG02	Water Level	SW	12/21/2023	NA	441.75

Notes:
BMP = below measuring point
NAVD88 = North American Vertical Datum 1988
UA = uppermost aquifer
SW = Illinois River surface water

Table 3-1. Monitoring Well Construction Details
Nature and Extent Report
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

Location	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft bgs)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
21	UA	12/9/1982	459.3	459.3	Top of PVC	459.8	49	59	410.8	400.8	59.6	400.1	10	2	41.299866	-89.328905
21R	UA	2/6/2020	452.1	452.2	Top of PVC	449.4	37.6	47.6	411.8	401.8	50	399.4	10	2	41.299866	-89.328914
22	UA	12/9/1982	464.4	464.6	Top of PVC	461.5	24.4	34.4	437.1	427.1	34.6	426.9	10	2	41.302032	-89.321512
22D	UA	8/7/2019	465.4	465.6	Top of PVC	461.8	49.7	59.7	412.2	402.2	59.67	401.8	10	2	41.302017	-89.321572
23	UA	12/10/1982	463.4	463.6	Top of PVC	460.9	34	44	426.9	416.9	45.2	415.7	10	2	41.300881	-89.325376
24	UA	12/13/1982	462.1	462.1	Top of PVC	461.1	56.4	66.4	404.7	394.7	64.5	396.6	10	2	41.300602	-89.327186
27	UA	9/11/1995	450.6	450.8	Top of PVC	448.2	30	35	418.2	413.2	36.3	412.0	5	2	41.296911	-89.328898
32	UA	8/21/1996	451.4	451.6	Top of PVC	448.8	7	17	441.8	431.8	17.3	431.4	10	2	41.292128	-89.328563
34	UA	8/22/1996	449.6	449.7	Top of PVC	448.2	30	35	418.2	413.2	35	413.2	5	2	41.299538	-89.33249
35	UA	9/8/1999	454.8	454.9	Top of PVC	451.5	8	18	443.5	433.5	17.6	433.9	10	2	41.29916	-89.324145
49	UA	7/6/2015	468.2	468.3	Top of PVC	465.8	35	45	430.8	420.8	45	420.8	10	2	41.301182	-89.32333
50	UA	8/7/2019	463.9	464.1	Top of PVC	460.6	19.6	29.6	441.0	431.0	29.6	430.6	10	2	41.302243	-89.320647
51	UA	2/4/2020	464.8	464.9	Top of PVC	461.5	56	66	405.5	395.5	66.3	394.5	10	2	41.300639	-89.326953
L4	CCR	8/21/1995	460.9	460.9	Top of PVC	461.3	13.0	23.0	448.3	438.3	28.0	29.0	10	2	41.30061	-89.327193
LPZ17	CCR	3/14/2017	463.9	463.9	Top of PVC	460.9	10.1	21.1	450.8	439.8	21.1	21.1	10	2	41.299504	-89.321795

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
bgs = below ground surface
ft = foot or feet
HSU = Hydrostratigraphic Unit
UA = Uppermost Aquifer
CCR = Coal Combustion Residuals
PVC = polyvinyl chloride

Table 3-2. Illinois River Surface Water Data
Nature and Extent Report
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

Sample Location	Sample Date	Fraction	Analyte	Unit	Result
IR01-C	9/2/2020	D	Arsenic	mg/L	0.0028
IR01-L	9/2/2020	D	Arsenic	mg/L	0.0027
IR01-R	9/2/2020	D	Arsenic	mg/L	0.0028
IR02-C	9/2/2020	D	Arsenic	mg/L	0.0028
IR02-L	9/2/2020	D	Arsenic	mg/L	0.0028
IR02-R	9/2/2020	D	Arsenic	mg/L	0.0027
IR03-C	9/2/2020	D	Arsenic	mg/L	0.0027
IR03-L	9/2/2020	D	Arsenic	mg/L	0.0027
IR03-R	9/2/2020	D	Arsenic	mg/L	0.0028
IR04-C	9/2/2020	D	Arsenic	mg/L	0.0027
IR04-L	9/2/2020	D	Arsenic	mg/L	0.0029
IR04-R	9/2/2020	D	Arsenic	mg/L	0.0027
IR05-C	9/2/2020	D	Arsenic	mg/L	0.003075
IR05-L	9/2/2020	D	Arsenic	mg/L	0.0027
IR05-R	9/2/2020	D	Arsenic	mg/L	0.0026
IR01-C	9/2/2020	D	Boron	mg/L	0.126
IR01-L	9/2/2020	D	Boron	mg/L	0.139
IR01-R	9/2/2020	D	Boron	mg/L	0.137
IR02-C	9/2/2020	D	Boron	mg/L	0.135
IR02-L	9/2/2020	D	Boron	mg/L	0.13
IR02-R	9/2/2020	D	Boron	mg/L	0.132
IR03-C	9/2/2020	D	Boron	mg/L	0.136
IR03-L	9/2/2020	D	Boron	mg/L	0.147
IR03-R	9/2/2020	D	Boron	mg/L	0.131
IR04-C	9/2/2020	D	Boron	mg/L	0.127
IR04-L	9/2/2020	D	Boron	mg/L	0.128
IR04-R	9/2/2020	D	Boron	mg/L	0.134
IR05-C	9/2/2020	D	Boron	mg/L	0.13225
IR05-L	9/2/2020	D	Boron	mg/L	0.134
IR05-R	9/2/2020	D	Boron	mg/L	0.125
IR01-C	9/2/2020	D	Lithium	mg/L	0.0075
IR01-L	9/2/2020	D	Lithium	mg/L	0.0072
IR01-R	9/2/2020	D	Lithium	mg/L	0.0078
IR02-C	9/2/2020	D	Lithium	mg/L	0.0071
IR02-L	9/2/2020	D	Lithium	mg/L	0.0073
IR02-R	9/2/2020	D	Lithium	mg/L	0.0075
IR03-C	9/2/2020	D	Lithium	mg/L	0.0072
IR03-L	9/2/2020	D	Lithium	mg/L	0.0072
IR03-R	9/2/2020	D	Lithium	mg/L	0.0075
IR04-C	9/2/2020	D	Lithium	mg/L	0.0072
IR04-L	9/2/2020	D	Lithium	mg/L	0.0071

Table 3-2. Illinois River Surface Water Data
Nature and Extent Report
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

Sample Location	Sample Date	Fraction	Analyte	Unit	Result
IR04-R	9/2/2020	D	Lithium	mg/L	0.0071
IR05-C	9/2/2020	D	Lithium	mg/L	0.00775
IR05-L	9/2/2020	D	Lithium	mg/L	0.0076
IR05-R	9/2/2020	D	Lithium	mg/L	0.0071
IR01-C	9/2/2020	T	Sulfate	mg/L	76
IR01-L	9/2/2020	T	Sulfate	mg/L	77
IR01-R	9/2/2020	T	Sulfate	mg/L	79
IR02-C	9/2/2020	T	Sulfate	mg/L	74
IR02-L	9/2/2020	T	Sulfate	mg/L	75
IR02-R	9/2/2020	T	Sulfate	mg/L	77
IR03-C	9/2/2020	T	Sulfate	mg/L	77
IR03-L	9/2/2020	T	Sulfate	mg/L	75
IR03-R	9/2/2020	T	Sulfate	mg/L	77
IR04-C	9/2/2020	T	Sulfate	mg/L	73
IR04-L	9/2/2020	T	Sulfate	mg/L	73
IR04-R	9/2/2020	T	Sulfate	mg/L	75
IR05-C	9/2/2020	T	Sulfate	mg/L	75
IR05-L	9/2/2020	T	Sulfate	mg/L	75
IR05-R	9/2/2020	T	Sulfate	mg/L	74

Notes:
Results presented represent the mean of field duplicates where collected.
D = dissolved
T = total
mg/L = milligrams per liter

Table 3-3. Exceedance Parameter Statistical Results
Nature and Extent Report
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

Location	Parameter	Unit	Groundwater Protection Standard	2023 Q2 LCL	2023 Q3 LCL	2023 Q4 LCL
21/21R	Arsenic, total	mg/L	0.010	0.0198	0.0194	0.0189
24/51	Arsenic, total	mg/L	0.010	0.0204	0.0204	0.0203
21/21R	Boron, total	mg/L	2	2.22	1.96	1.95
22	Boron, total	mg/L	2	3.33	3.15	3.04
23	Boron, total	mg/L	2	8.74	8.30	8.34
35	Boron, total	mg/L	2	12.4	12.3	12.1
22	Lithium, total	mg/L	0.04	0.0395	0.0405	0.0436
23	Sulfate, total	mg/L	400	422	423	423
35	Sulfate, total	mg/L	400	618	649	659
35	Total Dissolved Solids	mg/L	1,200	1,200	1,250	1,280

Notes:
LCL = Lower Confidence Level
mg/L = milligrams per liter

Table 3-4. Summary of Groundwater Data
Nature and Extent Report
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

HSU	Location	Well Type	Parameter	Unit	Sample Count	Non-Detect Results	Percent Non-Detect Results	First Sample	Last Sample	Minimum	Median	Mean	Maximum
UA	21	MWO	Sulfate, total	mg/L	18	0	0	3/18/2015	6/19/2019	51.0	140	130	169
UA	21	MWO	Total Dissolved Solids	mg/L	18	0	0	3/18/2015	6/19/2019	338	560	550	644
UA	21	MWO	Arsenic, total	mg/L	13	0	0	12/10/2015	6/19/2019	0.00240	0.0091	0.0083	0.0128
UA	21	MWO	Boron, total	mg/L	14	0	0	12/10/2015	6/19/2019	1.25	4.1	3.9	4.60
UA	21	MWO	Lithium, total	mg/L	13	0	0	12/10/2015	6/19/2019	0.00640	0.014	0.014	0.0208
UA	21R	C	Arsenic, total	mg/L	16	0	0	3/11/2020	11/14/2023	0.0210	0.026	0.026	0.0345
UA	21R	C	Boron, total	mg/L	16	0	0	3/11/2020	11/14/2023	1.70	3.0	2.9	3.72
UA	21R	C	Lithium, total	mg/L	16	0	0	3/11/2020	11/14/2023	0.0167	0.021	0.022	0.0280
UA	21R	C	Sulfate, total	mg/L	16	0	0	3/11/2020	11/14/2023	81.0	92	93	105
UA	21R	C	Total Dissolved Solids	mg/L	16	0	0	3/11/2020	11/14/2023	540	680	670	918
UA	22	C	Sulfate, total	mg/L	41	0	0	3/18/2015	11/15/2023	101	200	180	261
UA	22	C	Arsenic, total	mg/L	36	23	64	12/10/2015	11/15/2023	<0.00023	0.0010	0.0012	<0.0087
UA	22	C	Boron, total	mg/L	37	0	0	12/10/2015	11/15/2023	0.130	4.9	4.6	6.72
UA	22	C	Lithium, total	mg/L	36	0	0	12/10/2015	11/15/2023	0.00900	0.055	0.053	0.0764
UA	22	C	Total Dissolved Solids	mg/L	41	0	0	3/18/2015	11/15/2023	586	680	680	800
UA	22D	C	Arsenic, total	mg/L	16	1	6	9/17/2019	11/15/2023	0.00110	0.0013	0.0018	<0.0087
UA	22D	C	Boron, total	mg/L	16	0	0	9/17/2019	11/15/2023	1.30	2.0	2.0	2.68
UA	22D	C	Lithium, total	mg/L	16	0	0	9/17/2019	11/15/2023	0.0123	0.016	0.016	0.0190
UA	22D	C	Sulfate, total	mg/L	16	0	0	9/17/2019	11/15/2023	89.0	100	110	118
UA	22D	C	Total Dissolved Solids	mg/L	16	0	0	9/17/2019	11/15/2023	550	630	630	690
UA	23	C	Sulfate, total	mg/L	41	0	0	3/18/2015	11/15/2023	323	430	440	554
UA	23	C	Total Dissolved Solids	mg/L	41	0	0	3/18/2015	11/15/2023	820	890	910	1,020
UA	23	C	Arsenic, total	mg/L	36	30	83	12/10/2015	11/15/2023	0.000500	0.0010	0.0012	<0.0087
UA	23	C	Boron, total	mg/L	37	0	0	12/10/2015	11/15/2023	5.63	8.3	8.5	12.8
UA	23	C	Lithium, total	mg/L	36	2	6	12/10/2015	11/15/2023	<0.0019	0.0051	0.0050	0.00670
UA	24	MWO	Sulfate, total	mg/L	18	0	0	3/18/2015	6/9/2019	95.0	140	130	162
UA	24	MWO	Total Dissolved Solids	mg/L	18	0	0	3/18/2015	6/9/2019	458	650	640	822
UA	24	MWO	Arsenic, total	mg/L	13	0	0	12/10/2015	6/19/2019	0.0254	0.032	0.031	0.0380
UA	24	MWO	Boron, total	mg/L	14	0	0	12/10/2015	6/19/2019	2.11	2.5	2.7	3.84
UA	24	MWO	Lithium, total	mg/L	13	0	0	12/10/2015	6/19/2019	0.0193	0.022	0.023	0.0270

Table 3-4. Summary of Groundwater Data
Nature and Extent Report
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

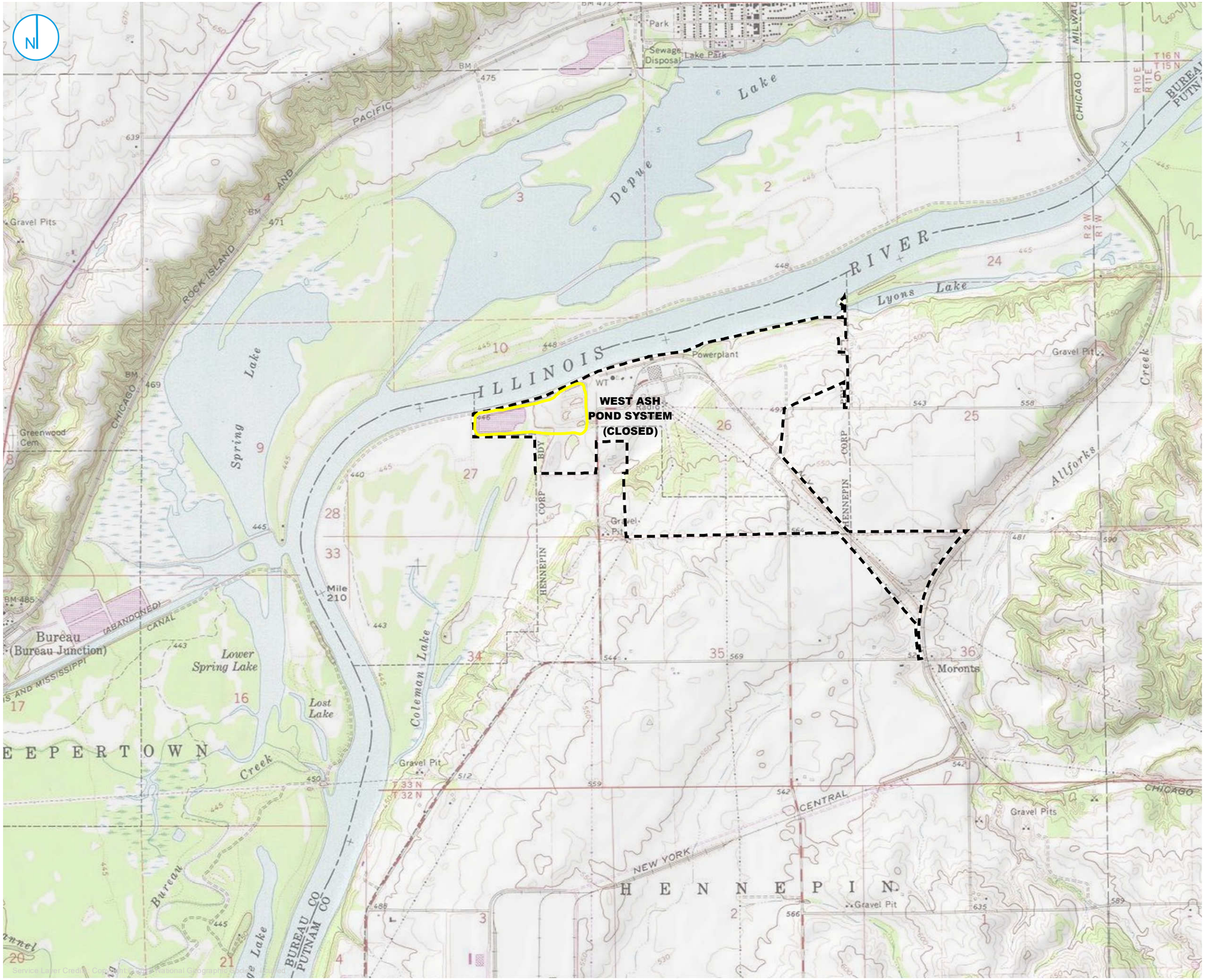
HSU	Location	Well Type	Parameter	Unit	Sample Count	Non-Detect Results	Percent Non-Detect Results	First Sample	Last Sample	Minimum	Median	Mean	Maximum
UA	27	C	Sulfate, total	mg/L	26	0	0	3/18/2015	11/14/2023	104	120	140	228
UA	27	C	Total Dissolved Solids	mg/L	26	0	0	3/18/2015	11/14/2023	442	660	670	808
UA	27	C	Arsenic, total	mg/L	19	9	47	9/12/2018	11/14/2023	0.000500	0.0010	0.0014	<0.0087
UA	27	C	Boron, total	mg/L	19	0	0	9/12/2018	11/14/2023	2.00	2.4	2.7	4.31
UA	27	C	Lithium, total	mg/L	19	0	0	9/12/2018	11/14/2023	0.0174	0.023	0.023	0.0266
UA	32	B	Sulfate, total	mg/L	35	0	0	3/18/2015	11/14/2023	37.0	60	58	82.0
UA	32	B	Total Dissolved Solids	mg/L	35	0	0	3/18/2015	11/14/2023	450	490	510	600
UA	32	B	Arsenic, total	mg/L	30	26	87	12/10/2015	11/14/2023	0.000370	0.0010	0.0011	<0.0087
UA	32	B	Boron, total	mg/L	31	0	0	12/10/2015	11/14/2023	0.0681	0.11	0.12	0.199
UA	32	B	Lithium, total	mg/L	30	0	0	12/10/2015	11/14/2023	0.00220	0.0037	0.0036	0.00510
UA	34	B	Sulfate, total	mg/L	32	0	0	3/18/2015	11/14/2023	45.0	77	80	117
UA	34	B	Total Dissolved Solids	mg/L	32	0	0	3/18/2015	11/14/2023	640	740	750	846
UA	34	B	Arsenic, total	mg/L	29	24	83	12/9/2015	11/14/2023	0.000500	0.0010	0.0012	<0.0087
UA	34	B	Boron, total	mg/L	30	0	0	12/9/2015	11/14/2023	0.0750	0.14	0.14	0.206
UA	34	B	Lithium, total	mg/L	29	0	0	12/9/2015	11/14/2023	0.00320	0.013	0.013	0.0160
UA	35	C	Arsenic, total	mg/L	31	20	65	12/9/2015	11/15/2023	0.000500	0.0010	0.0017	0.0109
UA	35	C	Boron, total	mg/L	32	0	0	12/9/2015	11/15/2023	4.98	11	10	18.1
UA	35	C	Lithium, total	mg/L	31	0	0	12/9/2015	11/15/2023	0.0128	0.029	0.028	0.0374
UA	35	C	Sulfate, total	mg/L	32	0	0	12/9/2015	11/15/2023	255	510	570	1,190
UA	35	C	Total Dissolved Solids	mg/L	32	0	0	12/9/2015	11/15/2023	708	1100	1200	1,940
UA	49	C	Arsenic, total	mg/L	31	27	87	12/10/2015	11/15/2023	0.000280	0.0010	0.0011	<0.0087
UA	49	C	Boron, total	mg/L	32	0	0	12/10/2015	11/15/2023	0.680	0.92	1.0	1.70
UA	49	C	Lithium, total	mg/L	31	0	0	12/10/2015	11/15/2023	0.0202	0.025	0.025	0.0297
UA	49	C	Sulfate, total	mg/L	32	0	0	12/10/2015	11/15/2023	71.0	84	90	114
UA	49	C	Total Dissolved Solids	mg/L	32	0	0	12/10/2015	11/15/2023	566	640	640	710
UA	50	C	Arsenic, total	mg/L	16	13	81	9/17/2019	11/14/2023	0.000760	0.0010	0.0015	<0.0087
UA	50	C	Boron, total	mg/L	16	0	0	9/17/2019	11/14/2023	0.590	0.79	0.83	1.43
UA	50	C	Lithium, total	mg/L	16	0	0	9/17/2019	11/14/2023	0.00710	0.023	0.022	0.0300
UA	50	C	Sulfate, total	mg/L	16	0	0	9/17/2019	11/14/2023	81.0	90	95	136
UA	50	C	Total Dissolved Solids	mg/L	16	0	0	9/17/2019	11/14/2023	580	620	630	700

Table 3-4. Summary of Groundwater Data
Nature and Extent Report
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

HSU	Location	Well Type	Parameter	Unit	Sample Count	Non-Detect Results	Percent Non-Detect Results	First Sample	Last Sample	Minimum	Median	Mean	Maximum
UA	51	C	Arsenic, total	mg/L	21	0	0	11/3/2020	11/15/2023	0.0102	0.019	0.019	0.0308
UA	51	C	Boron, total	mg/L	21	0	0	11/3/2020	11/15/2023	1.30	2.1	2.1	3.14
UA	51	C	Lithium, total	mg/L	21	0	0	11/3/2020	11/15/2023	0.0210	0.024	0.026	0.0714
UA	51	C	Sulfate, total	mg/L	21	0	0	11/3/2020	11/15/2023	87.0	100	100	127
UA	51	C	Total Dissolved Solids	mg/L	21	0	0	11/3/2020	11/15/2023	584	630	640	702
CCR	L4	Porewater	Boron, total	mg/L	3	0	0	12/7/2016	9/6/2017	21.2	32	30	37.4
CCR	L4	Porewater	Sulfate, total	mg/L	3	0	0	12/7/2016	9/6/2017	370	420	430	509
CCR	L4	Porewater	Arsenic, total	mg/L	2	0	0	4/25/2017	9/6/2017	0.0351	0.048	0.048	0.0610
CCR	L4	Porewater	Lithium, total	mg/L	2	0	0	4/25/2017	9/6/2017	0.0455	0.054	0.054	0.0627
CCR	L4	Porewater	Total Dissolved Solids	mg/L	2	0	0	4/25/2017	9/6/2017	900	940	940	972
CCR	LPZ17	Porewater	Arsenic, total	mg/L	2	0	0	4/25/2017	9/6/2017	0.0265	0.032	0.032	0.0381
CCR	LPZ17	Porewater	Boron, total	mg/L	2	0	0	4/25/2017	9/6/2017	26.9	28	28	28.6
CCR	LPZ17	Porewater	Lithium, total	mg/L	2	0	0	4/25/2017	9/6/2017	0.0903	0.094	0.094	0.0975
CCR	LPZ17	Porewater	Sulfate, total	mg/L	2	0	0	4/25/2017	9/6/2017	1,120	1200	1200	1,270
CCR	LPZ17	Porewater	Total Dissolved Solids	mg/L	2	0	0	4/25/2017	9/6/2017	1,910	2000	2000	2,090

Notes:
< = result less than the method detection limit
B = Background
C = Compliance
CCR = Coal Combustion Residuals
HSU = Hydrostratigraphic Unit
MWO - Water Level Only
mg/L = milligrams per liter
SU = Standard Unit
UA = Uppermost Aquifer

FIGURES



REGULATED UNIT (SUBJECT UNIT)

PROPERTY BOUNDARY

0 1,000 2,000 Feet

SITE LOCATION MAP

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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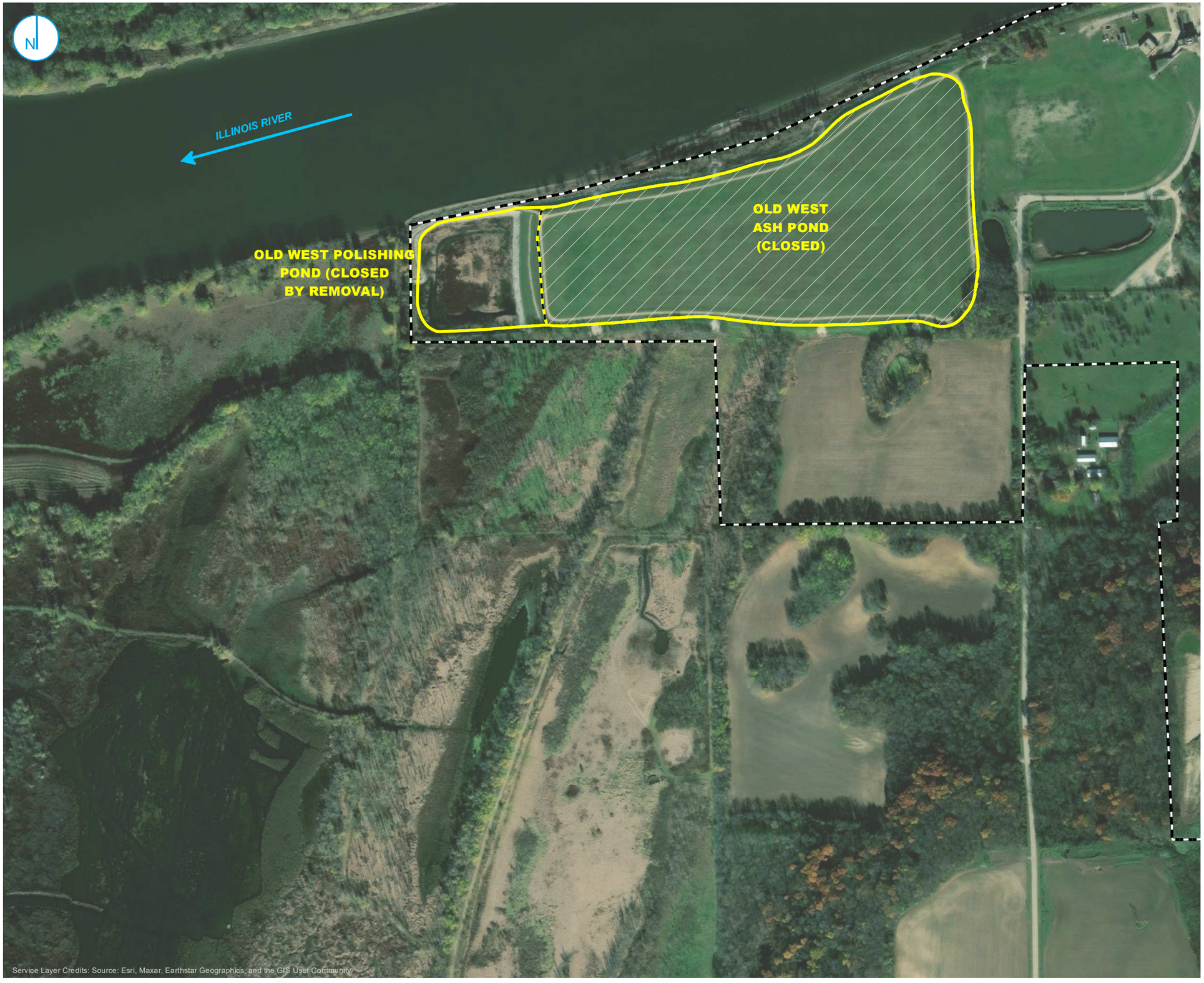
PROJECT: 169000XXXX | DATED: 4/23/2024 | DESIGNER: galammc

Y:\Mapping\Projects\22\2285\MXD\Nature_and_Extent\HEN\Nature_and_Extent_Report_Hen\West\Figure 1-1_Site Location Map.mxd

Y:\Mapping\Projects\222285\MXD\Nature_and_Extent\HEN\Nature_and_Extent_Report_HenWest\Figure 2-2_Ste Map.mxd



REGULATED UNIT (SUBJECT UNIT)

LIMITS OF FINAL COVER

PROPERTY BOUNDARY

0 200 400 Feet

SITE MAP

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 4/24/2024 | DESIGNER: galammc

B006 0 ft — BORING LOCATION WHERE ASH IS UNDERLAIN BY SAND AND/OR GRAVEL

B007 2 ft — BORING LOCATION AND KNOWN MINIMUM THICKNESS OF CLAY UNDERLYING ASH

INTERPOLATED BOTTOM OF ASH ELEVATION CONTOUR

REGULATED UNIT (SUBJECT UNIT)

LIMITS OF FINAL COVER

PROPERTY BOUNDARY

0 100 200 Feet

BASE OF CCR AND OBSERVED CLAY THICKNESS

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\22985\MXD\Nature_and_Extent\HEN\Nature_and_Extent_Report_HenWest\Figure 2-1_Bottom of Ash Map.mxd
PROJECT: 169000XXXX | DATED: 4/23/2024 | DESIGNER: galarnmc

LEACHATE WELL

REGULATED UNIT (SUBJECT UNIT)

LIMITS OF FINAL COVER

PROPERTY BOUNDARY

0 200 400 Feet

POREWATER SAMPLE LOCATION MAP

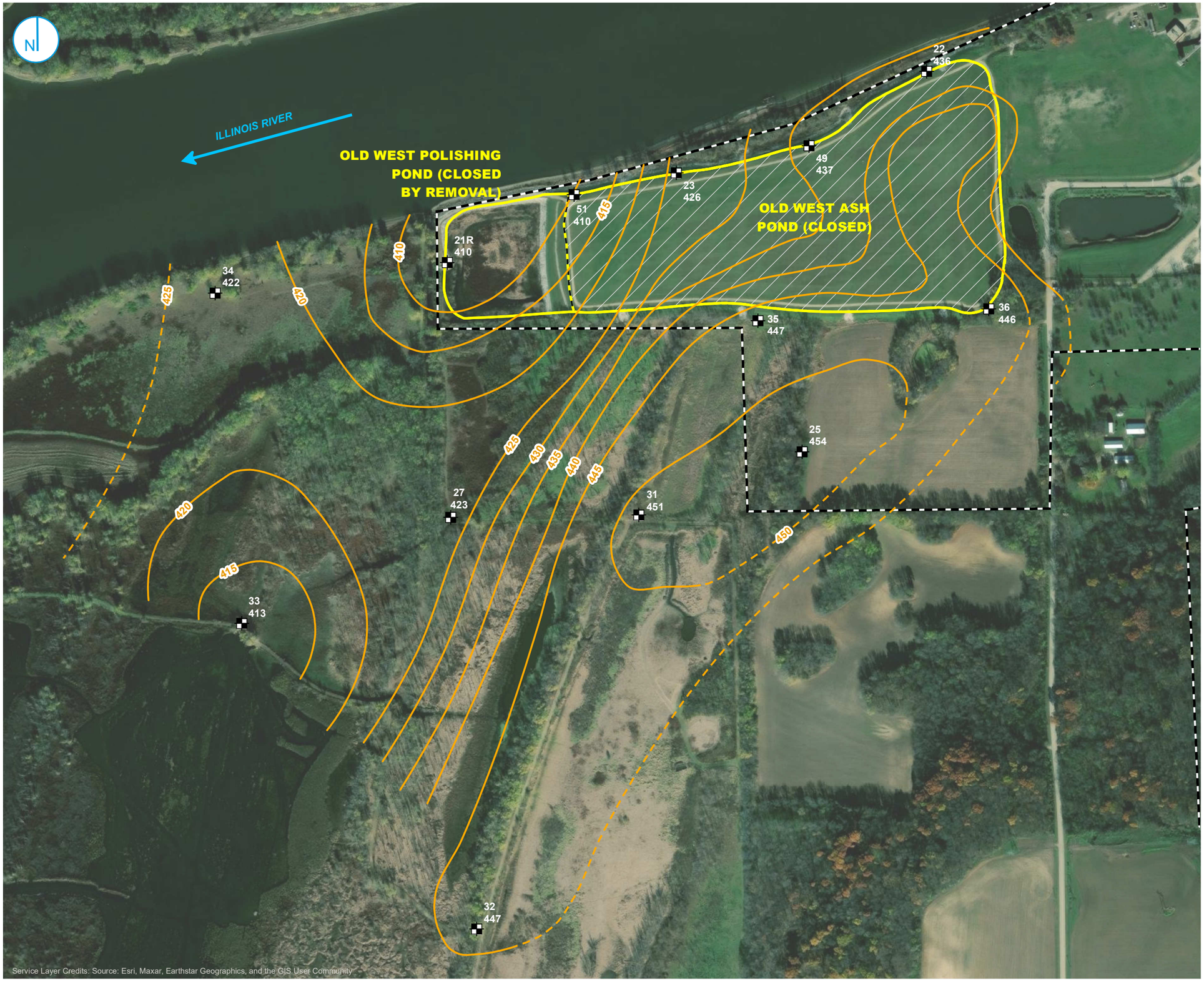
NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\22851\MXD\Nature_and_Extent\HEN\Nature_and_Extent_Report_HenWest\Figure 2-4. Leachate Sample Location Map.mxd
PROJECT: 169000XXXX | DATED: 4/24/2024 | DESIGNER: galanmc



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

TOP OF SAND AND GRAVEL IN UPPERMOST AQUIFER

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-5

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 5/6/2024 | DESIGNER: GALARNMC

Y:\Mapping\Projects\22\22851\MXD\Nature_and_Extent\HEN\Nature_and_Extent_Report_HenWest\Figure 2-5. Top of Aquifer Map.mxd

- COMPLIANCE MONITORING WELL
- BACKGROUND MONITORING WELL
- MONITORING WELL
- GROUNDWATER ELEVATION CONTOUR (1 FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- REGULATED UNIT (SUBJECT UNIT)
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY

NOTES:

1.ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.

2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

*ILLINOIS RIVER ELEVATION OBTAINED FROM STAFF GAGE SG02, LOCATED AT THE HENNEPIN POWER PLANT

0 200 400 Feet

POTENTIOMETRIC SURFACE MAP FEBRUARY 28 AND MARCH 1, 2023

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-6

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\22285\MXD\GW_Contours\Round_2023\Hennepin\OWAP_804\HEN 804 OWAP Pot Surface 20230228.mxd
PROJECT: 169000XXXX | DATED: 9/15/2023 | DESIGNER: GALARNMC

COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
MONITORING WELL
GROUNDWATER ELEVATION CONTOUR (1 FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

NOTES:

1.ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.

2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

*ILLINOIS RIVER ELEVATION OBTAINED FROM STAFF GAGE SG02, LOCATED AT THE HENNEPIN POWER PLANT

0 200 400 Feet

POTENTIOMETRIC SURFACE MAP MAY 30, 2023 (E001)

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

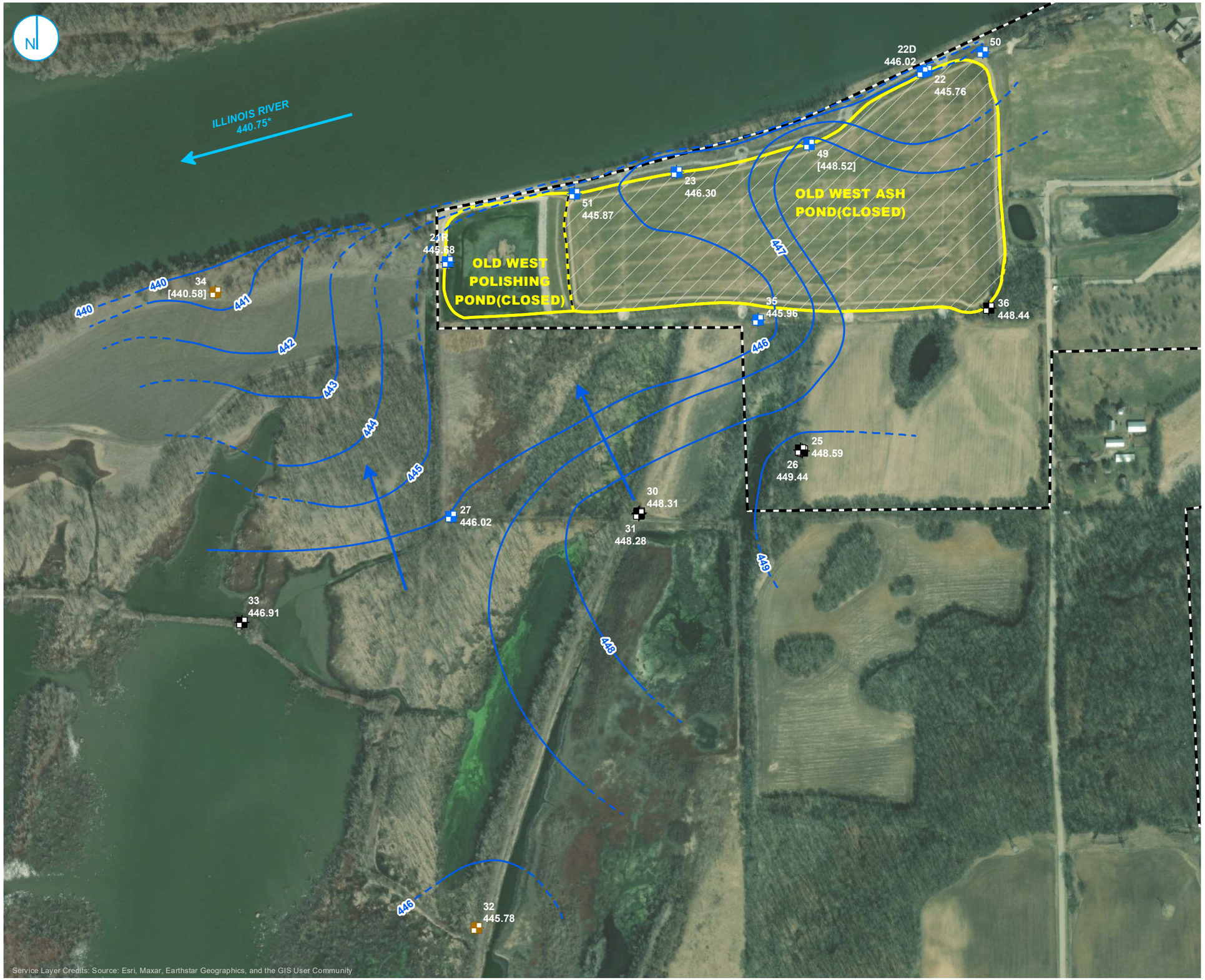
FIGURE 2-7

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 7/6/2023 | DESIGNER: GALARNMC

Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_2023\Hennepin\OWAP_804\HEN 804 OWAP Pot Surface 20230530.mxd



COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
MONITORING WELL
GROUNDWATER ELEVATION CONTOUR (1 FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

NOTES:

1.ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.
2. ELEVATIONS IN BRACKETS WERE OBTAINED OUTSIDE OF THE 24 HOUR PERIOD FROM INITIATION OF DEPTH TO GROUNDWATER MEASUREMENTS BUT WITHIN THE SAME SAMPLING EVENT.
3. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)
*ILLINOIS RIVER ELEVATION OBTAINED FROM STAFF GAGE SG02, LOCATED AT THE HENNEPIN POWER PLANT

0 200 400 Feet

POTENTIOMETRIC SURFACE MAP AUGUST 21 AND 22, 2023 (E002)

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-8

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\228SIMXD\GW_Contours\Round_2023\Hennepin\OWAP_804\HEN 804 OWAP Pot Surface 20230821.mxd

PROJECT: 169000XXXX | DATED: 12/18/2023 | DESIGNER: GALARNMC

COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
MONITORING WELL
GROUNDWATER ELEVATION CONTOUR (1 FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

NOTES:

1.ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.

2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

*ILLINOIS RIVER ELEVATION OBTAINED FROM STAFF GAGE SG02, LOCATED AT THE HENNEPIN POWER PLANT

0 200 400 Feet

POTENTIOMETRIC SURFACE MAP NOVEMBER 13, 2023 (E003)

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-9

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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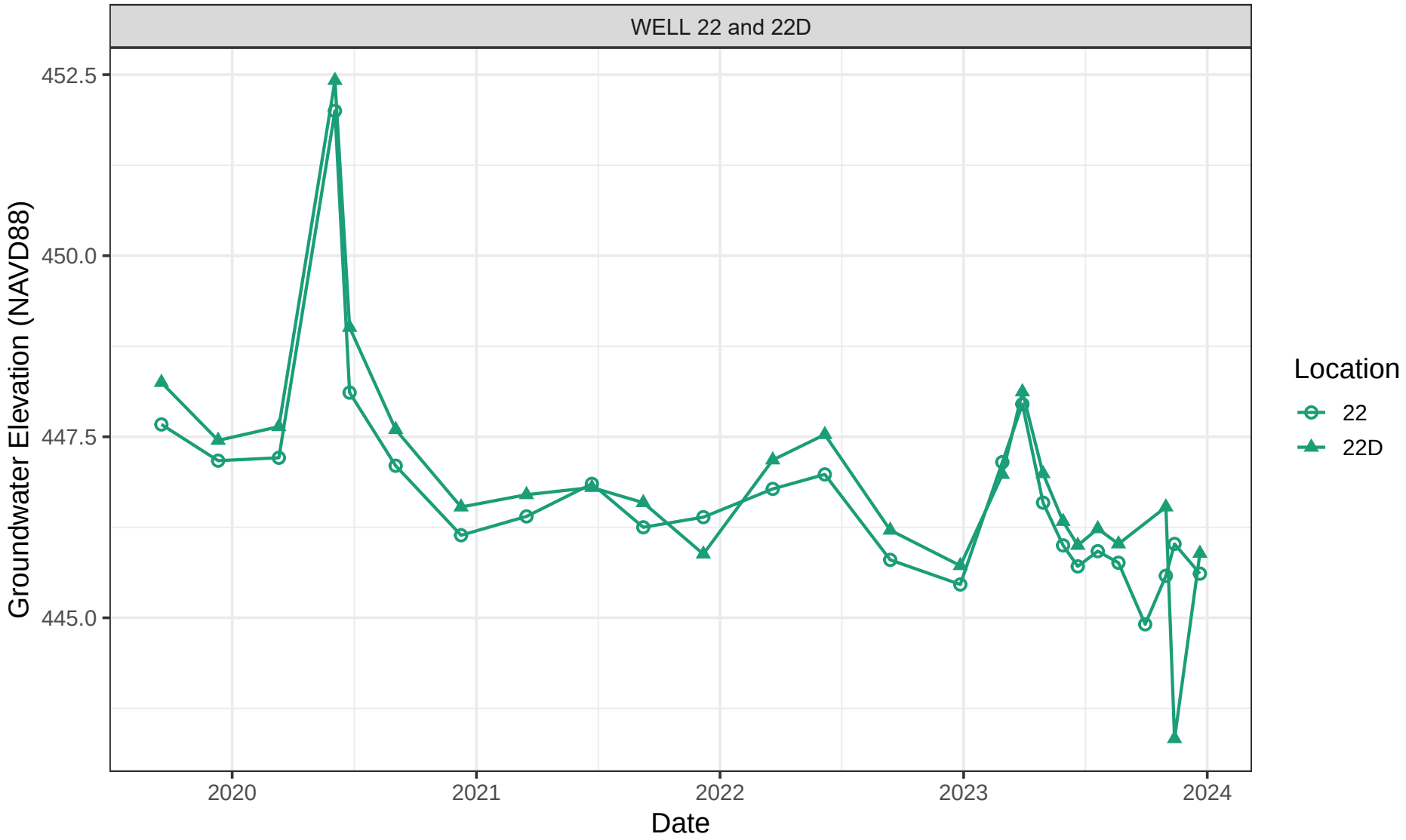
PROJECT: 169000XXXX | DATED: 12/18/2023 | DESIGNER: GALARNMC

Path: dara/Vistra − 845/Corrective Action Assessment/Nature and Extent/Hydrographs



RAMBOLL

HYDROGRAPH - WELLS 22 and 22D

Nature and Extent Report
Hennepin West Ash Pond System
Hennepin, IL

Figure
2-10

Drafter: AOC Date: 2024−04−24 Contract Number: 1940103584

COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
MONITORING WELL
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 200 400
Feet

MONITORING WELL LOCATION MAP

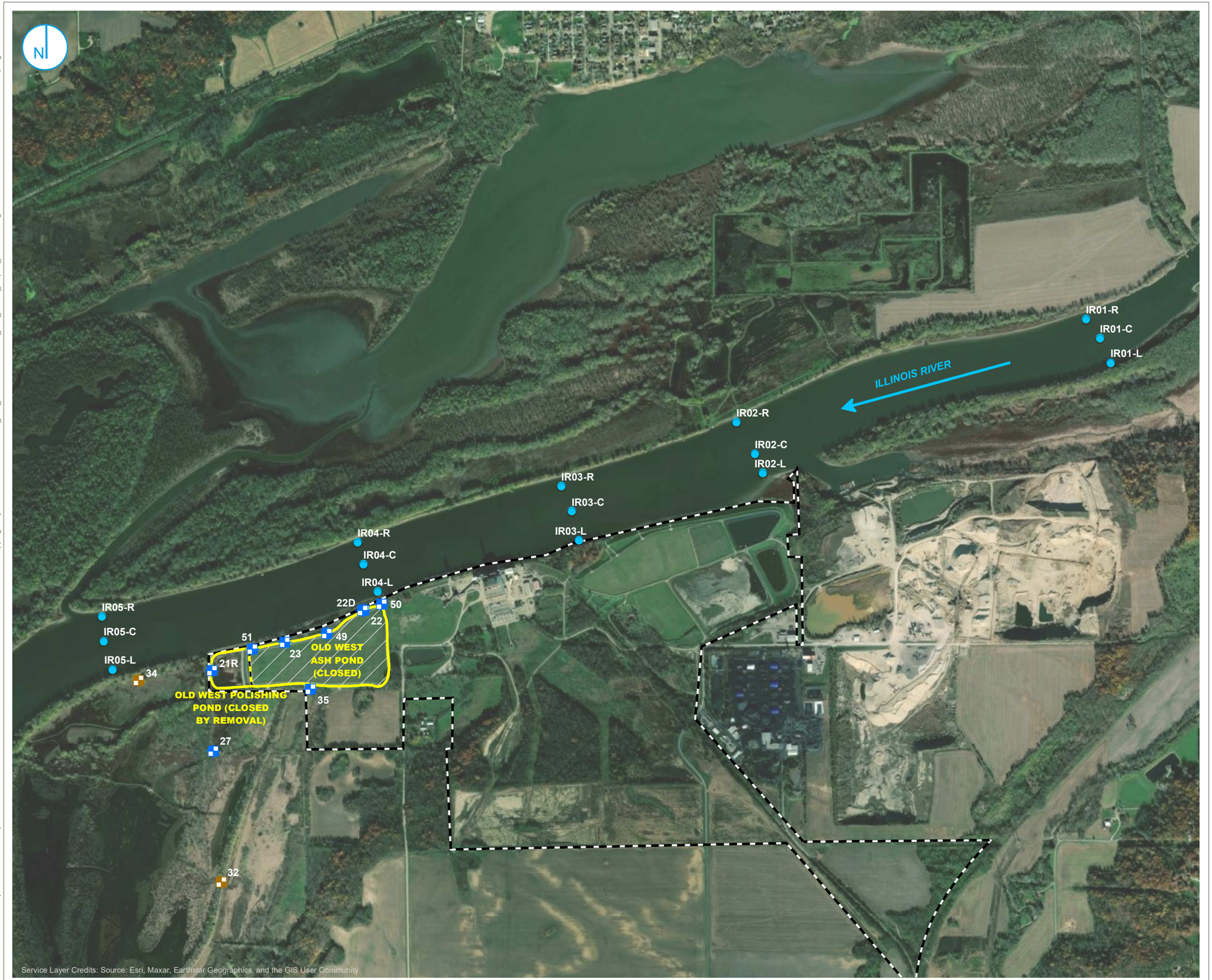
NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-11

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 4/24/2024 | DESIGNER: galammc
Y:\Mapping\Projects\2212285\MXD\Nature_and_Extent\HEN\Nature_and_Extent_Report_HenWest\Figure 2-10_Monitoring Well Location Map.mxd



SURFACE WATER SAMPLE
COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 625 1,250
Feet

ILLINOIS RIVER SURFACE WATER SAMPLING LOCATIONS

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 3-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\222285\MXD\Nature_and_Extent\HEN\Nature_and_Extent_Report_HenWest\Figure 3-2. Illinois River Surface Water Sampling Locations.mxd
PROJECT: 169000XXXX | DATED: 5/6/2024 | DESIGNER: GALARNMC

TOTAL ARSENIC EXCEEDANCE
TOTAL BORON EXCEEDANCE
TOTAL LITHIUM EXCEEDANCE
TOTAL SULFATE EXCEEDANCE
TOTAL DISSOLVED SOLIDS EXCEEDANCE
COMPLIANCE WELL WITHOUT EXCEEDANCE
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 200 400
Feet

GWPS EXCEEDANCE MAP UPPERMOST AQUIFER

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 3-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\Nature_and_Extent\HEN\Nature_and_Extent_Report_HenWest\Figure 3-1. HEN 804 GWPS UA.mxd
PROJECT: 169000XXXX | DATED: 4/24/2024 | DESIGNER: galammc

APPENDICES

APPENDIX A
Geologic Cross-Sections (NRT, 2017)

REFERENCES

1. SOURCE DRAWING DERIVED FROM CEC, INC.; PROJECT NUMBER 164-478, DRAWING NUMBER C200, DATED 3/27/17.
2. TOPOGRAPHIC INFORMATION BASED ON AERIAL SURVEY COMPLETED BY SURDEX ON AUGUST 17, 2015 AND TOPOGRAPHIC/BATHYMETRIC SURVEY COMPLETED BY WEAVER CONSULTANTS GROUP ON SEPTEMBER 22, 2015.
3. IMAGE PROVIDED BY GOOGLE EARTH. DATE OF IMAGE: SEPTEMBER 20,2015.

LEGEND

- WEST ASH POND SYSTEM LIMITS
- 450 EXISTING 10 FT CONTOUR
- 452 EXISTING 2 FT CONTOUR
- B13 CEC BORING LOCATION
- P-1 SOIL BORING BY OTHERS
- A A CROSS SECTION LOCATION

DRAWN BY:	AGC	DATE: 02/15/2017
CHECKED BY:	NRK	DATE: 02/21/2017
APPROVED BY:	SJC	DATE: 08/25/2017

DRAWING NO: OBG MOD - 16448 CROSS SECTIONS

REFERENCE: .

MONITORING WELL AND BORING LOCATIONS

HYDROGEOLOGIC CHARACTERIZATION REPORT
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

Natural Resource Technology
AN OBG COMPANY

PROJECT NO.
2421

FIGURE NO.
7

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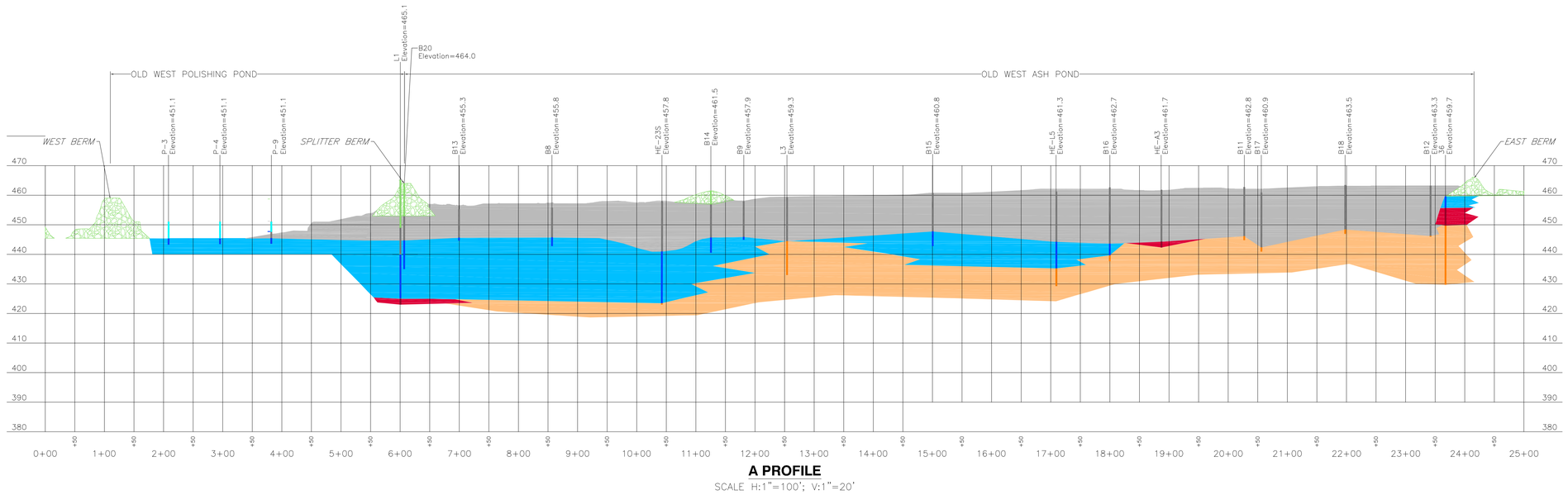
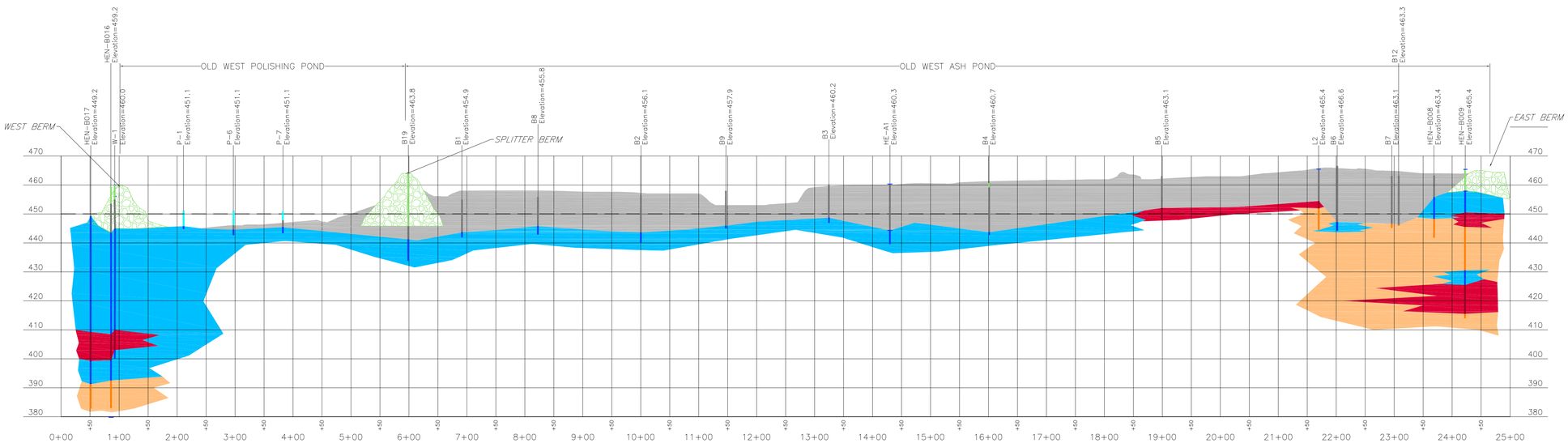


A PROFILE

SCALE H:1"=100'; V:1"=20'



B PROFILE

SCALE H:1"=100'; V:1"=20'

REFERENCES

1. SOURCE DRAWING DERIVED FROM CEC, INC.; PROJECT NUMBER 164-478, DRAWING NUMBER C200, DATED 3/27/17.
2. TOP OF EXISTING GRADE BASED ON DATA PROVIDED BY WEAVER CONSULTING GROUP SURVEY (2015) AS PRESENTED BY CEC INC.
3. GEOLOGIC INTERPRETATIONS ARE BASED ON BORING LOGS PERFORMED BY CEC INC., AECOM, SCIENCE AND TECHNOLOGY MANAGEMENT INC., JOHN MATHES & ASSOCIATES INC., AND NATURAL RESOURCE TECHNOLOGY INC.

LEGEND

- MISCELLANEOUS BERM SOIL FILL
- CCR/ASH
- SILTS AND CLAYS (ALLUVIAL)
- SANDS WITH FINES (ALLUVIAL)
- SAND AND GRAVEL (GLACIAL OUTWASH)

GEOLOGIC CONDITIONS

1. THE TEST BORING INFORMATION PRESENTED HEREIN DEPICTS SUBSURFACE CONDITIONS AT THE TEST BORING LOCATIONS AND AT THE TIME OF DRILLING. SOIL CONDITIONS AT OTHER LOCATIONS MAY DIFFER.
2. GEOLOGIC CORRELATIONS BETWEEN TEST BORINGS ARE GENERALLY BASED ON STRAIGHT-LINE INTERPOLATION. ACTUAL CONDITIONS BETWEEN TEST BORINGS MAY DIFFER.

DRAWN BY: AGC DATE: 02/15/2017
CHECKED BY: NRK DATE: 02/21/2017
APPROVED BY: SJC DATE: 08/25/2017
DRAWING NO: OBG MOD - 16448 CROSS SECTIONS
REFERENCE: .

CROSS-SECTION A-A' AND B-B'

HYDROGEOLOGIC CHARACTERIZATION REPORT

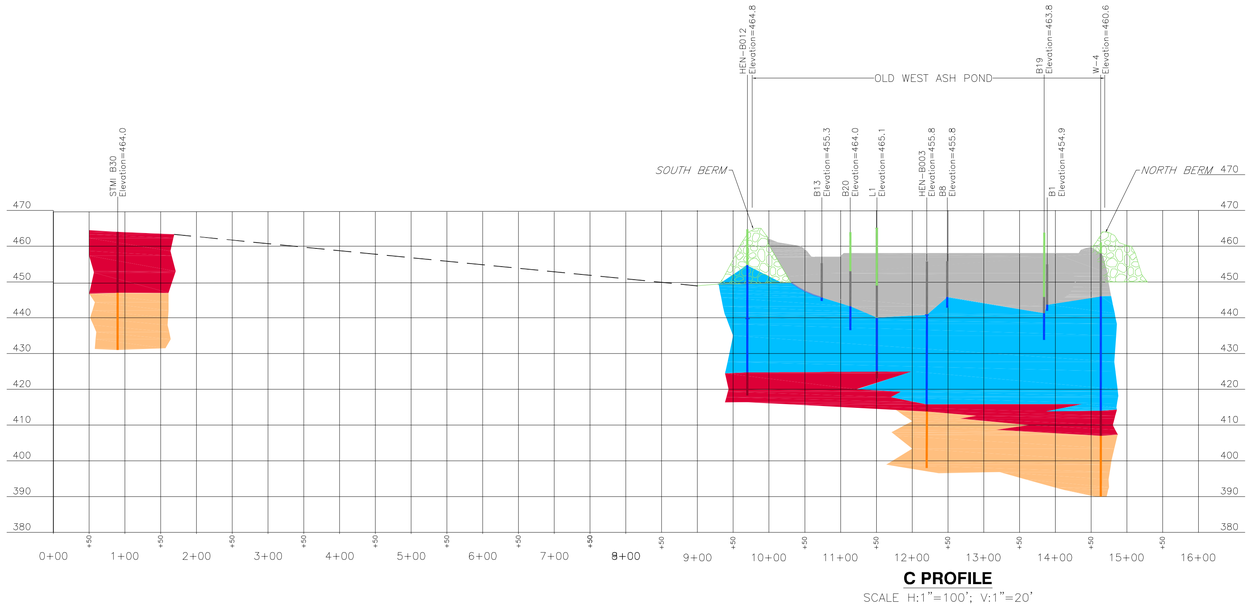
WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION
HENNEPIN, ILLINOIS

Natural Resource Technology
AN OBG COMPANY

PROJECT NO.
2421

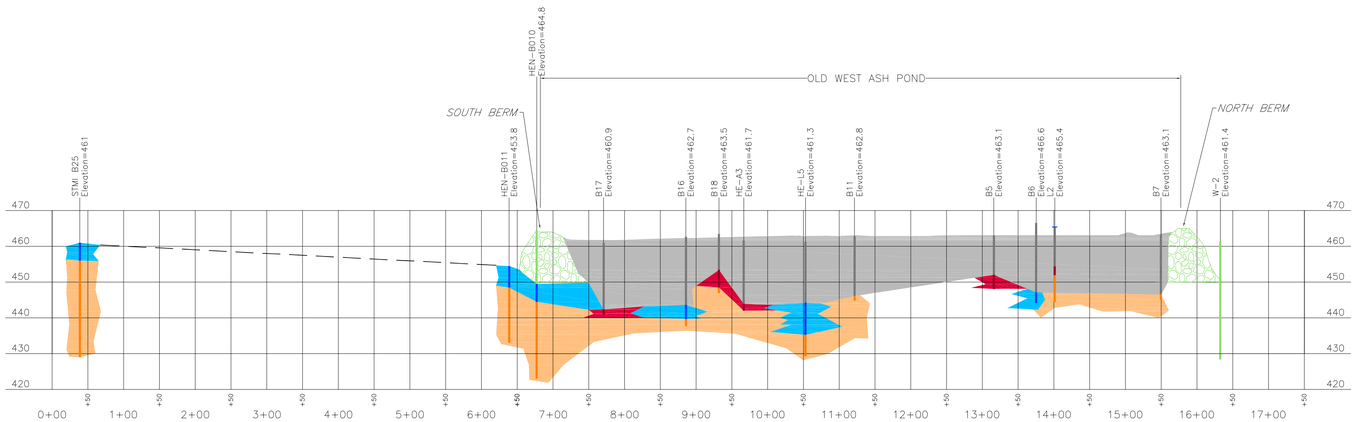
FIGURE NO.
9

Aug 29, 2017 1:07pm PLOTTED BY: DwellJm SAVED BY: DwellJm
N:\Active Projects\Dynegy\Hennepin\OBG MOD - 16447B-CVDI-C100-Cross Sections.dwg A-A' & B-B'
IMAGES: \Images\GoogleEarth Site Pix
WATER:



C PROFILE

SCALE H:1"=100'; V:1"=20'



D PROFILE

SCALE H:1"=100'; V:1"=20'

REFERENCES

1. SOURCE DRAWING DERIVED FROM CEC, INC.; PROJECT NUMBER 164-478, DRAWING NUMBER C200, DATED 3/27/17.
2. TOP OF EXISTING GRADE BASED ON DATA PROVIDED BY WEAVER CONSULTING GROUP SURVEY (2015) AS PRESENTED BY CEC INC.
3. GEOLOGIC INTERPRETATIONS ARE BASED ON BORING LOGS PERFORMED BY CEC INC., AECOM, SCIENCE AND TECHNOLOGY MANAGEMENT INC., JOHN MATHES & ASSOCIATES INC., AND NATURAL RESOURCE TECHNOLOGY INC.

LEGEND

- MISCELLANEOUS BERM SOIL FILL
- CCR/ASH
- SILTS AND CLAYS (ALLUVIAL)
- SANDS WITH FINES (ALLUVIAL)
- SAND AND GRAVEL (GLACIAL OUTWASH)
- INTERPRETED NATURAL GROUND SURFACE OUTSIDE OF ASH POND

GEOLOGIC CONDITIONS

1. THE TEST BORING INFORMATION PRESENTED HEREIN DEPICTS SUBSURFACE CONDITIONS AT THE TEST BORING LOCATIONS AND AT THE TIME OF DRILLING. SOIL CONDITIONS AT OTHER LOCATIONS MAY DIFFER.
2. GEOLOGIC CORRELATIONS BETWEEN TEST BORINGS ARE GENERALLY BASED ON STRAIGHT-LINE INTERPOLATION. ACTUAL CONDITIONS BETWEEN TEST BORINGS MAY DIFFER.

DRAWN BY: AGC DATE: 02/15/2017
CHECKED BY: NRK DATE: 02/21/2017
APPROVED BY: SJC DATE: 08/25/2017
DRAWING NO: OBG MOD - 16448 CROSS SECTIONS
REFERENCE: .

CROSS-SECTION C-C' AND D-D'

HYDROGEOLOGIC CHARACTERIZATION REPORT

WEST ASH POND SYSTEM
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION, HENNEPIN, ILLINOIS

Natural Resource Technology
AN OBG COMPANY

PROJECT NO.
2421

FIGURE NO.
10

Aug 29, 2017 - 1:06pm - PLOTTED BY: Orellijm - SAVED BY: Orellijm
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XREFS:

APPENDIX B
Geochemical Conceptual Site Model (Geosyntec Consultants, Inc., 2024)

Geosyntec consultants

engineers | scientists | innovators

Geochemical Conceptual Site Model

Hennepin Power Plant – West Ash Pond System

(CCR Unit #804)

Prepared for

Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Prepared by

Geosyntec Consultants, Inc.
134 N. Lasalle Street, Suite 300
Chicago, Illinois 60602

Project Number: GLP8079

May 2024

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ACRONYMS AND ABBREVIATIONS

ASD	alternative source demonstration
CCR	coal combustion residuals
COCs	constituents of concern
ft bg	feet below ground surface
GCSM	geochemical conceptual site model
GWPS	groundwater protection standard
HPP	Hennepin Power Plant
HSU	hydrostratigraphic unit
I.A.C.	Illinois Administrative Code
IEPA	Illinois Environmental Protection Agency
LOI	loss on ignition
mg/L	milligrams per liter
µg/g	micrograms per gram
N&E	nature and extent
ORP	oxidation-reduction potential
OWAP	Old West Ash Pond
OWPP	Old West Polishing Pond
SEP	sequential extraction procedure
SU	standard units
TDS	total dissolved solids
TOC	total organic carbon
UA	uppermost aquifer
WAPS	West Ash Pond System
wt %	weight percent
XRD	X-Ray diffraction

1. EXECUTIVE SUMMARY

This report documents the development of a geochemical conceptual site model (GCSM) to describe conditions at the Hennepin Power Plant (HPP) West Ash Pond System (WAPS) coal combustion residuals (CCR) unit (Unit #804). A GCSM describes the geochemical processes that contribute to the mobilization, distribution, and attenuation of chemicals in the subsurface soil and groundwater environment. The GCSM was prepared in support of an evaluation of the nature and extent (N&E) of exceedances of constituents of concern (COCs) above the groundwater protection standards (GWPS) at the WAPS. Through the second, third, and fourth quarters of 2023, COC exceedances of arsenic, boron, lithium, sulfate, and total dissolved solids (TDS) were reported at WAPS compliance wells. The exceedances occur exclusively in the uppermost aquifer (UA), which consists of fill, unconsolidated alluvium, and Pleistocene-age glacial outwash and till deposits.

The CCR materials are the primary source of constituent loading to the CCR porewater (i.e., CCR source water). Over an extended period (e.g., months to years), the CCR source water (i.e., water contained within the interstitial pore spaces of the CCR that can be sampled by low-flow groundwater sampling methods) reaches equilibrium with the CCR materials. The porewater is therefore representative of the mobile phase constituents capable of migrating into the underlying materials and potentially downgradient in groundwater. The WAPS CCR source water is therefore the primary indicator of boron and sulfate *available* to the groundwater and is considered as the primary source term for environmental investigation and fate and transport modeling.

Arsenic, boron, lithium, and sulfate are naturally present in coal deposits and are concentrated in CCR. TDS is a measure of inorganic and organic substances in solution and, as such, TDS trends are generally consistent with those of major ions in the WAPS groundwater system. Arsenic, boron, and lithium were identified in UA solids adjacent to downgradient and background wells, which suggests that aquifer solids could provide a secondary natural geogenic source of arsenic, boron, and lithium to the groundwater. Redox conditions vary across the site, with more oxidizing conditions on the east side of the WAPS and more reducing conditions on the west. Reducing conditions may be enhancing arsenic mobility and thus aqueous arsenic concentrations at select wells on the west of the WAPS. The source of arsenic, boron, lithium, sulfate, and TDS to groundwater of the UA is currently expected to be the WAPS CCR porewater.

Arsenic, boron, lithium, and sulfate in the groundwater system may be attenuated via surface complexation reactions with metal (i.e., aluminum, iron, and manganese) oxyhydroxides. Iron oxides were detected in aquifer solids and are generally predicted to be stable at monitoring wells across the network. Clay minerals were also identified in aquifer solids and may provide an additional attenuation mechanism for arsenic, boron, lithium, and sulfate in groundwater. At the limited locations across the network where reducing conditions are present, microbial sulfate reduction may also contribute to decreased sulfate concentrations in the groundwater. Attenuation of the constituents contributing to TDS, such as sulfate, will reduce TDS concentrations as well.

2. INTRODUCTION

This report documents the development of a geochemical conceptual site model (GCSM) to describe conditions at the Hennepin Power Plant (HPP) West Ash Pond System (WAPS) coal combustion residuals (CCR) unit (Unit #804). A GCSM describes the geochemical processes that contribute to the mobilization, distribution, and attenuation of chemicals in the subsurface soil and groundwater environment. The GCSM was prepared in support of an evaluation of the nature and extent (N&E) of exceedances of constituents of concern (COCs) above the groundwater protection standards (GWPS) at the WAPS. This document has been prepared as an appendix to the HPP WAPS N&E Report prepared by Ramboll Americas Engineering Solutions, Inc. (Ramboll). Parameters with exceedances above the GWPS at the HPP WAPS compliance wells for the second, third, and fourth quarters of 2023 (Q2 2023, Q3 2023, and Q4 2023) sampling events completed under Illinois Administrative Code (I.A.C.) Title 35 Section 845.630 include arsenic, boron, lithium, sulfate, and total dissolved solids (TDS). Arsenic exceedances were observed at compliance wells 21R and 51. Boron exceedances were observed at compliance wells 21R, 22, 23, 35, and 27. Lithium was an exceedance at compliance well 22, and sulfate exceedances were observed at compliance wells 23 and 35. TDS exceeded the GWPS at compliance well 35. The exceedances identified at the WAPS occur exclusively in the uppermost aquifer (UA), the only monitored unit at the WAPS.

An exceedance of cadmium was observed at compliance monitoring well 22 during the Q2 2023 sampling event. However, an alternative source demonstration (ASD), as allowed by I.A.C. 845.650(e), was completed for the cadmium exceedance (Ramboll 2023). The cadmium ASD was accepted by the Illinois Environmental Protection Agency (IEPA) on December 7, 2023 (IEPA 2023); therefore, cadmium is not included as a COC in this GCSM.

3. SITE BACKGROUND

3.1 Site Overview

An overview of site characteristics and hydrogeology is presented in the HPP WAPS N&E Report. A site layout figure is provided in Attachment A.[1] The Hennepin WAPS consists of the Old West Ash Pond (OWAP) (Ponds No. 1 and No. 3) and the Old West Polishing Pond (OWPP). Pond No. 1 of the OWAP was constructed in 1951 and 1952, and Pond No 3. was constructed in 1968. Ponds No. 1 and No. 3 comprising the OWAP were merged in 1988 and 1989 when the embankment surrounding OWAP was raised. The OWPP was also constructed during this time (1988-1989). The WAPS operated between 1952 to 1996, and closure occurred between August 2019 and November 2020. The OWPP was closed by removal and consolidation of the CCR into OWAP, and subsequently, the OWAP was closed with a geomembrane and vegetated soil cover. A steel sheetpile wall was installed between the OWAP and the OWPP during closure as a temporary support-of-excavation feature to facilitate CCR consolidation and a compacted clay dike was constructed in front of the steel sheet pile wall to provide a permanent and continuous earthen containment system around the consolidated WAPS. The steel sheetpile was left in place following closure of the unit.

The Hennepin WAPS is located west of the HPP and adjacent to the Illinois River. The HPP property is bordered by farm fields to the east and south, low lying floodplains to the west, and the Illinois River to the north.

A Hydrogeologic Site Characterization Report (NRT 2017) and a Hydrogeologic Monitoring Plan (OBG 2017) previously described the hydrostratigraphic units (HSUs) present in the vicinity of the Hennepin WAPS. These reports indicate that the subsurface stratigraphy of the WAPS consists of fill, unconsolidated alluvium, and Pleistocene-age glacial outwash and till deposits, which comprise the UA. Sand and gravel deposits are thicker underneath the eastern portion of the WAPS, while the western portion is underlain by less permeable, silty and clay material (OBG, 2017). The UA may be up to 130 feet thick beneath the WAPS and is underlain by Pennsylvanian-age shale bedrock with interbedded limestone, sandstone, and coal seams.

3.2 Groundwater Monitoring Network

A groundwater monitoring network was proposed in accordance with I.A.C. Title 35 Section 845.630 to monitor groundwater quality which passes the waste boundary as part of the Operating Permit application to IEPA for the WAPS. The proposed groundwater monitoring network is

[1] This figure is also provided as Figure 2-2 of the HPP WAPS N&E Report.

described in the Addendum to the Groundwater Monitoring Plan (Ramboll 2021) and shown in Attachment B.[2] Well construction information is provided in Attachment C.[3]

Groundwater flow beneath the WAPS within the UA is predominantly to the north and northwest, towards the Illinois River, although the flow direction varies with the elevation of the river. During a high river stage, the groundwater flow direction may reverse, saturating the ash in the OWAP (NRT 2017; NRT 2018). There are localized flow conditions near the south boundary of the WAPS (near compliance well 35) as a result of the elevation of the top of the sand and gravel portion of the UA at this location, continuity of the silt and clay underlying the WAPS, and the presence of drainage features and wetlands south of the unit. A detailed discussion of the hydrogeology of the Site is presented in Section 2 of the HPP WAPS N&E Report.

[2] This figure is also provided as Figure 2-10 of the HPP WAPS N&E Report.
[3] This table is also provided as Table 3-1 of the HPP WAPS N&E Report.

4. GEOCHEMICAL SITE CONDITIONS

4.1 Constituent Transport and Fate

As described in Section 2 and the HPP WAPS N&E Report, arsenic, boron, lithium, sulfate, and TDS exceeded the GWPS at the HPP WAPS. These constituents are frequently present and detectable in CCR porewater and groundwater impacted by CCR.

Arsenic speciation in groundwater is dependent on both pH and oxidation/reduction reactions and is typically present as arsenic (III) or arsenic (V) in environmental systems. Arsenic (III) is the predominant species under relatively reducing conditions and, a pH values less than 9 standard units (SU), forms the neutral complex $As(OH)_3$. Arsenic (V) is the predominant species under relatively oxidizing conditions and typically exists as $HAsO_4^{2-}$ at pH values above 7 SU. Arsenic (V) is more likely to be attenuated than neutral arsenic (III) species due to its negative charge and electrostatic interactions with soil/aquifer solids. In general, arsenic has a high sorption affinity for metal (i.e., aluminum, iron, and manganese) oxyhydroxides and may also sorb to clay minerals (Rahman et al. 2019, Nguyen et al. 2021). Arsenic sorption is typically highest at lower pH values where favorable electrostatics enhance attenuation, and also under oxidizing conditions due to the greater propensity for attenuation of the negatively charged $HAsO_4^{2-}$ species relative to neutral $As(OH)_3$ species. Further, the presence of divalent cations (such as calcium [Ca^{2+}]) can promote arsenic (V) absorption (Nguyen et al. 2021).

Boron is primarily present in groundwater as boric acid (H_3BO_3) or borate ($B[OH]^{4-}$) (Bolan et al. 2023). The speciation of boron depends on pH: at pH below 9.2 standard units (SU), H_3BO_3 is the dominant species (NCBI 2024a). Boron is not subject to oxidation/reduction reactions (Lemarchand et al. 2015; Bolan et al. 2023). Boron primarily adsorbs to positively charged sites on solid metal oxide phases, including iron and aluminum oxides (Goldberg and Glaubig 1985; Bolan et al. 2023). Boron sorbs most extensively to amorphous metal oxides between pH 7 SU and 8 SU (Goldberg and Glaubig 1985). Boron can also sorb onto natural organic substances such as humic acids or coal under favorable conditions, most extensively between pH 8 and 10 SU (LeMarchand et al. 2015). Clay minerals have been correlated with boron sorption in soils (Goldberg 1997), with this sorption mechanism presenting an additional potential attenuation mechanism for boron under certain geochemical conditions.

Lithium in solution is typically conservative. Lithium is more hydrated than other similarly charged cations, which reduces its ability to bind to soil colloids (Robinson et al. 2018, Elbana and Osman 2023). Lithium in groundwater may adsorb to iron and manganese oxides and clay minerals, though retention is often weak, and sorption may decrease with increasing lithium concentrations and/or decreasing pH (Robinson et al. 2018, Elbana and Osman 2023; Steinhoefel et al., 2021). However, lithium sorbed to secondary clays may be incorporated deeper into the mineral matrix for more permanent immobilization (Li and Liu, 2020; Steinhoefel et al., 2021).

Sulfate is the primary form of oxidized sulfur (S(VI)) in the environment and is a divalent oxyanion at pH values greater than 2 SU (Stumm and Morgan 1996). Sulfate in groundwater may adsorb onto positively charged sites on solid metal oxide phases, most commonly iron and manganese oxides (Brown et al. 1999). The extent and strength of sulfate adsorption to metal oxide surfaces depends on pH, ionic strength, and oxide surface area available for sorption. Sulfate can also form insoluble complexes such as barite ($BaSO_4$) (NCBI 2024b). Sulfate in groundwater may be reduced to elemental sulfur (S[0]) or sulfide (S[-II]) under sufficiently reducing conditions, a process governed by local microbial communities (Stumm and Morgan 1996). Generally, reduced sulfur is less mobile in groundwater than sulfate. Reduced sulfur readily precipitates as metal sulfides and adsorbs to solid phases such as iron and manganese oxides (Stumm and Morgan 1996).

TDS is a measure of the mass of dissolved material in water, rather than a specific chemical constituent. Individual constituent contributions to TDS depend on both the concentration and molar mass of each contributor. Typically, major ions (i.e., calcium, sodium, magnesium, potassium, chloride, sulfate, and carbonate species) represent the primary contributors to TDS. As such, TDS is often positively correlated with electrical conductivity and ionic strength (Rusydi 2018, Ghalib et al. 2020). TDS concentrations can be reduced by the removal from aqueous phases of the individual constituents that contribute to TDS.

4.2 Site Solids Characterization

Solid phase data were not collected from the CCR source material prior to completion of unit closure with a geomembrane cover system in 2020.

Site solids were characterized to determine the type and abundance of minerals present in the UA, their geochemical properties, and their effect on the aqueous geochemistry of the groundwater system. Solids were characterized using a variety of analytical techniques, the results of which are presented in Tables 1 to 4. Aquifer solids were collected from three locations within the UA adjacent to existing wells in the WAPS monitoring network:

- SB-22, located downgradient of the WAPS to the northeast adjacent to well 22. Solids were collected from two intervals within the UA (26-27 feet below ground surface [ft bgs] and 29-30 ft bgs). Exceedances of boron and lithium above the GWPS were first observed at well 22 during the Q2 and Q3 2023 statistical evaluations, respectively.

- SB-34, adjacent to background well 34, which is unimpacted by the WAPS. Solids were collected from one interval within the UA (32-33 ft bgs).

- SB-51, located downgradient and northwest of the WAPS adjacent to well 51. Solids were collected from one interval within the UA (42-43 ft bgs). An exceedance of arsenic above the GWPS was first observed at well 51 during the Q2 2023 statistical evaluation.

The monitoring well locations are shown in Attachment B. Boring logs for these locations are provided in Attachment D.

4.2.1 Total Organic Carbon, Loss on Ignition, Sulfate, and Sulfide

Total organic carbon (TOC) represents only the carbon component of organic matter within a solid material, while loss on ignition (LOI) represents the combustible portions of a solid material and is often used as an approximation of organic matter in a sample. The TOC and LOI values for aquifer solids from SB-22, SB-34, and SB-51 are presented in Table 1. TOC values range from 0.34 to 4.6 percent weight [% wt] and LOI values vary from 11.6 to 21.5% wt, indicating that the aquifer solids contain a moderate amount of organic matter. Solids adjacent to well 51 generally contained a higher proportion of organic matter compared to wells to the east based on the LOI results.

Sulfate, as measured in solid leachate after HCl digestion, and sulfide, as measured by combustion-infrared absorption after digestion, were also quantified for the aquifer solids. Observed concentrations of sulfate were below detection (0.1%) in the samples (see Table 1). Total sulfide ranged from below the detection limit (0.04%) at SB-22 (26-27 ft bgs) to 0.18% at SB-51. The presence of sulfides may indicate that sulfate reduction is actively occurring, particularly at well 51 which has reducing conditions (as discussed in Subsection 4.3.2). The laboratory analytical results for TOC, LOI, sulfate, and sulfide are available in Attachment E.

4.2.2 Total Metals via Bulk Characterization

Total metals were analyzed to determine the major and trace metal content of the aquifer solids with results presented in Table 2. The laboratory analytical results are available in Attachment E. Arsenic, boron, and lithium were detected in solids adjacent to wells 22, 34 and 51. The solids from SB-22 had the highest arsenic concentrations while solids from SB-34 (background) and SB-51 had comparable arsenic concentrations (though of these two, only well 51 has an arsenic exceedance in groundwater). Lithium and boron concentrations were both highest in the solids from SB-51. Total iron concentrations were relatively low in aquifer solids sampled from the three wells, with values ranging from 9,400 to 14,000 micrograms per gram (µg/g). Similarly, total manganese concentrations were also relatively low, with values ranging from 220 to 350 µg/g. Both iron and manganese were highest in the aquifer solids from SB-51. Aluminum was also present in the solids from the three wells, with the highest value (8,200 µg/g) at SB-51. The presence of these metals (aluminum, iron, and manganese) in the aquifer solids may provide potential attenuation sites for COCs in the form of metal oxyhydroxides.

4.2.3 Sequential Extraction Procedure Analysis of Metals

A sample of composited material from each boring location was submitted to SGS Canada Inc. (Lakefield, ON, CA) for sequential extraction procedure (SEP). SEPs are chemical extractions used to dissolve metals from specific solid-associated phases. SEPs use progressively stronger reagents to solubilize metals from increasingly recalcitrant phases. Although these procedures do not quantitatively identify the specific metal phases in a soil/aquifer matrix, they do provide a

means to evaluate the class of solids and relative stability in relation to oxidation/reduction (redox) potential and pH fluctuations (Tessier et al. 1979, Kuo et al. 1983, Sposito et al. 1984, Hickey and Kittrick 1984, Gruebel et al. 1988). Therefore, SEP data are useful to interpret the mechanism and potential reversibility of attenuation processes. The 6-step extraction procedure is briefly described, and the results of the SEP analysis are provided in Table 3 and Attachment F.

Manganese was primarily detected in fractions associated with carbonates, iron and manganese oxides, and residual metals, with lesser amounts bound to organic material. Between 8.8% and 25.5% of the iron extracted from the aquifer solids was associated with metal oxide phases, indicating that iron oxides are present at significant concentrations and may provide potential sorption sites for COCs. Arsenic in aquifer solids from SB-34 (background) and SB-51 were bound to the fraction associated with iron and manganese oxides at similar concentrations (0.8 and 0.9 µg/g [29.6% and 25%], respectively). This suggests that iron and manganese oxides in the solids have some capacity to serve as adsorption sites for arsenic and that arsenic may be naturally present in background. Lithium was only identified in association with the residual fraction, which could indicate incorporation into clay minerals. While boron was largely identified in association with the residual fraction, some portion (6.7 to 16.7%) was also identified in the fraction associated with metal oxides (Table 3). SEP data indicated that there was little association of arsenic, boron, and lithium to organics. Overall, these results suggest some attenuation via interaction with metal oxides may be feasible in the aquifer.

4.2.4 Mineralogical Analysis

X-Ray diffraction (XRD) with Rietveld refinement was conducted for identification of minerals in aquifer solid samples. XRD is an analytical technique that provides information about the identity of the crystalline material within a sample but does not provide information about non-crystalline or amorphous phases. XRD results are normalized to 100% of the total weight, meaning that material not characterized by XRD is ignored in the percent calculation. The four samples analyzed by XRD were determined to be primarily composed of quartz (SiO_2), ranging from 33.1 to 57.0 percent by weight (wt%) of the minerals present (Table 4; Attachment G). The second most abundant mineral was either dolomite (ranging from 11.4 to 14.4 wt% in SB-22) or calcite (11.1 wt% in well 34; 20.9 wt% in SB-51), both of which are carbonate minerals. These results are consistent with the field observations documented in the boring logs provided in Attachment D.

Magnetite, which is a mixed valence iron oxide, was identified in the aquifer solids from 0.2 to 0.5 wt%. Magnetite contains both ferrous (2+) and ferric (3+) forms of iron and is therefore considered to be one of the more stable iron oxide minerals in the environment (Cornell and Schwertmann 2003). Magnetite provides adsorption sites to attenuate constituents in solution. Magnetite concentrations do not correlate well with observations of total iron in the solids (i.e., samples with higher iron concentrations do not necessarily have higher abundances of iron oxides minerals as identified in the XRD results). This may be related to the presence of non-crystalline, amorphous iron oxides that are not detected by XRD (described above), which provide additional adsorption capacity in the aquifer.

The aquifer solids samples also had measurable proportions of kaolinite (0.6 to 3.4%) and chlorite, (1.9 to 6.8%; Table 4). Clay minerals, such as kaolinite and chlorite, provide potential attenuation sites for arsenic, boron, lithium, and/or sulfate due to the presence of surface hydroxyl groups (Goldberg 1997; Lins and Puls, 2002; Mohapatra et al. 2007; Sokolova and Alekseeva 2008; Li and Liu 2020). Chlorite is of particular importance for the attenuation of arsenic, as it is an iron-rich mineral which contains a hydroxide interlayer that provides adsorption sites (Lin and Puls, 2002). Kaolinite, a secondary clay mineral commonly formed during feldspar weathering, provides a particularly strong (i.e., irreversible) sorbing surface for lithium (Li and Liu 2020). Naturally occurring kaolinites tend to be enriched in lithium attenuated from groundwater (Anderson et al. 1989; Pogge von Strandmann et al. 2021; Steinhoefel et al., 2021).

4.3 Aqueous Geochemistry

UA groundwater from wells across the delineation network were analyzed for a range of geochemical parameters and data from October 2012 to November 2023 are presented in Figures 1 through 8. For clarity in interpretation, wells are arranged from east to west in the legends, with a warm (east) to cold (west) color scheme. Concentrations discussed in the following subsections are inclusive of the two most recent years of monitoring data (December 2021 to November 2023). The groundwater data used in the site evaluation are presented in Attachment H.

CCR porewater (i.e., CCR source water) from porewater wells (L4, LPZ-1, LPZ-3, and LPZ-17) distributed across the WAPS were collected April 2017 and analyzed for a range of geochemical parameters. The United States Environmental Protection Agency (USEPA) considers the use of porewater data as the most appropriate approach to estimate constituent fluxes to groundwater from CCR surface impoundments. As per USEPA, “this is because porewater better represents the leachate seeping from the bottom of the impoundment than impoundment water samples” (USEPA 2015). CCR porewater data are presented in Table 5 and discussed in the following subsections.

4.3.1 Exceedance Parameters

Arsenic concentrations in groundwater were consistently below the GWPS of 0.010 milligrams per liter (mg/L) in background wells and compliance wells, with two exceptions, 21R and 51. Arsenic concentrations in exceedance of the GWPS were identified[4] at compliance wells 21R (21R was installed to replace 21; 21 was decommissioned in 2019) and 51 (51 was installed to replace 24; 24 was decommissioned in 2019) (Figure 1). Wells 21R and 51 are located near the northwest corner of the WAPS. Arsenic at well 21R has been elevated post-closure, with concentrations ranging from 0.0210 to 0.0345 mg/L for the last two years of monitoring data (December 2021 to November 2023). Arsenic at well 51 has also been elevated post-closure, with concentrations ranging from 0.0182 to 0.0308 mg/L. The trends at well 51 are consistent with previous arsenic values measured in well 24 prior to decommissioning. Arsenic concentrations at wells 21R and 51 are also consistent with those of porewater wells, which had arsenic concentrations ranging from

[4] Using data pooled from both original and replacement wells collected from 2015 onward.

0.0123 to 0.0351 mg/L during the 2017 sampling event. Arsenic concentrations at other wells within the delineation network (including background wells) were low, with concentrations ranging from below detection to 0.0017 mg/L.[5]

Boron concentrations were generally stable or decreased through time across the site (Figure 2). In background wells 32 and 34, boron concentrations were consistently low (between 0.075 and 0.206 mg/L). Boron concentrations at wells 49, 50, and 51 are slightly elevated above background but below the GWPS of 2.0 mg/L during recent events. Exceedances above the GWPS were reported in compliance wells 21R, 22, 23, 35, and 27. Boron at wells 21R, 22, and 27 decreases over time, with values ranging from 0.13 to 4.84 mg/L. The exceedance at monitoring well 27 may be attributed to groundwater flow conditions prior to closure, wherein groundwater was mounded within the WAPS and flowed radially from the unit and migrated to the nearby wetland (Section 2 of the N&E Report). Concentrations at well 23 have an average value of 9.3 mg/L for the previous two years of data. Well 35 has exhibited an increase in boron since closure activities started in 2019, with a range of concentrations (9.58 to 18.1 mg/L) reported over the last two years. Localized post-closure flow conditions at well 35 are likely contributing to the increase in boron. However, once water levels in the WAPS reach equilibrium, concentrations of boron are expected to stabilize and decline in the future. Boron concentrations in porewater wells ranged from 21 to 28 mg/L in 2017. These concentrations suggest that the porewater may be contributing to the stable to increasing boron concentrations observed at wells 23 and 35.

Lithium concentrations remained stable or decreased over time in the wells across the delineation network (Figure 3). Concentrations at background wells 32 and 34 have been consistently low, ranging from 0.0029 to 0.0051 mg/L and 0.0032 to 0.0160 mg/L for wells 32 and 34, respectively. Lithium concentrations across the site have generally been below the GWPS of 0.040 mg/L but elevated relative to background wells, with two exceptions. Lithium exceeds the GWPS at well 22 but exhibits a decreasing trend over time, with concentrations ranging from 0.0419 to 0.0620 mg/L. There was a spike in lithium during the May 2023 sampling event at well 51, but this was not determined to represent an exceedance and all other data points for well 51 are below the lithium GWPS. Lithium concentrations at porewater wells were generally similar to or greater than that of well 22, with reported values ranging from 0.046 to 0.109 mg/L during the 2017 sampling event.

Sulfate concentrations across the site were stable or decreased over time, except in well 35 (Figure 4). In background wells 32 and 34, sulfate concentrations were consistently low (between 45 and 82 mg/L). Exceedances above the sulfate GWPS of 400 mg/L were reported at wells 23 and 35. Sulfate concentrations remained relatively stable in well 23, unlike the increasing boron concentration, ranging from 413 to 471 mg/L. In well 35, sulfate concentrations exhibited an increasing trend post-closure, similar to boron, with variable sulfate concentrations (476 to 1190

[5] The apparent spike in arsenic concentrations in most wells (except 21R and 51) during the May 2023 sampling event is a result of the higher detection limit (0.0087 mg/L) that was used during analysis on that date, rather than an increase in arsenic in the groundwater.

mg/L) over the last two years. Other compliance and monitoring wells had sulfate concentrations below the GWPS. Concentrations at these wells were similar to or slightly greater than that of background wells, ranging from 77 to 159 mg/L. Porewater wells exhibited a wide range of sulfate concentrations during the 2017 sampling event (370 to 1270 mg/L), which is generally consistent with the range of concentrations observed at wells 23 and 35.

TDS concentrations across the network were stable over time, with the exception of well 35 (Figure 5). In background wells 32 and 34, TDS concentrations ranged from 514 to 845 mg/L. TDS in well 35 exceeded the GWPS of 1,200 mg/L and has increased following closure activities in 2019. TDS trends in well 35 have a positive and linear correlation with sulfate trends (R^2 = 0.97, Figure 6), which indicates that sulfate may be a major contributor to elevated TDS at well 35. Other compliance and monitoring wells had TDS concentrations that were generally within the range of background measurements, though well 23 consistently had TDS concentrations above background but below the GWPS. TDS concentrations at the porewater wells ranged from 768 to 2090 mg/L, which is similar to the range observed at well 35 in the last two years (918 to 1940 mg/L).

4.3.2 Redox/pH Summary

The oxidation-reduction (redox) potential (ORP) and pH in aqueous systems are major controls on the speciation of redox-active chemicals. ORP and pH will affect arsenic and sulfate (COCs for WAPS groundwater) mobility in groundwater and determine the stability of iron and manganese oxyhydroxides.

In wells across the groundwater monitoring network, groundwater pH values have declined since placement of CCR and use of the WAPS ceased in the late 1990s (Figure 7). In recent years, pH values are circumneutral and fairly consistent across the site (ranging between 6.8 to 7.7 standard units [SU]), though compliance wells along the north side of the WAPS tend to have slightly higher pH values than background wells. This may reflect a consistent influence from the pond water, which had reported pH values ranging from 7.6 to 10 SU (Table 5).

Redox conditions vary across the site, with the east side of the WAPS generally exhibiting more oxidizing conditions and the west side exhibiting more reducing conditions (Figure 8). The oxidizing conditions are a result of these wells being located closer to a recharge zone where sand and/or gravel are near the land surface. The presence of a silty, organic-rich deposit on the west side of the WAPS may be creating the observed reducing conditions in that area (EPRI 2002). More reducing conditions exist at compliance wells 21R, 22D, 23, 27, and 51, background well 34, and leachate porewater wells. Reducing conditions at 21R and 51 are consistent with the elevated arsenic concentrations at these wells, which is likely attributed to the lower stability of iron and/or manganese oxyhydroxides and the desorption of arsenic associated with these phases and/or changes in arsenic speciation as discussed in Section 4.3.3.

4.3.3 Pourbaix Diagrams

Eh-pH, or Pourbaix, diagrams can be used to illustrate the predicted stability of specific phases at thermodynamic equilibrium under the conditions observed for a groundwater sample. Select crystalline mineral species were suppressed to be representative of groundwater conditions (e.g., mineral formation not anticipated to be kinetically favored), except when identified in XRD data from solids in the site (e.g., magnetite). Conditions observed at well 21R on 22 August 2023 were used to represent wells with arsenic exceedances, which tend to be more reducing (Table 6). Conditions observed at well 22 on 25 August 2023 were used to represent wells with more oxidizing conditions (Table 6).[6]

Using conditions observed at wells 22 and 21R in August 2023 (Table 6), magnetite is predicted to be stable in the aquifer (Figure 9a and Figure 9b) The predicted stability of magnetite is consistent with XRD analysis which detected magnetite in aquifer solids at abundances ranging between 0.2 and 0.5 wt% (Table 4). When magnetite is suppressed, amorphous iron oxyhydroxides (represented by ferrihydrite) are generally predicted to be stable in the aquifer at locations with oxidizing (Figure 9c) conditions. Iron oxides, whether crystalline or amorphous, may provide potential mineral surfaces for sorption of arsenic, boron, lithium, and/or sulfate within the aquifer. Ankerite, which is represented by siderite in Figures 10a – 10d, may be stable under reducing conditions (Figure 9d), which is consistent with XRD detection of ankerite in aquifer solids at abundances ranging from 1.3 to 6.0 wt%. In general, iron oxyhydroxide minerals appear to be less stable under the more reducing conditions observed in site groundwater and as such, select wells (21R, 23, 34, and 51) may experience dynamic equilibrium conditions in which dissolution and subsequent precipitation of these minerals are more likely occur.

Arsenic is predicted to primarily exist as the arsenic (V) species $HAsO_4^{2-}$ even under reducing aquifer conditions at well 21R (Figure 10), which is a more readily attenuated arsenic (V) species. Under oxidizing conditions, the presence of $HAsO_4^{2-}$ in combination with more stable ferrihydrite suggests the potential for arsenic attenuation via interaction of arsenic (V) species with iron oxides.

A review of Eh-pH conditions for manganese found that solid phase manganese minerals are not predicted to be stable under conditions that exist at the compliance and background wells (Figures 11a and 11b).

4.3.4 Total and Dissolved Iron and Manganese Concentrations

The distribution of iron and manganese between total and dissolved phases can provide insights on site redox conditions and constituent behavior. A comparison of the total and dissolved iron and manganese data for the Q2 and Q3 2023 sampling events is provided in Table 7. Total iron was detected at least once at all sample locations, with values ranging from 0.037 mg/L (well 22, Q2 2023) to 8.5 mg/L (well 21R, Q2 2023). Dissolved iron was detected at 6 of the 11 sample

[6] Field ORP measurements were converted to Eh by adding +200 millivolts to correct for the Ag/AgCl electrode.

locations, with values ranging from 0.14 mg/L (well 23, Q3 2023) to 6.8 mg/L (background well 34, Q3 2023). Reducing conditions exist at all six sampling locations that had detectable dissolved iron, indicating that reducing conditions are contributing to dissolved iron in the groundwater. Where dissolved iron was detected, the dissolved concentrations were typically a significant (>50%) portion of the total iron identified. These results align with the findings of the Pourbaix diagrams, which predicted lower ferrihydrite stability at wells with more reducing conditions (Figures 10c and 10d).

Total manganese was detected at all locations analyzed, with reported values ranging from 0.012 mg/L (well 22, Q3 2023) to 1.3 mg/L (background well 34, Q3 2023). Dissolved manganese was detected at 12 of the 13 locations, with values ranging from 0.0044 (well 49, Q3 2023) to 1.3 (background well 34, Q3 2023). Where dissolved manganese was detected, dissolved concentrations as a percent of total concentrations varied widely, from 0 to greater than 100%. This is consistent with the widespread mobilization of manganese to the aqueous phase predicted by the Pourbaix diagrams (Figures 11a and 11b) and the lack of observed crystalline manganese-bearing minerals (like rhodochrosite) across the site (Table 4).

4.3.5 Total and Dissolved Organic Carbon Concentrations

Concentrations of organic carbon in groundwater can provide insights into redox conditions and constituent mobility. A comparison of aqueous TOC and dissolved organic carbon (DOC) concentrations for the Q2 and Q3 2023 sampling events is provided in Table 8. TOC and DOC were detected at all sampling locations during this time period. TOC concentrations ranged from 0.83 mg/L (well 27, Q3 2023) to 8.9 mg/L (well 35, Q2 2023) and DOC ranged from 0.88 mg/L (background well 32, Q3 2023) to 26 mg/L (well 22D, Q3 2023). The silty, organic-rich deposit on the west side of the WAPS likely contributes to higher TOC and DOC concentrations, particularly at well 34 which had higher TOC and DOC concentrations than most wells for both the 2023 Q2 and Q3 sampling events. In most cases, DOC concentrations were greater than or equal to TOC, suggesting that much of the organic carbon in the aquifer is dissolved. The presence of organic carbon can contribute to reducing conditions, which impacts the speciation and mobility of arsenic, iron, and manganese and the reduction of sulfate. Further, DOC can influence arsenic mobility by competing for binding sites on iron oxides, passivating the surface of iron oxides to reduce their reactivity, or serving as a substrate for iron-reducing microbial species, all of which could increase arsenic mobility via reduced attenuation with iron mineral surfaces (Aftabtalab et al. 2022). Wells with arsenic exceedances (51 and 21R) had TOC and DOC concentrations ranging from 1.5 to 3.3 mg/L and 1.6 to 2.6 mg/L (TOC and DOC, respectively), which are similar to that of other wells in the network.

4.3.6 Major Ion Distribution and Groundwater Signatures

A piper diagram was constructed using data from the delineation network and leachate to visualize major ion distributions in UA groundwater. Piper diagrams are a common tool for assessing geochemical similarities or differences between aqueous samples. The major ion distribution is

similar for most wells in the delineation network (Figure 12) and is characterized by relatively high contributions of calcium and bicarbonate ions. The relatively high contribution of carbonate species to groundwater composition is consistent with the abundance of carbonate-bearing minerals such as calcite and dolomite in the site solids (Table 4). Wells 23 and 35, which have boron and sulfate exceedances, exhibit a different ion distribution, with higher abundances of sulfate and lower abundances of bicarbonate relative to other wells in the network. The major groundwater composition in wells 23 and 35 is similar to that of the source water samples, which suggests that porewater may have contributed to boron and sulfate exceedances at these wells.

5. LABORATORY ATTENUATION TESTING

The aquifer solids described in Section 4.2 were submitted to SIREM laboratory to test attenuation behavior of arsenic using batch testing. Batch test studies combine soil and groundwater collected from the site to evaluate the sorption and desorption of chemical constituents. The methods and results of batch adsorption testing completed to evaluate attenuation of the arsenic with Site solids is described below. Batch desorption testing was not completed due to the redox sensitivity of arsenic, which contributed to poor recoveries in the batch attenuation testing.

5.1 Batch Attenuation Testing Methods

Aquifer solids from boring SB-34 and groundwater from well 51 were used for the batch attenuation tests. Test bottles (referred to as a microcosm) were constructed with five soil to water ratios (Table 9). The groundwater added to the microcosms was spiked with sodium arsenite to a target concentration of 0.1 mg/L arsenic, and the sample bottles were allowed to tumble for seven days. An initial sample of the stock solution was collected on Day 0 and a control sample (i.e., MW-51 groundwater with no aquifer solids) was collected on Day 7 following tumbling to evaluate any less to interactions with the bottleware or ambient conditions. Duplicates were constructed for each microcosm, including the control sample.

After seven days of contact time, an aliquot of the free liquid was collected and filtered through a 0.45-micron filter prior to analysis for dissolved arsenic. Analysis of the dissolved phase is important to adequately measure the partitioning of mass between the solid and liquid fractions of the experiment. The redox and pH were measured for each batch test at the beginning and end of the contact period and in the control samples.

5.2 Batch Attenuation Testing Results

While pH between the initial and final control samples remained consistent, ORP increased from -136 mV to -58 mV, suggesting a slight oxidation of the sample bottles during the experimental period. pH and redox results were generally consistent between the control and test samples, except for the 1:1 soil:water ratio microcosms which had a significantly lower ORP recorded (Table 9). The cause of the anomalously low ORP values for this soil:water ratio is not immediately apparent. The recovery of arsenic in the control samples was approximately 58% of the initial total, with the loss of aqueous arsenic likely associated with the observed change in redox conditions in the control.

While interpretation of the data is limited by the poor recovery in the control samples, the data obtained from the tests (Table 9) were used to construct 5-point isotherms for arsenic by averaging duplicate results for each soil:solution ratio. Mathematical fitting was used to calculate the attenuation distribution coefficients (K_d), assuming linear adsorption. The linear adsorption equation was used:

$$q_e = K_d \times C_e \quad \text{Eq. 1}$$

where q_e is the mass of constituent adsorbed to the solid phase at equilibrium, C_e is the remaining aqueous constituent concentration at equilibrium, and K_d is the linear sorption coefficient (reported in liters per kilogram [L/kg]). The linear data output is provided as Figure 13.

The data were also fitted to a non-linear Langmuir isotherm:

$$q_e = \frac{q_m K_L C_e}{1 + K_L C_e} \quad \text{Eq. 2}$$

where q_m is the inverse of the slope and K_L is the Langmuir distribution coefficient. The adsorption data were linearized according to:

$$\frac{C_e}{q_e} = \frac{1}{(K_L \times q_m)} + \frac{C_e}{q_m} \quad \text{Eq. 3}$$

A common non-linear Freundlich equation was also used:

$$q_e = K_F (C_e)^{1/n} \quad \text{Eq. 4}$$

where q_e is the mass of constituent adsorbed to the solid phase at equilibrium, C_e is the remaining aqueous constituent concentration at equilibrium, K_F is the Freundlich distribution coefficient, and $1/n$ is a non-linearity constant. The adsorption data were plotted as log-transformed values to perform the non-linear isotherm fitting using the linearized Freundlich equation:

$$log(q_e) = \log(K_F) + (1/n)\log(C_e) \quad \text{Eq. 5}$$

The calculated linear, Langmuir, and Freundlich distribution coefficients (K_d, K_L, and K_F, respectively) and $1/n$ values are shown in Table 10.

The linear K_d of 36.4 L/kg was selected for well 51 based on its goodness-of-fit ($R^2 = 0.69$) and compatibility with values reported in literature (which range from several orders of magnitude from 1 to $1x10^5$; USEPA 2005). As noted above, the calculated K_d may be influenced by the loss of arsenic in the control solution; the batch attenuation results instead may serve as a proof of concept for the attenuation of arsenic in the system in lieu of a more quantitative measurement.

6. GEOCHEMICAL CONCEPTUAL SITE MODEL

6.1 Source and Mobilization Mechanisms

Arsenic, boron, sulfate, and lithium are naturally present in coal deposits and are concentrated within CCR. Sulfate may also be present in CCR as a byproduct of flue gas desulphurization. Arsenic, boron, and lithium were detected within UA aquifer solids from compliance and background wells, although groundwater concentrations of these constituents in background wells consistently do not exceed GWPSs. Arsenic, boron, sulfate, and lithium all exhibited elevated concentration in CCR porewater at the time of collection (2017). While naturally occurring sources of arsenic, boron, and lithium are present in the UA as supported by solid phase characterization of background material, the primary source of these constituents, as well as sulfate, in the UA is expected to be the WAPS CCR porewater. The elevated concentrations of sulfate are a major contributor to the exceedance of TDS identified at well 35.

6.2 Potential Attenuation Mechanisms

Arsenic is predicted to exist primarily as the arsenic (V) species $HAsO_4^{2-}$ which has a high affinity for metal (hydr)oxides. Neutral arsenic (III) species $As(OH)_3$ may also be present in the UA, particularly under reducing conditions. Boron is anticipated to largely be present as the neutral H_3BO_3 species, as groundwater pH values are below the pK_a for boric acid (9.2 SU). The presence of iron oxides in aquifer solids (Table 4) suggests that a portion of the arsenic, boron, lithium, and/or sulfate in the groundwater could be attenuated via surface (inner- and outer-sphere) complexation reactions. Aluminum and manganese oxyhydroxides, clay minerals, and calcite (Table 4) in the aquifer solids may also serve as sorption sites for arsenic, boron, lithium, and/or sulfate (Goldberg 1997, Sokolova and Alekseeva 2008, Robinson et al. 2018, Rahman et al. 2019, Nguyen et al. 2021, Elbana and Osman 2023). This suggests that attenuation of these constituents via sorption mechanisms is possible, though it will be dependent on speciation, redox conditions, and pH in the UA. In addition, bioremediation of sulfate (via microbial sulfate reduction) may naturally occur in the UA under reducing conditions. Attenuation of sulfate will likely contribute to a reduction of TDS in the groundwater.

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TABLES

Table 1 - Total Organic Carbon, Loss on Ignition, Sulfate, and Sulfide in Aquifer Solids *Geosyntec Consultants, Inc.*
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Field Boring Location	SB-22		SB-34	SB-51
Sample Depth (ft bgs)	26-27	29-30	32-33	42-43
Location	Downgradient		Background	Downgradient
Sample Collection Date	4-Mar-21	4-Mar-21	4-Mar-21	4-Mar-21
Field Boring Description	Fine sand	Gravel with sand and trace clay	Fine-medium sand	Silty clay with trace sand
TOC %	0.34	4.6	1.9	3.6
LOI %	11.6	15.3	13.3	21.5
Sulfate (%)	< 0.1	< 0.1	< 0.1	< 0.1
Sulfide (%)	< 0.04	0.06	0.09	0.18

Notes
Sample depth is shown in feet below ground surface (ft bgs)
TOC - total organic carbon
LOI - loss on ignition
Non-detects are shown as less than the reporting limit.

Table 2 - Bulk Characterization of Aquifer Solids
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Field Boring Location	SB-22		SB-34	SB-51
Sample Depth (ft bgs)	26-27	29-30	32-33	42-43
Location	Downgradient		Background	Downgradient
Sample Collection Date	4-Mar-21	4-Mar-21	4-Mar-21	4-Mar-21
Field Boring Description	Fine sand	Gravel with sand and trace clay	Fine-medium sand	Silty clay with trace sand
Aluminum	2800	3700	5000	8200
Antimony	< 0.8	< 0.8	< 0.8	< 0.8
Arsenic	5.1	8.4	2.7	3.5
Barium	20	31	47	84
Beryllium	0.20	0.87	0.29	0.50
Bismuth	0.13	0.26	0.23	0.59
Boron	6	7	5	10
Cadmium	0.76	2.9	0.53	0.89
Calcium	56000	36000	52000	91000
Chromium	79	130	45	27
Cobalt	5.2	9.8	6.9	9.3
Copper	11	25	8	14
Iron	9400	12000	10000	14000
Lead	7.7	28	6.1	11
Lithium	4	6	6	12
Magnesium	21000	16000	13000	15000
Manganese	310	220	260	350
Molybdenum	3.1	5.0	0.9	2.0
Nickel	15	43	12	19
Potassium	910	1200	1200	1900
Phosphorous	350	330	380	430
Selenium	< 0.7	0.8	< 0.7	1.1
Silicon	5400	1600	7200	4500
Silver	< 0.05	0.08	< 0.05	0.06
Sodium	190	160	180	170
Thallium	0.13	0.26	0.16	0.25
Tin	< 0.5	0.5	1.1	0.6
Tungsten	0.07	0.10	0.06	0.05
Uranium	1.3	1.8	0.65	1.2
Vanadium	17	41	12	18
Yttrium	6.1	7.6	5.7	8.0
Zinc	46	91	40	67

Notes
Sample depth is shown in feet below ground surface (ft bgs)
All results are shown in µg/g (microgram per gram).
Total metals samples prepared via method SW 3050 and analyzed via USEPA method 6020A.
Non-detect results are shown as less than the reporting limit.

Table 3 - SEP Analysis of Aquifer Solids
Geochemical Conceptual Site Model
Hennepin West Ash pond System, Illinois

Field Boring Location			**SB-22**				**SB-34**		**SB-51**	
Sample Depth (ft bgs)			**26-27**		**29-30**		**32-33**		**42-43**	
Location			**Downgradient**				**Background**		**Downgradient**	
Sample Collection Date			**4-Mar-21**		**4-Mar-21**		**4-Mar-21**		**4-Mar-21**	
Field Boring Description			**Fine sand**		**Gravel with sand and trace clay**		**Fine-medium sand**		**Silty clay with trace sand**	
Fraction	**Reagent**	**Arsenic SEP**	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total
1	Deionized Water	Water Soluble Metals	< 0.5	-	< 0.5	-	< 0.5	-	< 0.5	-
2	$MgCl_2$	Exchangeable Metals	< 0.5	-	< 0.5	-	< 0.5	-	< 0.5	-
3	Sodium acetate, acetic acid	Metals Bound to Carbonates	< 0.5	-	< 0.5	-	< 0.5	-	< 0.5	-
4	Hydroxylamine HCl and acetic acid	Metals Bound to Fe and Mn Oxides	< 0.5	-	< 0.5	-	0.8	29.6%	0.9	25.0%
5	HNO_3, H_2O_2, and ammonium acetate	Bound to Organic Material	< 0.5	-	< 0.5	-	< 0.5	-	< 0.5	-
6	HNO_3, HCl, and HF	Residual Metals	3.9	100%	6.6	100%	1.9	70.4%	2.7	75.0%
SEP Total			**3.9**	-	**6.6**	**-**	**2.7**	**-**	**3.6**	-
Fraction	**Reagent**	**Boron SEP**	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total
1	Deionized Water	Water Soluble Metals	< 1	-	1	4.5%	< 1	-	1	3.3%
2	$MgCl_2$	Exchangeable Metals	< 1	-	< 1	-	< 1	-	< 1	-
3	Sodium acetate, acetic acid	Metals Bound to Carbonates	< 1	-	1	4.5%	< 1	-	< 1	-
4	Hydroxylamine HCl and acetic acid	Metals Bound to Fe and Mn Oxides	2	16.7%	2	9.1%	1	7.1%	2	6.7%
5	HNO_3, H_2O_2, and ammonium acetate	Bound to Organic Material	< 1	-	< 1	-	< 1	-	1	3.3%
6	HNO_3, HCl, and HF	Residual Metals	10	83.3%	18	81.8%	13	92.9%	26	86.7%
SEP Total			**12**	-	**22**	**-**	**14**	**-**	**30**	-
Fraction	**Reagent**	**Lithium SEP**	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total
1	Deionized Water	Water Soluble Metals	< 2	-	< 2	-	< 2	-	< 2	-
2	$MgCl_2$	Exchangeable Metals	< 2	-	< 2	-	< 2	-	< 2	-
3	Sodium acetate, acetic acid	Metals Bound to Carbonates	< 2	-	< 2	-	< 2	-	< 2	-
4	Hydroxylamine HCl and acetic acid	Metals Bound to Fe and Mn Oxides	< 2	-	< 2	-	< 2	-	< 2	-
5	HNO_3, H_2O_2, and ammonium acetate	Bound to Organic Material	< 2	-	< 2	-	< 2	-	< 2	-
6	HNO_3, HCl, and HF	Residual Metals	5	100%	13	100%	11	100%	18	100%
SEP Total			**5**	-	**13**	**-**	**11**	**-**	**18**	-

Table 3 - SEP Analysis of Aquifer Solids
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Field Boring Location			SB-22		SB-22		SB-34		SB-51	
Sample Depth (ft bgs)			26-27		29-30		32-33		42-43	
Location			Downgradient		Downgradient		Background		Downgradient	
Sample Collection Date			4-Mar-21		4-Mar-21		4-Mar-21		4-Mar-21	
Field Boring Description			Fine sand		Gravel with sand and trace clay		Fine-medium sand		Silty clay with trace sand	
Fraction	**Reagent**	**Aluminum SEP**	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total
1	Deionized Water	Water Soluble Metals	32	0.2%	310	1.7%	120	0.5%	140	0.6%
2	$MgCl_2$	Exchangeable Metals	<1	-	3	0.0%	3	0.0%	4	0.0%
3	Sodium acetate, acetic acid	Metals Bound to Carbonates	28	0.2%	6	0.0%	5	0.0%	2	0.0%
4	Hydroxylamine HCl and acetic acid	Metals Bound to Fe and Mn Oxides	270	1.9%	230	1.3%	270	1.2%	320	1.3%
5	HNO_3, H_2O_2, and ammonium acetate	Bound to Organic Material	150	1.0%	630	3.5%	77	0.3%	120	0.5%
6	HNO_3, HCl, and HF	Residual Metals	14,000	96.7%	17,000	93.5%	22,000	97.9%	24,000	97.6%
SEP Total			**14,480**	-	**18,179**	-	**22,475**	-	**24,586**	-
Fraction	**Reagent**	**Iron SEP**	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total
1	Deionized Water	Water Soluble Metals	22	0.2%	310	2.5%	72	0.6%	68	0.4%
2	$MgCl_2$	Exchangeable Metals	< 1	-	2	0.0%	5	0.0%	6	0.0%
3	Sodium acetate, acetic acid	Metals Bound to Carbonates	41	0.4%	32	0.3%	8	0.1%	4	0.0%
4	Hydroxylamine HCl and acetic acid	Metals Bound to Fe and Mn Oxides	1,600	15.7%	1,100	8.8%	3,100	25.5%	2,500	14.9%
5	HNO_3, H_2O_2, and ammonium acetate	Bound to Organic Material	34	0.3%	1,100	8.8%	170	1.4%	180	1.1%
6	HNO_3, HCl, and HF	Residual Metals	8,500	83.4%	10,000	79.7%	8,800	72.4%	14,000	83.5%
SEP Total			**10,197**	-	**12,544**	-	**12,155**	-	**16,758**	-
Fraction	**Reagent**	**Manganese SEP**	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total	µg/g	% of Total
1	Deionized Water	Water Soluble Metals	0.5	0.2%	4.0	1.8%	1.4	0.5%	1.3	0.4%
2	$MgCl_2$	Exchangeable Metals	1.5	0.5%	17	7.7%	6.5	2.4%	8.5	2.4%
3	Sodium acetate, acetic acid	Metals Bound to Carbonates	140	47.4%	69	31.4%	78	29.0%	74	20.8%
4	Hydroxylamine HCl and acetic acid	Metals Bound to Fe and Mn Oxides	90	30.5%	65	29.5%	110	40.9%	170	47.7%
5	HNO_3, H_2O_2, and ammonium acetate	Bound to Organic Material	3.5	1.2%	11	5.0%	5.1	1.9%	7.5	2.1%
6	HNO_3, HCl, and HF	Residual Metals	60	20.3%	54	24.5%	68	25.3%	95	26.7%
SEP Total			**296**	-	**220**	-	**269**	-	**356**	-

Notes
Sample depth is shown in feet below ground surface (ft bgs)
Non-detect values are shown as less than the detection limit
SEP - sequential extraction procedure
µg/g - microgram per gram

Table 4 - XRD Analysis of Aquifer Solids
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Field Boring Location			SB-22		SB-34	SB-51
Sample Depth (ft bgs)			26-27	29-30	32-33	42-43
Location			Downgradient		Background	Downgradient
Sample Collection Date			4-Mar-21	4-Mar-21	4-Mar-21	4-Mar-21
Field Boring Description			Fine sand	Gravel with sand and trace clay	Fine-medium sand	Silty clay with trace sand
Mineral/Compound	**Formula**	**Mineral Type**	**(wt %)**	**(wt %)**	**(wt %)**	**(wt %)**
Quartz	SiO_2	Silicate	57.0	54.5	53.0	33.1
Calcite	$CaCO_3$	Carbonate	7.2	3.3	11.1	20.9
Albite	$NaAlSi_3O_8$	Feldspar	7.3	9.8	7.1	6.6
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	Mica	2.1	7.4	7.9	12.5
Dolomite	$CaMg(CO_3)_2$	Carbonate	14.4	11.4	2.6	5.0
Microcline	$KAlSi_3O_8$	Feldspar	5.2	5.2	5.1	9.8
Ankerite	$CaFe(CO_3)_2$	Carbonate	2.9	2.8	6.0	1.3
Actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$	Amphibole	0.8	ND	ND	ND
Magnetite	Fe_3O_4	Oxide	0.5	0.4	0.4	0.2
Kaolinite	$Al_2Si_2O_5(OH)_4$	Clay	0.6	2.5	3.4	3.4
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$	Clay	1.9	2.7	3.4	6.8
Pyrite	FeS_2	Sulfide	ND	ND	0.2	0.3

Notes
Sample depth is shown in feet below ground surface (ft bgs)
wt % - percentage by weight
ND - not detected in the sample

Table 5 - Porewater Geochemistry Results
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Porewater Well Location		L4	LPZ-1	LPZ-3	LPZ-17
Sample Collection Date		25-Apr-17	25-Apr-17	25-Apr-17	25-Apr-17
Parameter	Units				
pH	SU	7.6	9.1	10	10
Turbidity	NTU	< 1.0	5.6	< 1.0	28
Oxidation Reduction Potential	mV	-149	-177	-87.0	-163
Carbonate Alkalinity	mg/L $CaCO_3$	0	84	52	80
Bicarbonate Alkalinity	mg/L $CaCO_3$	316	0	0	0
Total Dissolved Solids	mg/L	900	1600	768	2090
Sulfate	mg/L	370	926	375	1270
Fluoride	mg/L	0.28	< 0.10	< 0.10	< 0.10
Chloride	mg/L	10	39	7	< 5
Calcium	mg/L	190	370	214	578
Magnesium	mg/L	27	8.5	0.96	1.3
Potassium	mg/L	9.3	46	13	27
Sodium	mg/L	58	65	7.4	16
Arsenic	µg/L	35	31	12	27
Barium	µg/L	51	60	25	92
Boron	mg/L	21	28	22	27
Cadmium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0
Chromium	µg/L	< 1.0	2.1	32	4
Lead	µg/L	< 1.0	1.2	8.9	7.7
Lithium	µg/L	46	109	52	98
Molybdenum	µg/L	78	3400	264	289
Selenium	µg/L	1.4	8.6	112	118

Notes
mg/L - milligram per liter
mV - millivolts
NTU - nephelometric turbidity units
SU - standard units
µg/L - microgram per liter

Table 6 - Eh-pH Diagram Inputs
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Well ID		21R	22
Sample Collection Date		22-Aug-23	25-Aug-23
Input Parameter	**Units**		
pH	SU	7.51	7.67
Arsenic	mg/L	0.0230	0.0002
Bicarbonate Alkalinity	mg/L $CaCO_3$	370	240
Calcium	mg/L	120	23
Chloride	mg/L	95	89
Iron	mg/L	7.90	0.07
Magnesium	mg/L	39	7
Manganese	mg/L	0.14	0.012
Sodium	mg/L	45	12
Sulfate	mg/L	94	120
Temperature	°C	16.6	16.1

Notes
mg/L - milligram per liter
SU - standard units

Table 7 - Total and Dissolved Aqueous Iron and Manganese Results
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Well ID	Well Classification	General Redox Condition	Date	Dissolved Iron (mg/L)	Total Iron (mg/L)	Dissolved Manganese (mg/L)	Total Manganese (mg/L)
50	Downgradient	Oxidizing	31-May-23	< 0.02	0.11	0.18	0.28
			25-Aug-23	< 0.047	0.27	0.27	0.052
22	Downgradient	Oxidizing	31-May-23	< 0.02	0.037	0.034	0.051
			25-Aug-23	< 0.047	0.070	0.036	0.012
22D	Downgradient	Reducing	31-May-23	1.9	2.4	0.065	0.070
			22-Aug-23	2.2	2.3	0.065	0.063
49	Downgradient	Oxidizing	31-May-23	< 0.02	0.91	0.0045	0.57
			25-Aug-23	< 0.047	0.22	0.0044	0.049
35	Downgradient	Oxidizing	31-May-23	< 0.02	0.054	0.57	0.76
			24-Aug-23	< 0.047	< 0.047	0.50	0.52
23	Downgradient	Reducing	31-May-23	0.15	0.21	1.2	1.2
			22-Aug-23	0.14	0.21	1.1	1.1
51	Downgradient	Reducing	31-May-23	6.5	7.8	0.17	0.20
			22-Aug-23	6.1	6.7	0.15	0.15
21R	Downgradient	Reducing	31-May-23	5.6	8.5	0.11	0.16
			22-Aug-23	5.4	7.9	0.11	0.14
27	Downgradient	Reducing	31-May-23	0.26	0.53	0.66	0.68
			24-Aug-23	0.21	0.24	0.66	0.67
32	Background	Oxidizing	31-May-23	< 0.02	0.30	0.050	0.10
			22-Aug-23	< 0.047	0.11	0.092	0.11
34	Background	Reducing	31-May-23	4.9	6.2	1.2	1.1
			25-Aug-23	6.8	6.7	1.3	1.3

Notes
Non-detect values are shown as less than the reporting limit
mg/L - milligrams per liter

Table 8 - Total and Dissolved Organic Carbon Results
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Well ID	Well Classification	General Redox Condition	Date	Dissolved Organic Carbon (mg/L)	Total Organic Carbon (mg/L)
50	Downgradient	Oxidizing	31-May-23	1.8	1.2
			25-Aug-23	1.7	1.4
22	Downgradient	Oxidizing	31-May-23	3.1	3.1
			25-Aug-23	1.5	1.4
22D	Downgradient	Reducing	31-May-23	2.4	2.4
			22-Aug-23	26	0.97
49	Downgradient	Oxidizing	31-May-23	1.6	1.2
			25-Aug-23	1.1	5.1
35	Downgradient	Oxidizing	31-May-23	1.9	8.9
			24-Aug-23	1.4	1.2
23	Downgradient	Reducing	31-May-23	1.6	3.2
			22-Aug-23	6.0	1.0
51	Downgradient	Reducing	31-May-23	1.6	1.5
			22-Aug-23	2.2	2.5
21R	Downgradient	Reducing	31-May-23	2.4	3.3
			22-Aug-23	2.6	1.7
27	Downgradient	Reducing	31-May-23	1.4	1.4
			24-Aug-23	2.1	0.83
32	Background	Oxidizing	31-May-23	1.0	1.0
			22-Aug-23	0.88	0.94
34	Background	Reducing	31-May-23	4.6	4.6
			25-Aug-23	5.3	6.1

Notes
Non-detect values are shown as less than the reporting limit
mg/L - milligrams per liter

Table 9 - Batch Attenuation Results
Geochemical Coneptual Site Model
Hennepin West Ash Pond System, Illinois

Groundwater Sample ID	Geologic Material	Treatment	Date	Day	Replicate	Dissolved Arsenic mg/L	pH SU	ORP mV
MW-51	--	Water Only Control	17-Oct-22	0				
					MW-51-1	0.10	6.90	-149
					MW-51-2	0.093	6.82	-122
					Average Result	**0.10**	**6.9**	**-136**
			24-Oct-22	7	MW-51-1	0.057	6.85	-61
					MW-51-2	0.059	6.89	-55
					Average Result	**0.058**	**6.9**	**-58**
	SB-34 32-33'	2:1 Soil:Water Ratio	17-Oct-22	0				
			24-Oct-22	7	SB-34 32-33':MW-51 2:1-1	0.0040	6.81	-2
					SB-34 32-33':MW-51 2:1-2	0.0030	6.78	6
					Average Result	**0.0035**	**6.8**	**2**
		1:1 Soil:Water Ratio	17-Oct-22	0				
			24-Oct-22	7	SB-34 32-33':MW-51 1:1-1	0.0090	6.79	-278
					SB-34 32-33':MW-51 1:1-2	0.0090	6.77	-179
					Average Result	**0.0090**	**6.8**	**-229**
		1:5 Soil:Water Ratio	17-Oct-22	0				
			24-Oct-22	7	SB-34 32-33':MW-51 1:5-1	0.035	6.84	-9
					SB-34 32-33':MW-51 1:5-2	0.033	6.88	-15
					Average Result	**0.034**	**6.9**	**-12**
		1:10 Soil:Water Ratio	17-Oct-22	0				
			24-Oct-22	7	SB-34 32-33':MW-51 1:10-1	0.025	6.91	-81
					SB-34 32-33':MW-51 1:10-2	0.030	6.85	-11
					Average Result	**0.028**	**6.9**	**-46**
		1:20 Soil:Water Ratio	17-Oct-22	0				
			24-Oct-22	7	SB-34 32-33':MW-51 1:20-1	0.041	6.89	-23
					SB-34 32-33':MW-51 1:20-2	0.044	6.86	-12
					Average Result	**0.043**	**6.9**	**-18**

Notes:
mg/L - milligrams per liter
mV - millivoltes
SU - standard units

Table 10 - Arsenic Partition Coefficients
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Groundwater Sample ID	Geologic Material Sample ID	Analyte	Isotherm	Variable	Value
MW-51	**SB-34 23-33'**	**Arsenic**	Linear	R^2	0.69
				K_d (L/kg)	**36.40**
			Langmuir	R^2	0.90
				q_m (mg/g)	0.004
				K_L (L/kg)	**2.43E+08**
			Freundlich	R^2	0.60
				1/n	0.15
				K_F (L/kg)	**109.5**

Notes

K_d - linear partition coefficient

K_L - Langmuir partition coefficient

K_F - Freundlich partition coefficient

q_m - inverse of the slope of the linearized Langmuir isotherm

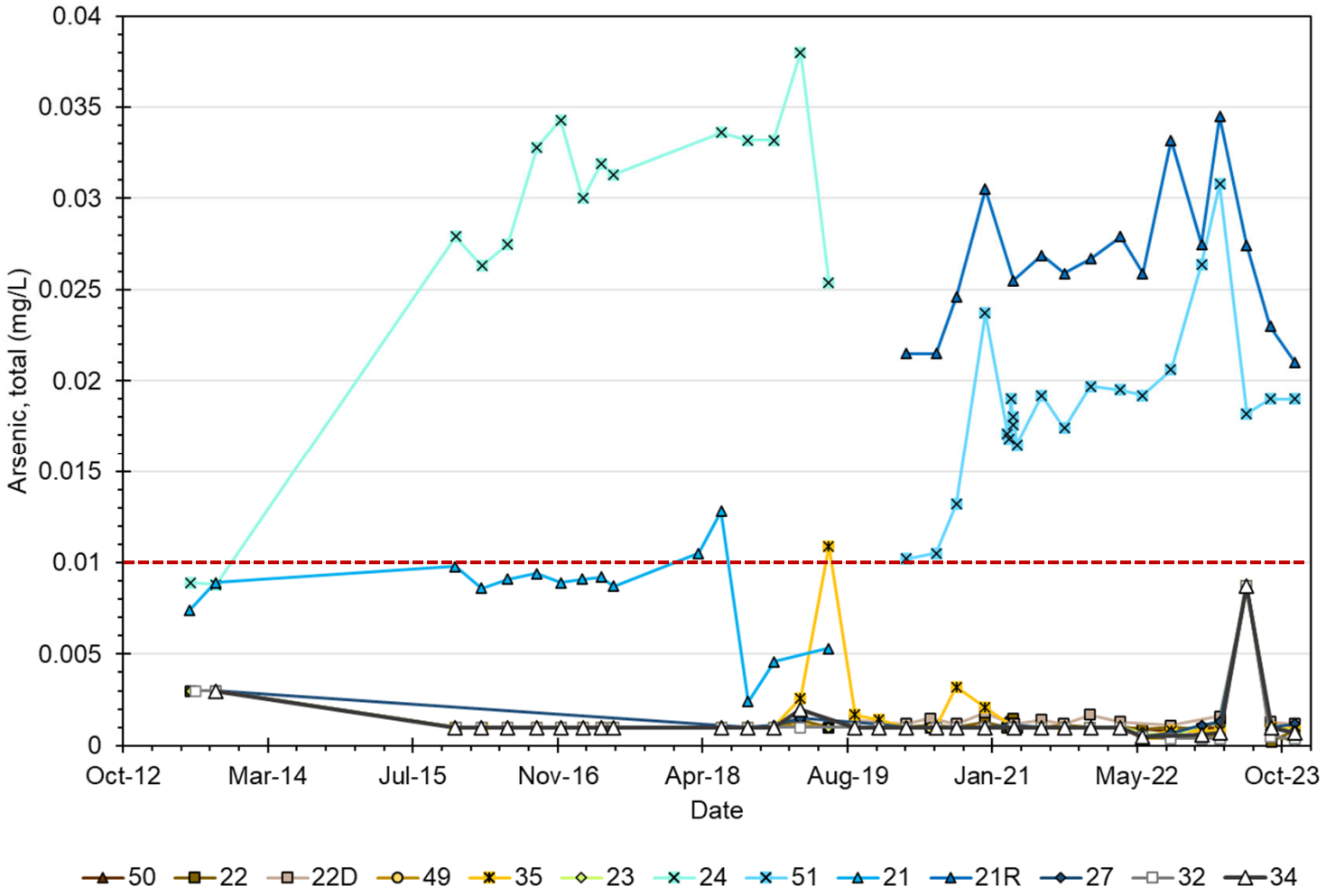
n - non-linearity constant of the Freundlich isotherm

ft bgs - feet below ground surface

L/kg - liters per kilogram

mg/g - milligrams of arsenic per gram of soil

FIGURES



Notes:
1. Wells 21 and 24 were abandoned during closure activities and replaced with 21R and 51, respectively.
2. mg/L: milligrams per liter
3. Red dashed line denotes groundwater protection standard.

Arsenic Concentration Time Series

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Figure 1

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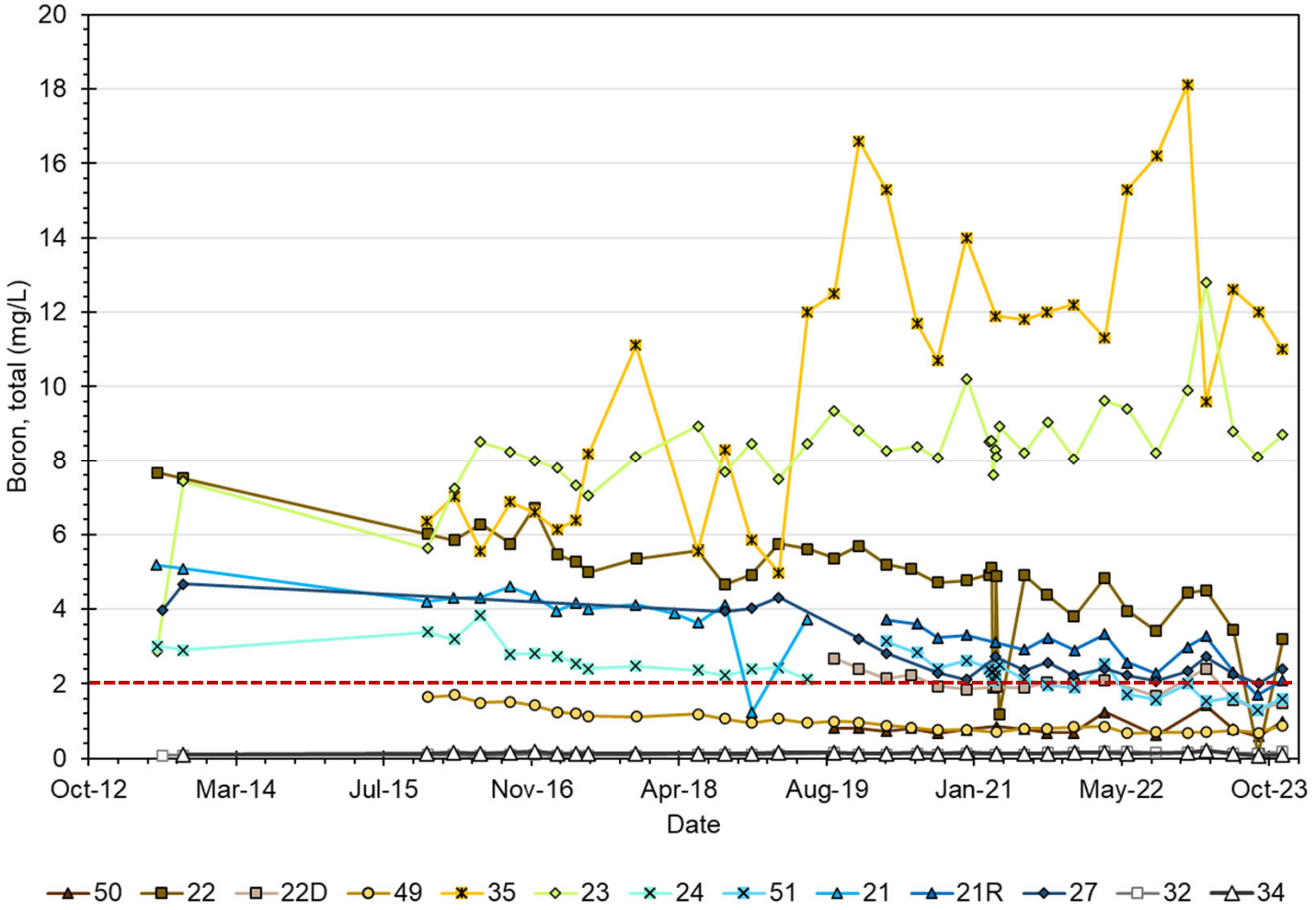

Notes:
1. Wells 21 and 24 were abandoned during closure activities and replaced with 21R and 51, respectively.
2. mg/L: milligrams per liter
3. Red dashed line denotes groundwater protection standard.

Boron Concentration Time Series

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Figure 2

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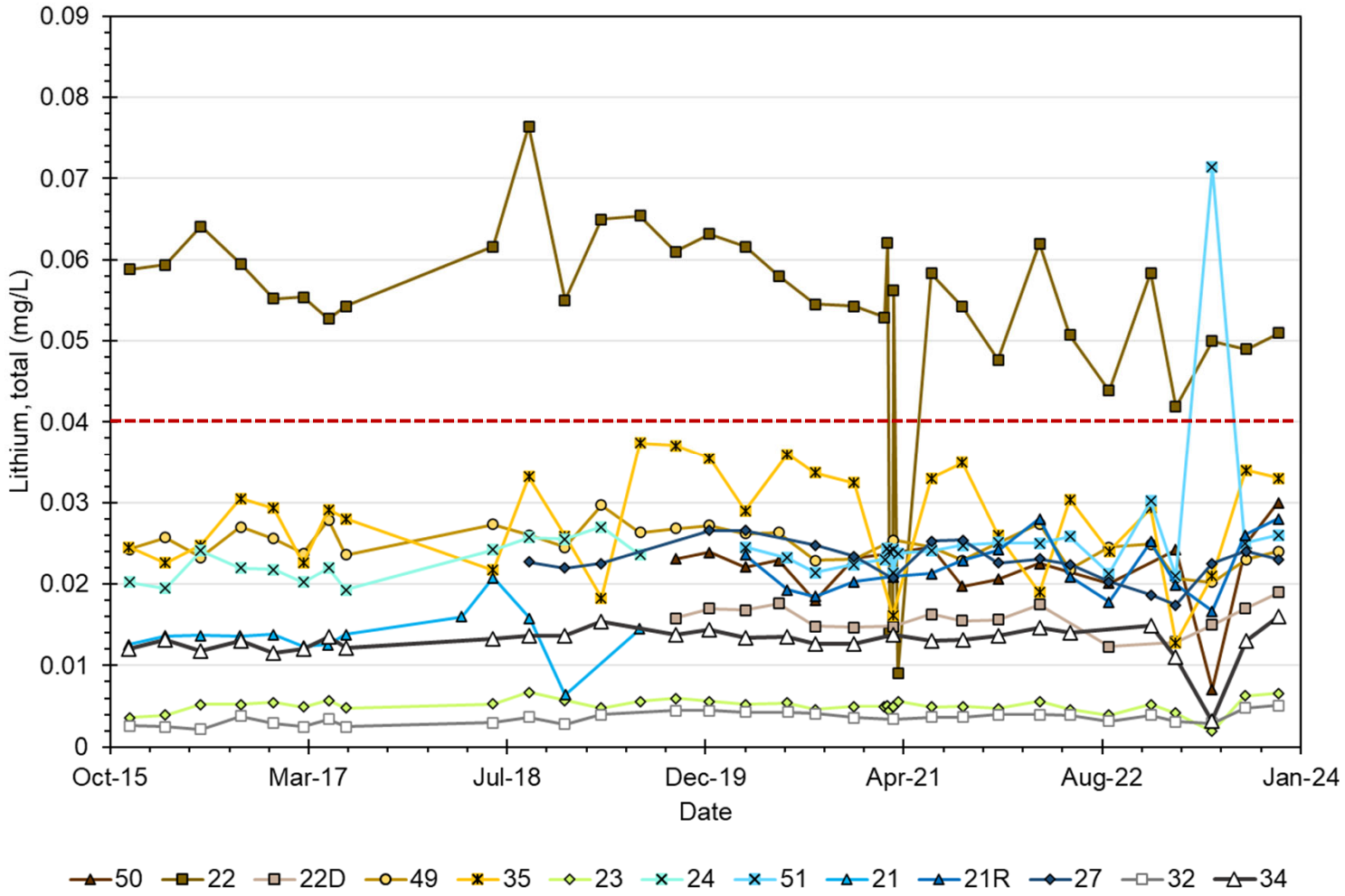

Notes:
1. Wells 21 and 24 were abandoned during closure activities and replaced with 21R and 51, respectively.
2. mg/L: milligrams per liter
3. Red dashed line denotes groundwater protection standard.

Lithium Concentration Time Series

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Figure 3

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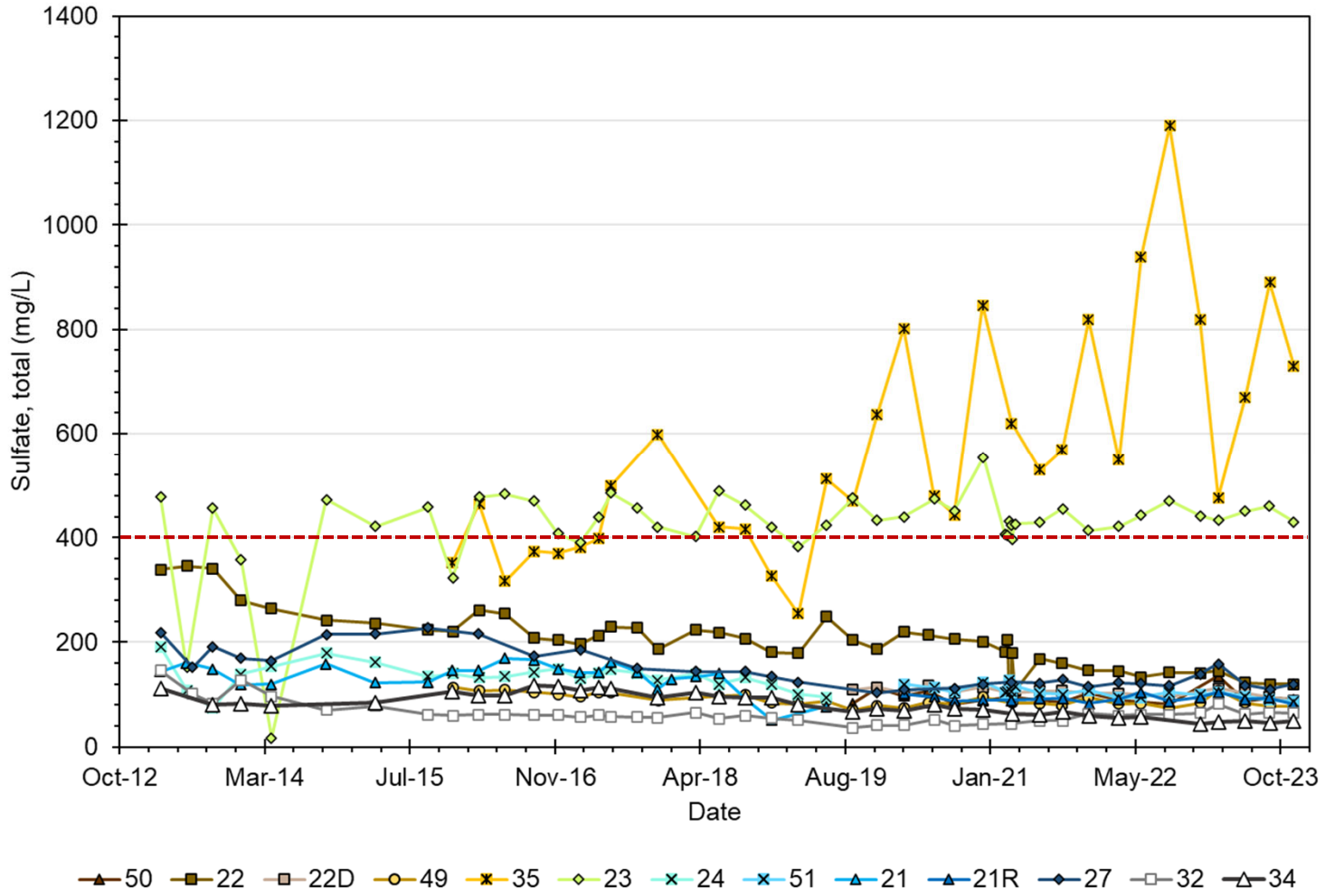

Notes:
1. Wells 21 and 24 were abandoned during closure activities and replaced with 21R and 51, respectively.
2. mg/L: milligrams per liter
3. Red dashed line denotes groundwater protection standard.

Sulfate Concentration Time Series

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Figure 4

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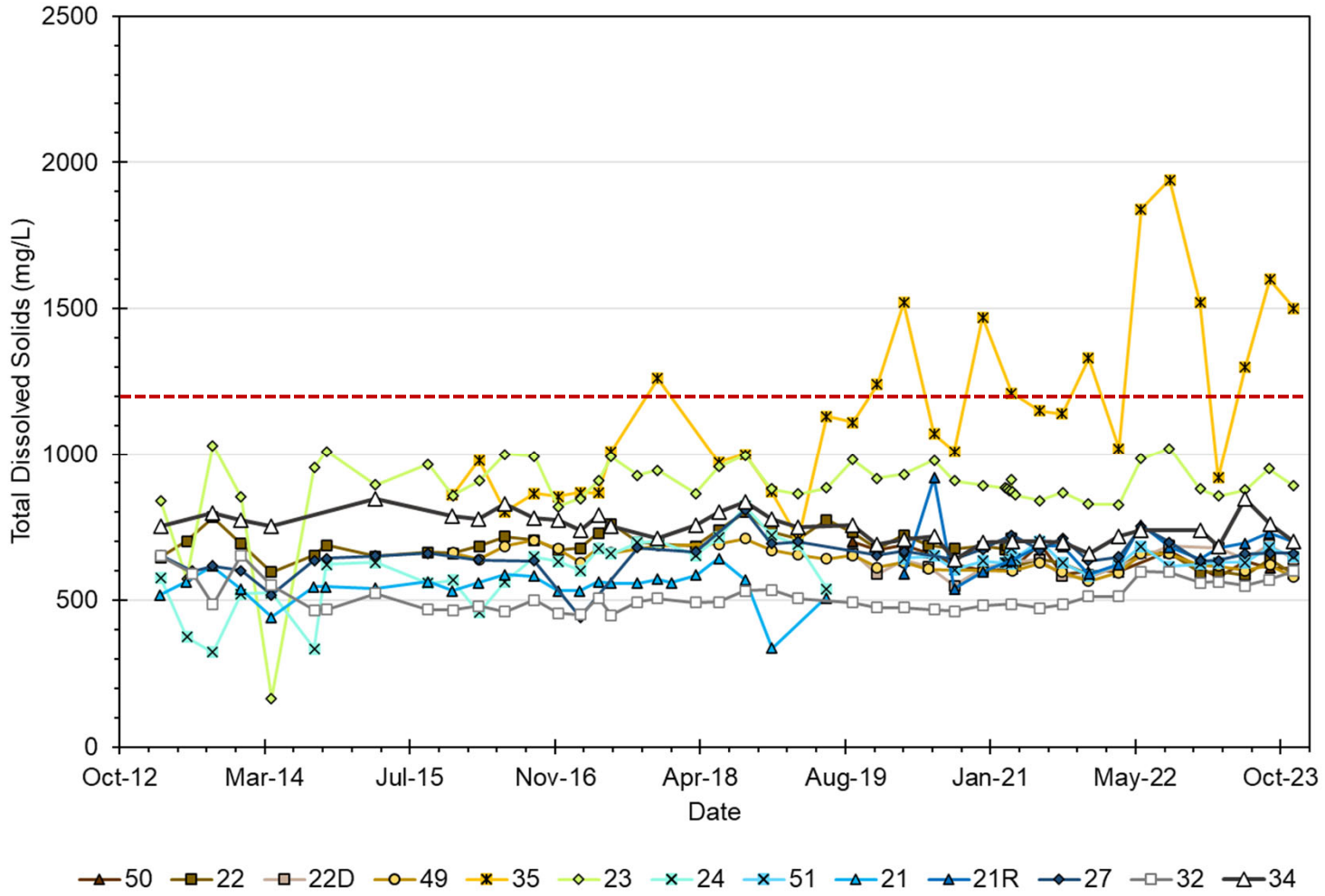

TDS Concentration Time Series

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Figure 5

Notes:
1. Wells 21 and 24 were abandoned during closure activities and replaced with 21R and 51, respectively.
2. mg/L: milligrams per liter
3. Red dashed line denotes groundwater protection standard.

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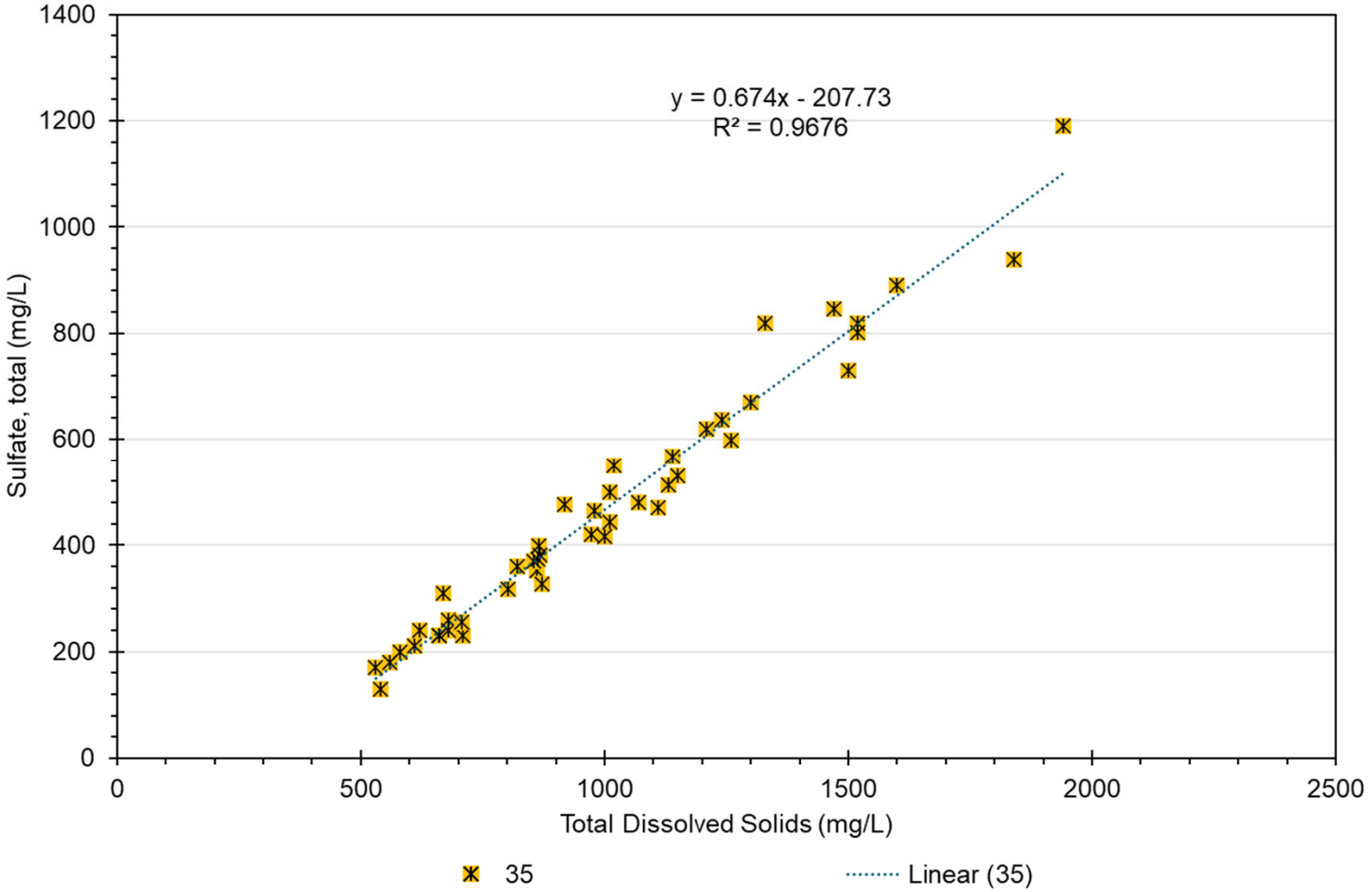

Sulfate and Total Dissolved Solids Correlation, Well 35
Hennepin West Ash Pond System

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Figure 6

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Notes:
1. mg/L: milligrams per liter

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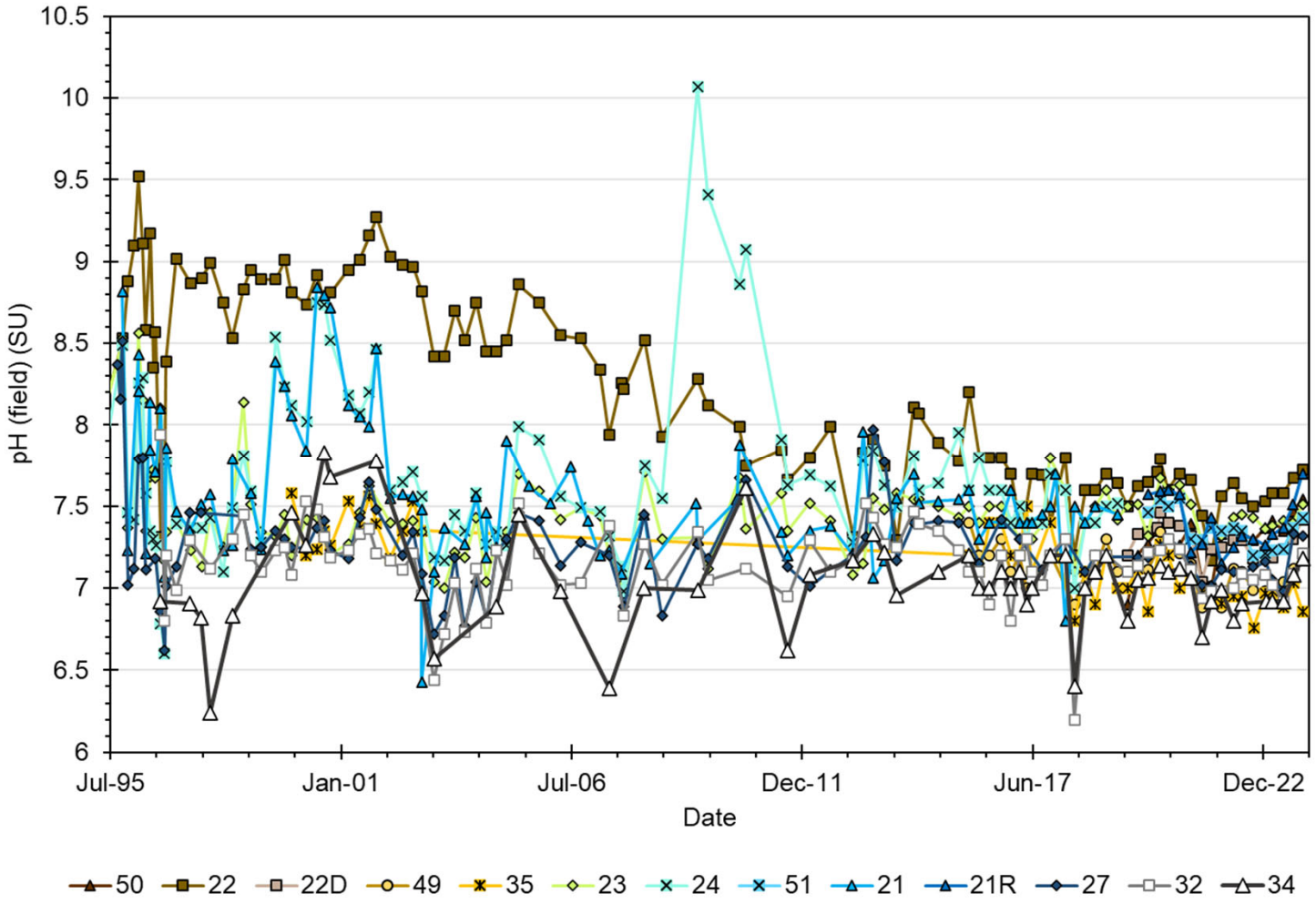

Notes:
1. Wells 21 and 24 were abandoned during closure activities and replaced with 21R and 51, respectively.
2. SU: standard units

pH Time Series

Hennepin West Ash Pond System

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Figure 7

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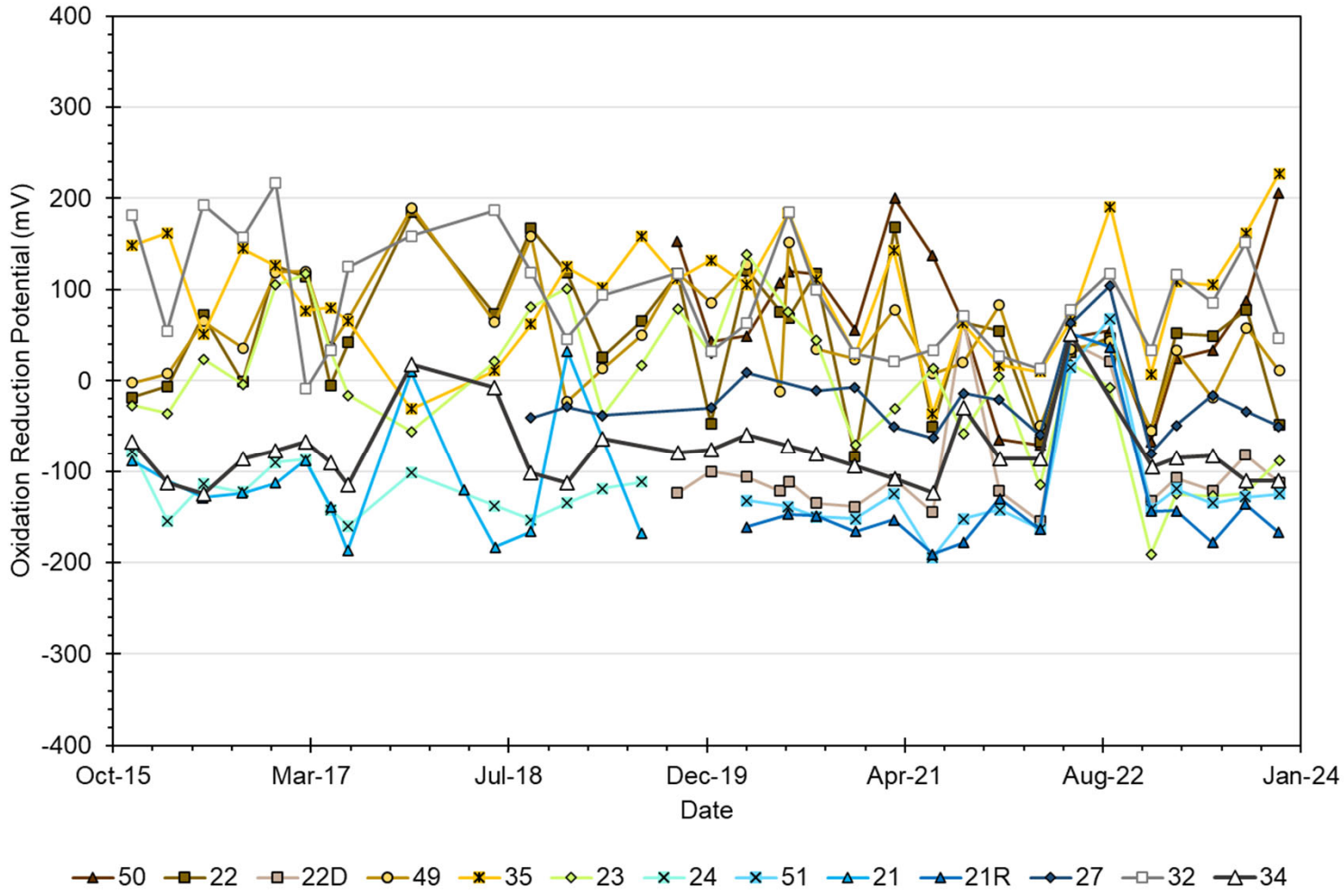

Notes:
1. Wells 21 and 24 were abandoned during closure activities and replaced with 21R and 51, respectively.
2. mV: millivolts

ORP Time Series

Hennepin West Ash Pond System

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Figure 8

Geosyntec\Vistra - Groundwater Compliance - Documents\General\GCSM\Hennepin

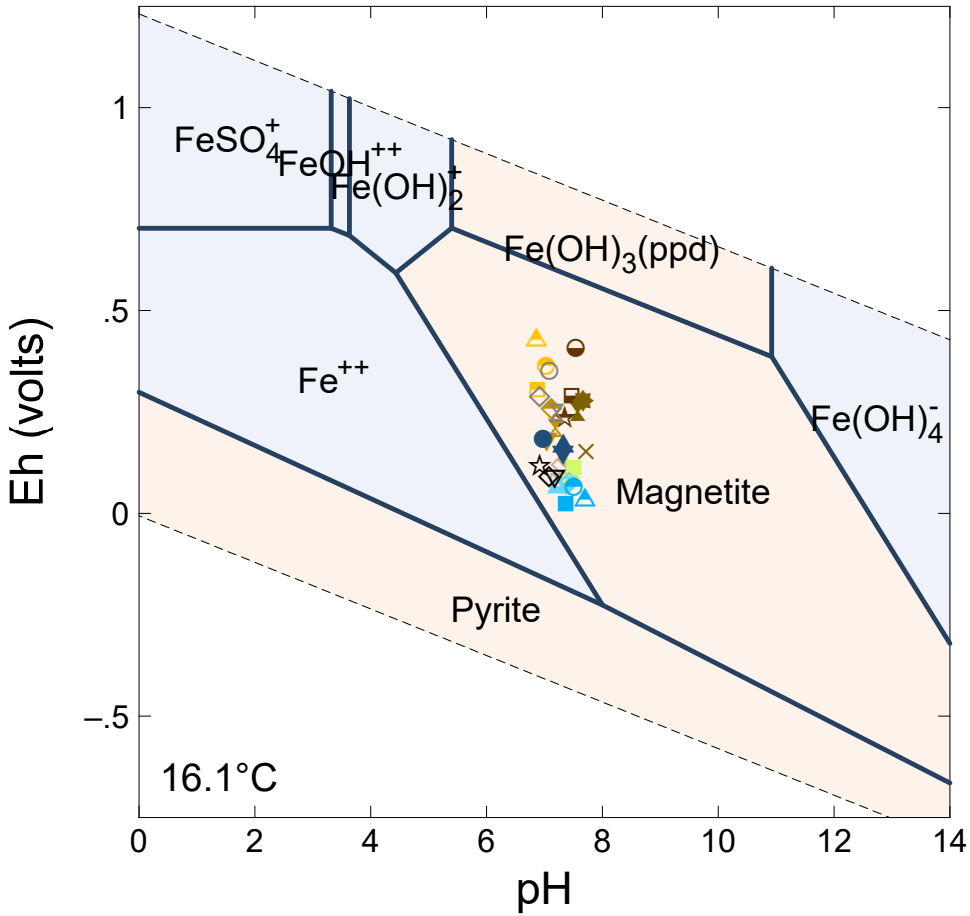

Diagram Fe^{++}, T = 16.1 °C, P = 1.013 bars, a [main] = $10^{-6.131}$, a [H_2O] = 1, a [Cl^-] = $10^{-2.64}$, a [Ca^{++}] = $10^{-3.47}$, a [HCO_3^-] = $10^{-2.357}$, a [Mg^{++}] = $10^{-3.736}$, a [Na^+] = $10^{-3.325}$, a [SO_4^{--}] = $10^{-3.093}$, a [Mn^{++}] = $10^{-6.89}$; Suppressed: $FeHSO_4^{++}$, Ferrite−2−Ca, Ferrite-Ca, Ferrite-Mg, Goethite, Hematite

- 50_2023/05/31
- 50_2023/08/25
- 50_2023/11/14
- 22_2023/05/31
- 22_2023/08/25
- 22_2023/11/15
- 22D_2023/05/31
- 22D_2023/08/22
- 22D_2023/11/15
- 49_2023/05/31
- 49_2023/08/25
- 49_2023/11/15
- 35_2022/05/31
- 35_2023/08/24
- 35_2023/11/15
- 23_2023/05/31
- 23_2023/08/22
- 23_2023/11/15
- 51_2023/05/31
- 51_2023/08/22
- 51_2023/11/15
- 21R_2022/05/31
- 21R_2023/08/22
- 21R_2023/11/14
- 27_2022/05/31
- 27_2023/08/24
- 27_2023/11/14
- 32_2022/05/31
- 32_2023/08/22
- 32_2023/11/14
- 34_2023/05/31
- 34_2023/08/25
- 34_2023/11/14

Notes:
1. Diagram generated using conditions at well 22 on August 25, 2023 to represent iron stability under more oxidizing conditions.
2. Crystalline phases ferrite-Ca, ferrite-Mg, goethite, and hematite are suppressed.

Iron Pourbaix Diagram, Magnetite - 22

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Figure 9a

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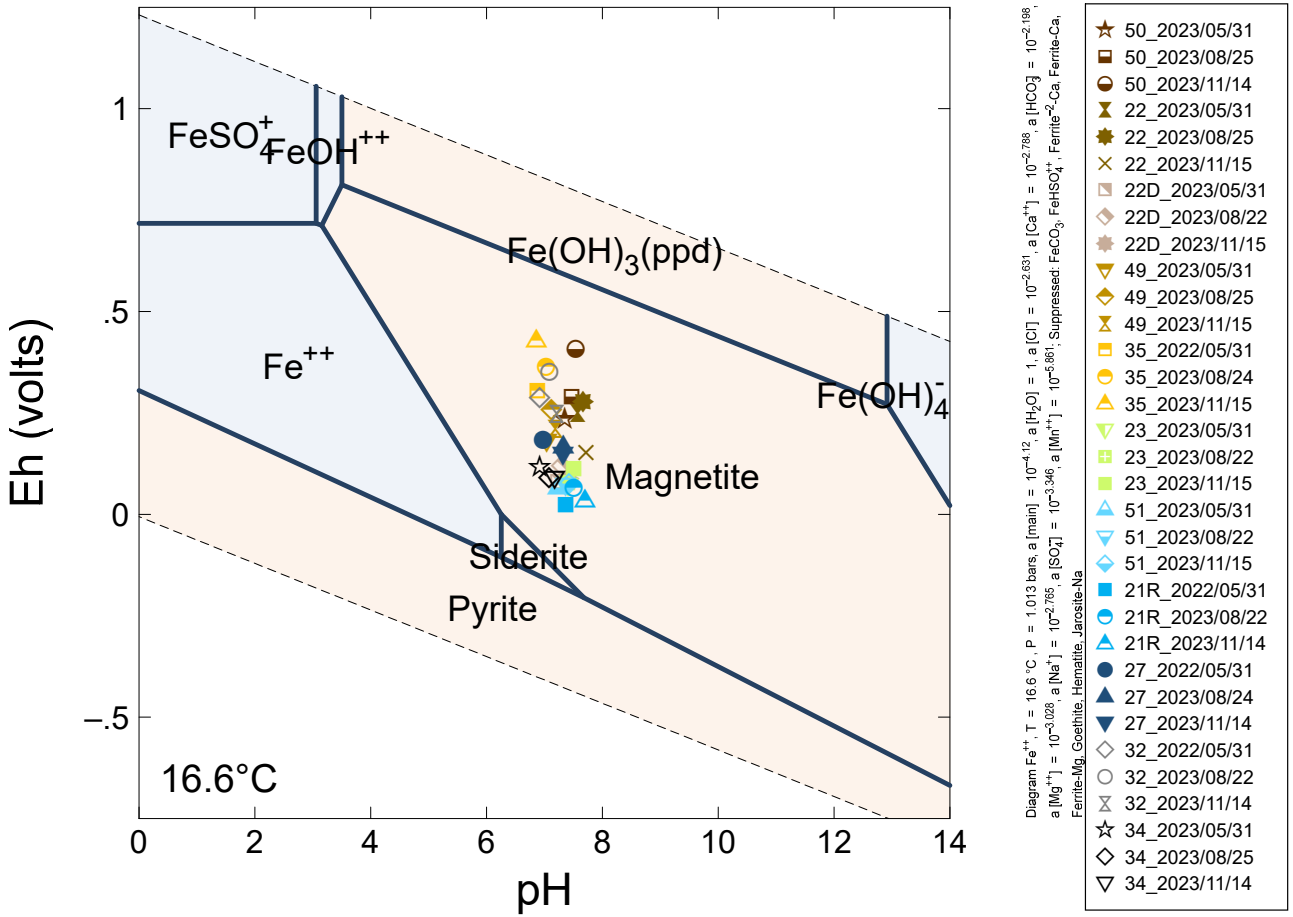

Notes:
1. Diagram generated using conditions at well 21R on August 22, 2023 to represent iron stability under more reducing conditions.
2. Crystalline phases ferrite-Ca, ferrite-Mg, goethite, hematite, and jarosite-Na are suppressed.

Iron Pourbaix Diagram, Magnetite – 21R

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Figure 9b

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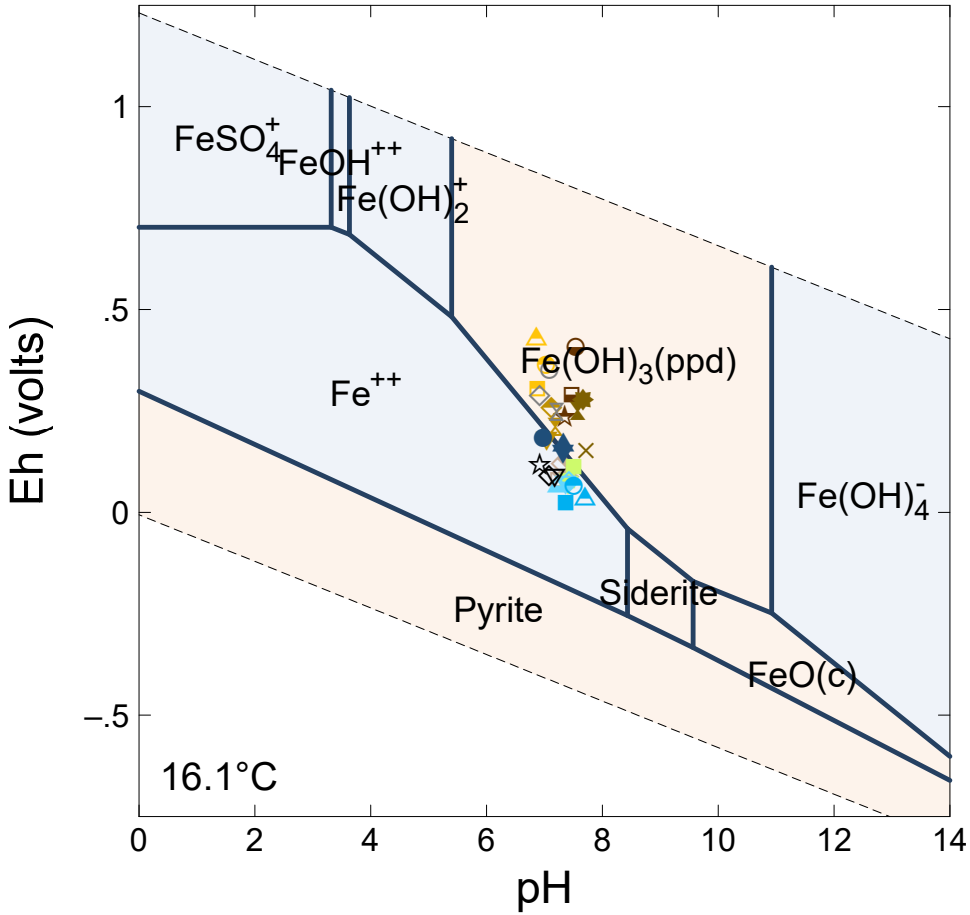


Diagram Fe^{++}, T = 16.1 °C, P = 1.013 bars, a [main] = $10^{-6.131}$, a [H_2O] = 1, a [Cl^-] = $10^{-2.64}$, a [Ca^{++}] = $10^{-3.47}$, a [HCO_3^-] = $10^{-2.357}$, a [Mg^{++}] = $10^{-3.736}$, a [Na^+] = $10^{-3.325}$, a [SO_4^{--}] = $10^{-3.093}$, a [Mn^{++}] = $10^{-6.89}$; Suppressed: $FeHSO_4^{++}$, Ferrite-2-Ca, Ferrite-Ca, Ferrite-Mg, Goethite, Hematite, Magnetite

- 50_2023/05/31
- 50_2023/08/25
- 50_2023/11/14
- 22_2023/05/31
- 22_2023/08/25
- 22_2023/11/15
- 22D_2023/05/31
- 22D_2023/08/22
- 22D_2023/11/15
- 49_2023/05/31
- 49_2023/08/25
- 49_2023/11/15
- 35_2022/05/31
- 35_2023/08/24
- 35_2023/11/15
- 23_2023/05/31
- 23_2023/08/22
- 23_2023/11/15
- 51_2023/05/31
- 51_2023/08/22
- 51_2023/11/15
- 21R_2022/05/31
- 21R_2023/08/22
- 21R_2023/11/14
- 27_2022/05/31
- 27_2023/08/24
- 27_2023/11/14
- 32_2022/05/31
- 32_2023/08/22
- 32_2023/11/14
- 34_2023/05/31
- 34_2023/08/25
- 34_2023/11/14

Notes:
1. Diagram generated using conditions at well 22 on August 25, 2023 to represent iron stability under more oxidizing conditions.
2. Crystalline iron phases ferrite-Ca, ferrite-Mg, goethite, hematite, and magnetite are suppressed.

Iron Pourbaix Diagram, Ferrihydrite - 22

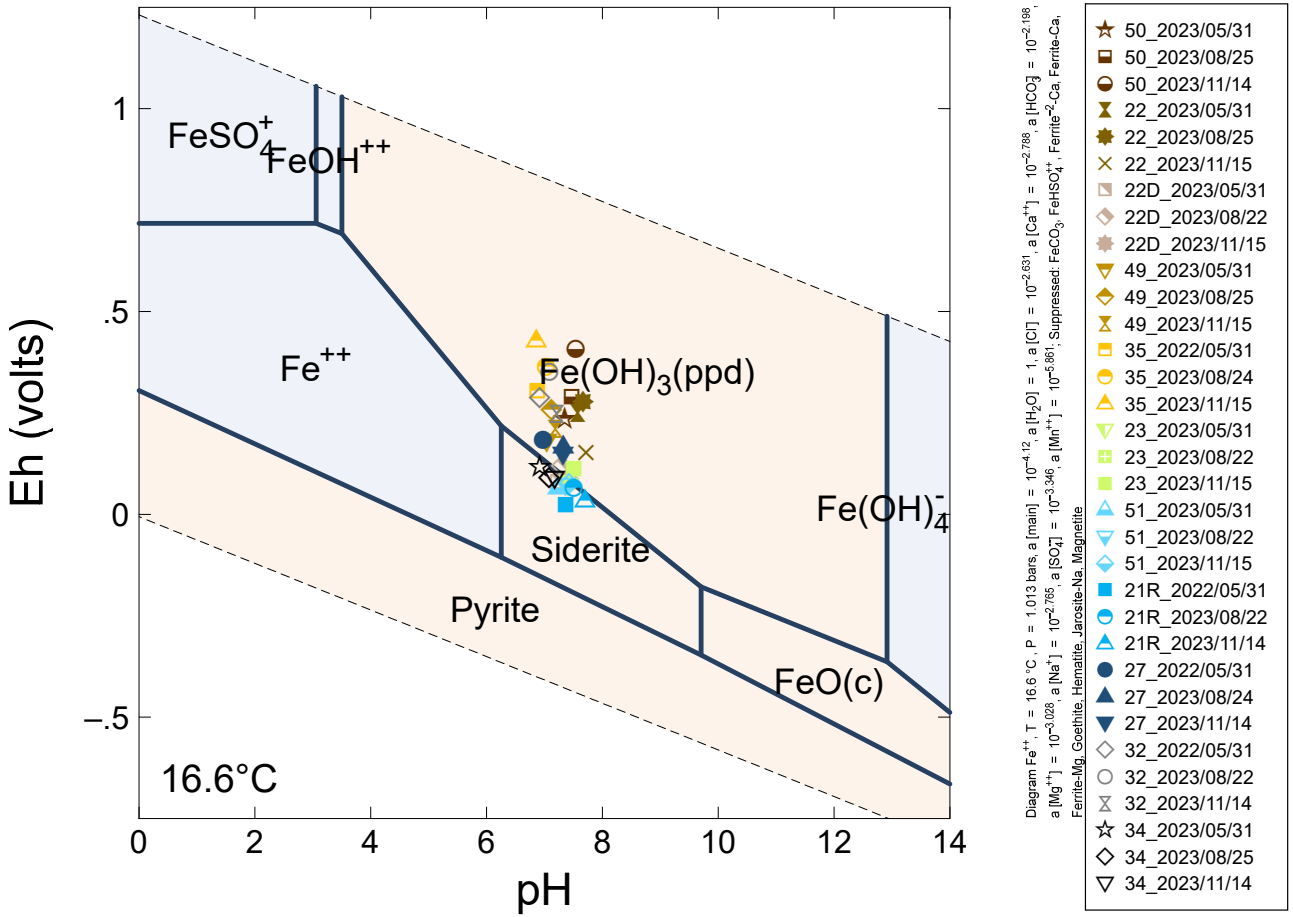
Hennepin West Ash Pond System

Geosyntec consultants

Chicago, Illinois | April 2024

Figure 9c

Geosyntec\Vistra - Groundwater Compliance - Documents\General\GCSM\Hennepin



Notes:
1. Diagram generated using conditions at well 21R on August 22, 2023 to represent iron stability under more reducing conditions.
2. Crystalline phases ferrite-Ca, ferrite-Mg, goethite, hematite, magnetite, and jarosite-Na are suppressed.

Iron Pourbaix Diagram, Ferrihydrite – 21R

Hennepin West Ash Pond System

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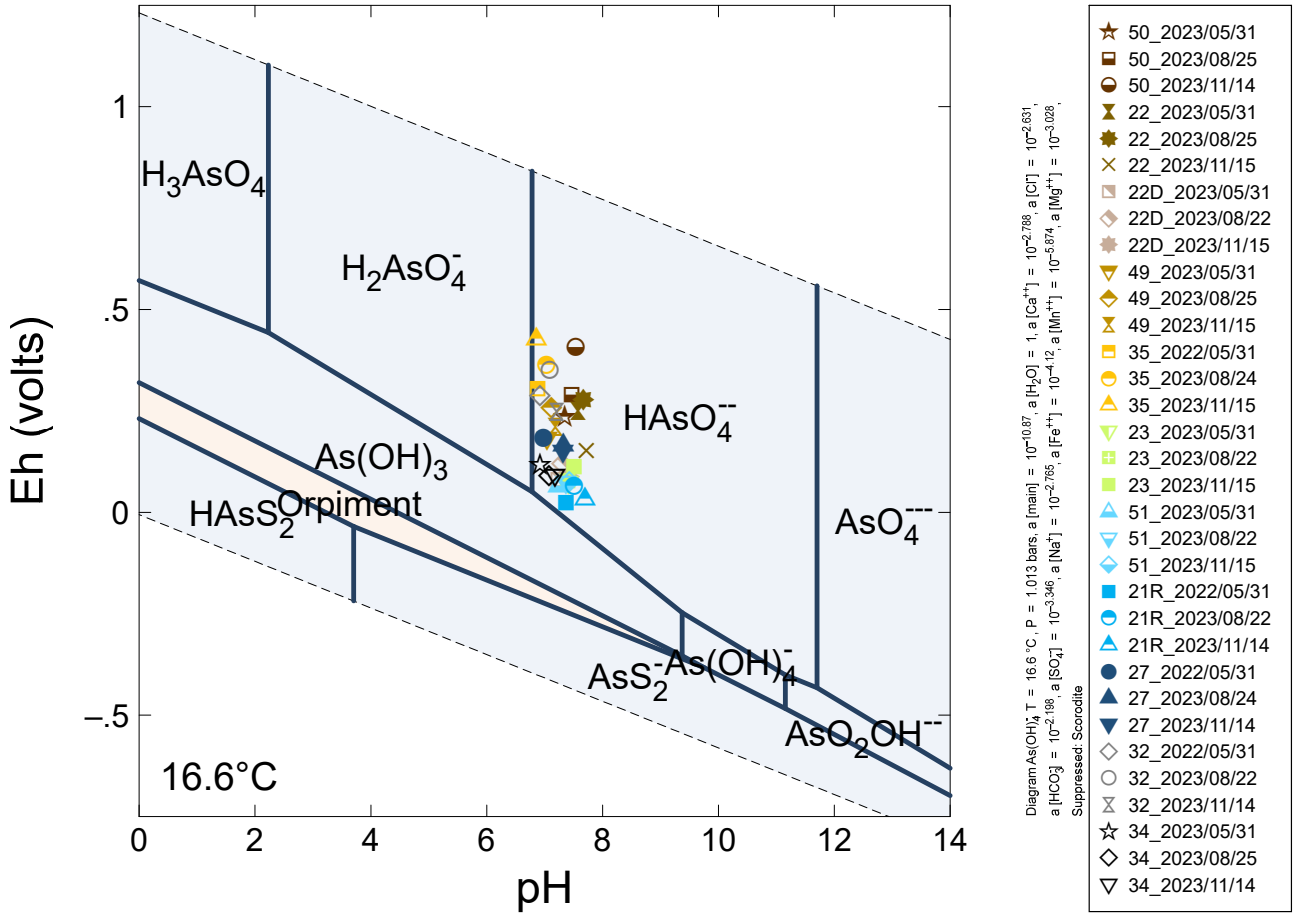
Figure 9d

Chicago, Illinois | April 2024

Geosyntec\Vistra - Groundwater Compliance - Documents\General\GCSM\Hennepin



Notes:
1. Diagram generated using conditions at well 21R on August 22, 2023 to represent arsenic stability under more reducing conditions.
2. Crystalline phase scorodite is suppressed.

Arsenic Pourbaix Diagram - 21R

Hennepin West Ash Pond System

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Figure 10

Chicago, Illinois | April 2024

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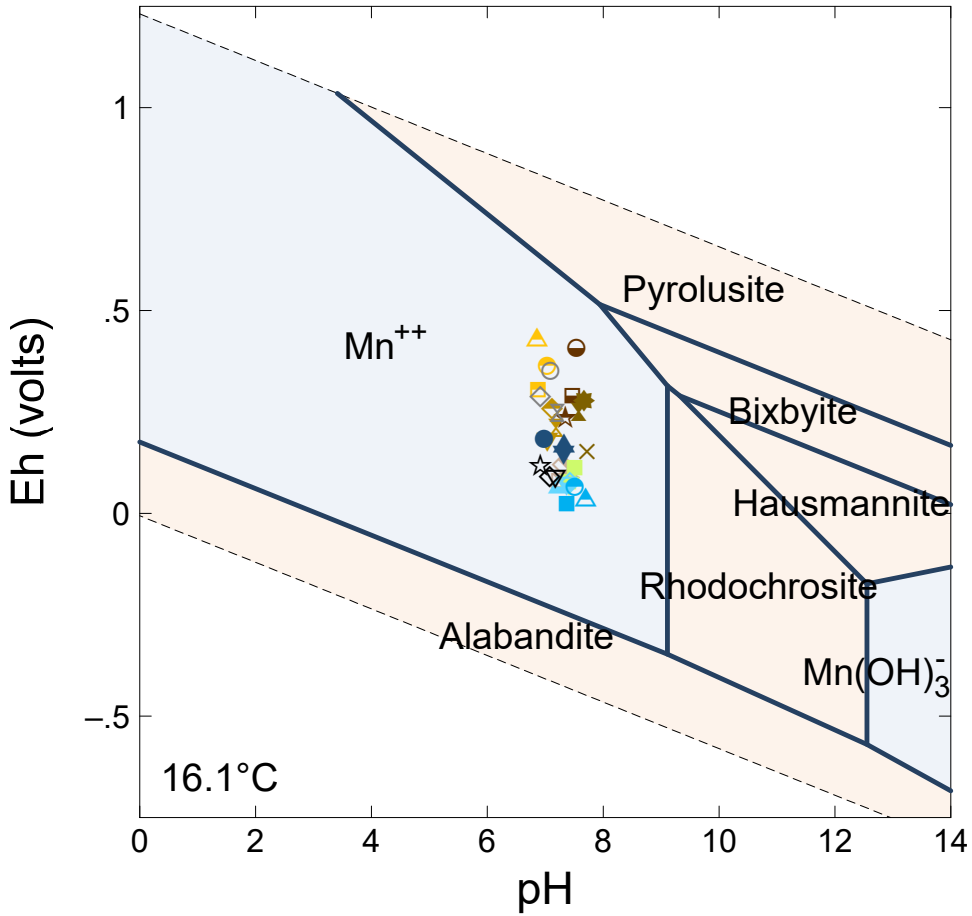


Diagram Mn^{++}, T = 16.1 °C, P = 1.013 bars, a [main] = $10^{-6.89}$, a [H_2O] = 1, a [Cl⁻] = $10^{-2.64}$, a [Ca^{++}] = $10^{-3.47}$, a [HCO_3^-] = $10^{-2.357}$, a [Mg^{++}] = $10^{-3.736}$, a [Na^+] = $10^{-3.325}$, a [SO_4^{--}] = $10^{-3.093}$, a [Fe^{++}] = $10^{-6.131}$; Suppressed: $FeHSO_4^+$, Ferrite-$^{-2}$Ca, Ferrite-Ca, Ferrite-Mg, Goethite, Hematite, $Mn_2(OH)_3^+$

- 50_2023/05/31
- 50_2023/08/25
- 50_2023/11/14
- 22_2023/05/31
- 22_2023/08/25
- 22_2023/11/15
- 22D_2023/05/31
- 22D_2023/08/22
- 22D_2023/11/15
- 49_2023/05/31
- 49_2023/08/25
- 49_2023/11/15
- 35_2022/05/31
- 35_2023/08/24
- 35_2023/11/15
- 23_2023/05/31
- 23_2023/08/22
- 23_2023/11/15
- 51_2023/05/31
- 51_2023/08/22
- 51_2023/11/15
- 21R_2022/05/31
- 21R_2023/08/22
- 21R_2023/11/14
- 27_2022/05/31
- 27_2023/08/24
- 27_2023/11/14
- 32_2022/05/31
- 32_2023/08/22
- 32_2023/11/14
- 34_2023/05/31
- 34_2023/08/25
- 34_2023/11/14

Notes:
1. Diagram generated using conditions at well 22 on August 25, 2023 to represent manganese stability under more oxidizing conditions.

Manganese Pourbaix Diagram - 22

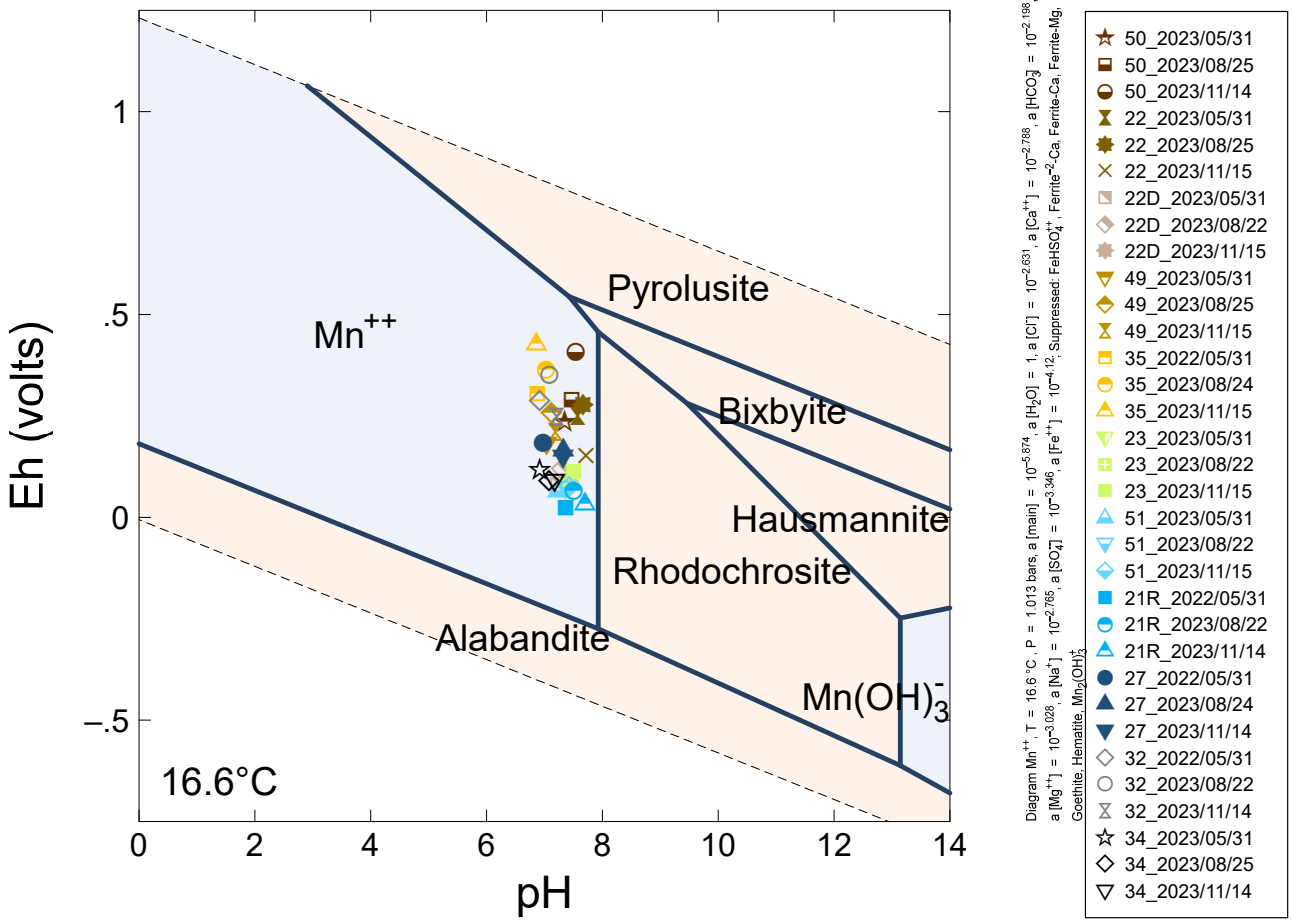
Hennepin West Ash Pond System

Geosyntec consultants

Chicago, Illinois | April 2024

Figure 11a

Geosyntec\Vistra - Groundwater Compliance - Documents\General\GCSM\Hennepin



Notes:
1. Diagram generated using conditions at well 21R on August 22, 2023 to represent manganese stability under more reducing conditions.

Manganese Pourbaix Diagram – 21R

Hennepin West Ash Pond System

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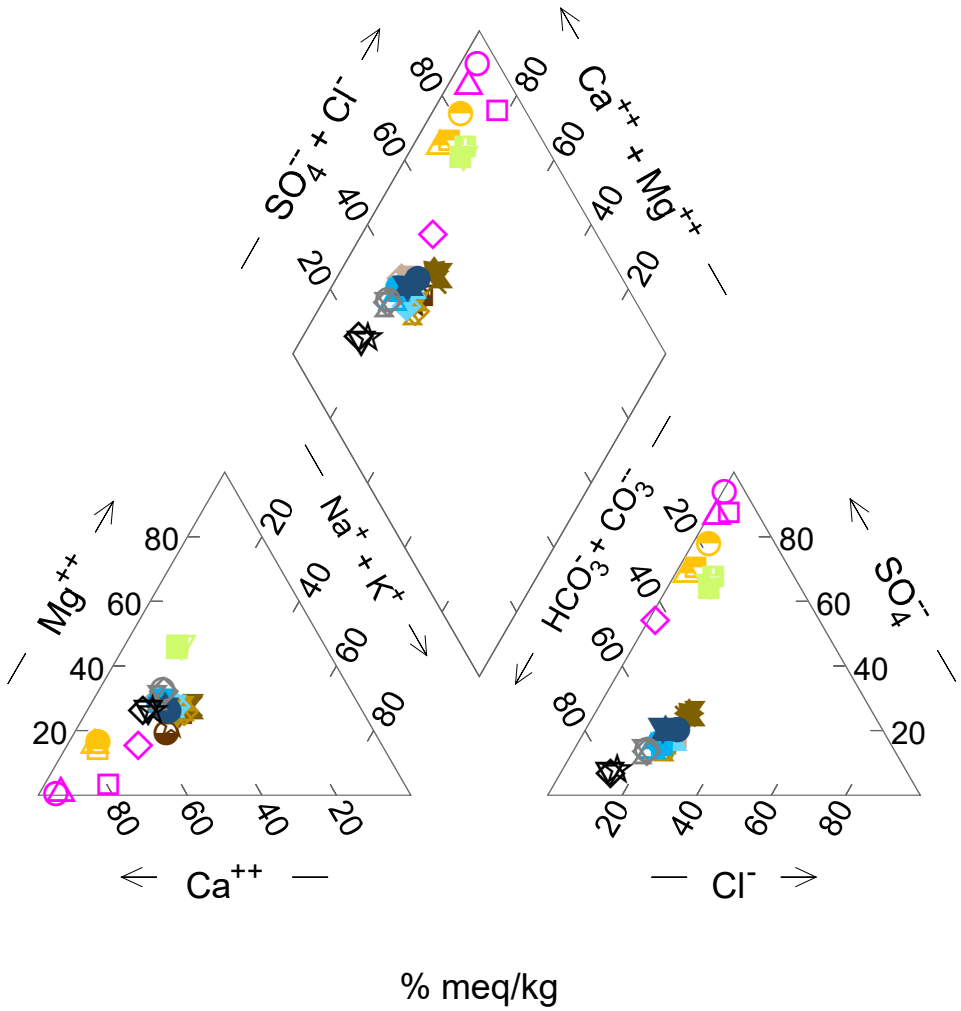
Chicago, Illinois | April 2024

Figure 11b

Geosyntec\Vistra - Groundwater Compliance - Documents\General\GCSM\Hennepin



- 50_2023/05/31
- 50_2023/08/25
- 50_2023/11/14
- 22_2023/05/31
- 22_2023/08/25
- 22_2023/11/15
- 22D_2023/05/31
- 22D_2023/08/22
- 22D_2023/11/15
- 49_2023/05/31
- 49_2023/08/25
- 49_2023/11/15
- 35_2022/05/31
- 35_2023/08/24
- 35_2023/11/15
- 23_2023/05/31
- 23_2023/08/22
- 23_2023/11/15
- 51_2023/05/31
- 51_2023/08/22
- 51_2023/11/15
- 21R_2022/05/31
- 21R_2023/08/22
- 21R_2023/11/14
- 27_2022/05/31
- 27_2023/08/24
- 27_2023/11/14
- 32_2022/05/31
- 32_2023/08/22
- 32_2023/11/14
- 34_2023/05/31
- 34_2023/08/25
- 34_2023/11/14
- L4 Leachate_2017/04/25
- LPZ–1 Leachate_2017/04/25
- LPZ–3 Leachate_2017/04/25
- LPZ–17 Leachate_2017/04/25

Notes:
1. meq/kg: milliequivalents per kilogram

Piper Diagram

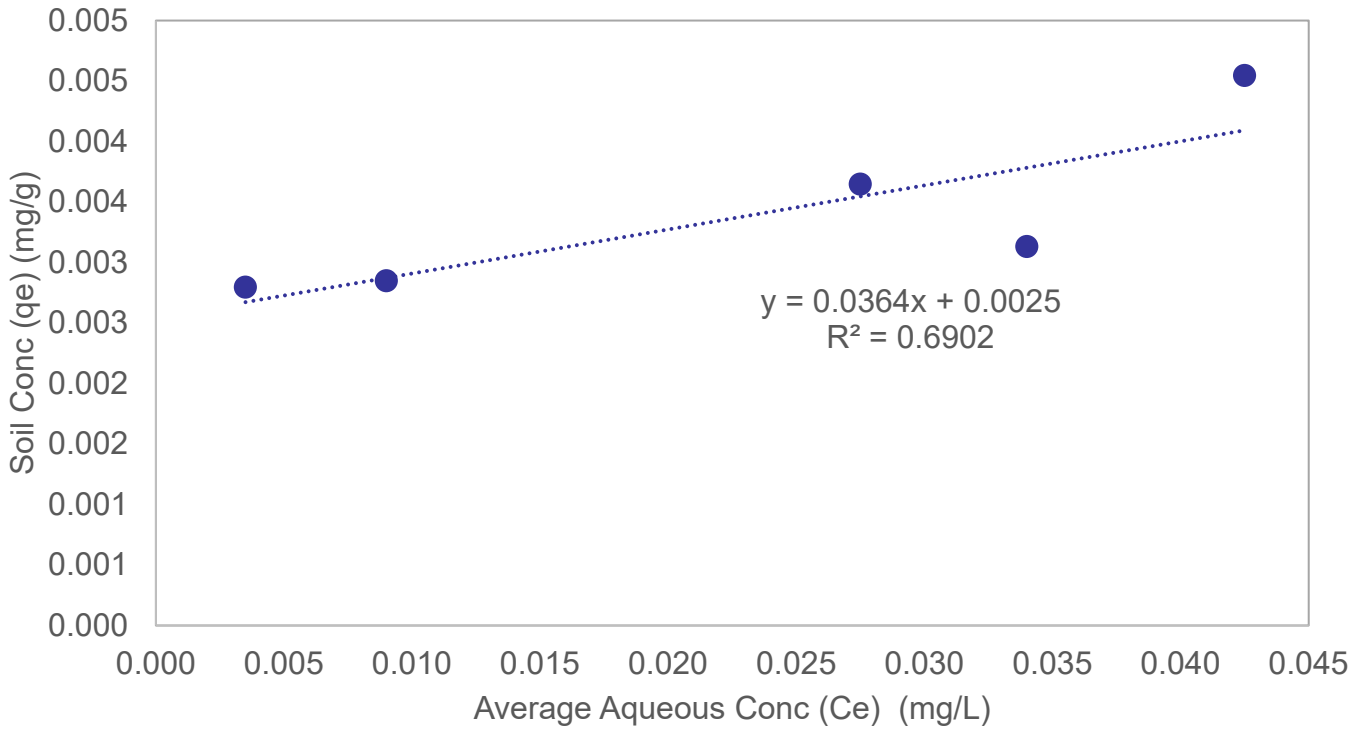
Hennepin West Ash Pond System

Geosyntec consultants

Figure 12

Chicago, Illinois | April 2024

Geosyntec\Vistra - Groundwater Compliance - Documents\General\GCSM\Hennepin



Notes:
1. mg/L: milligrams per liter
2. mg/g: milligrams of arsenic per gram of soil

Batch Adsorption Testing – Linear Isotherm

Hennepin West Ash Pond System

Geosyntec consultants

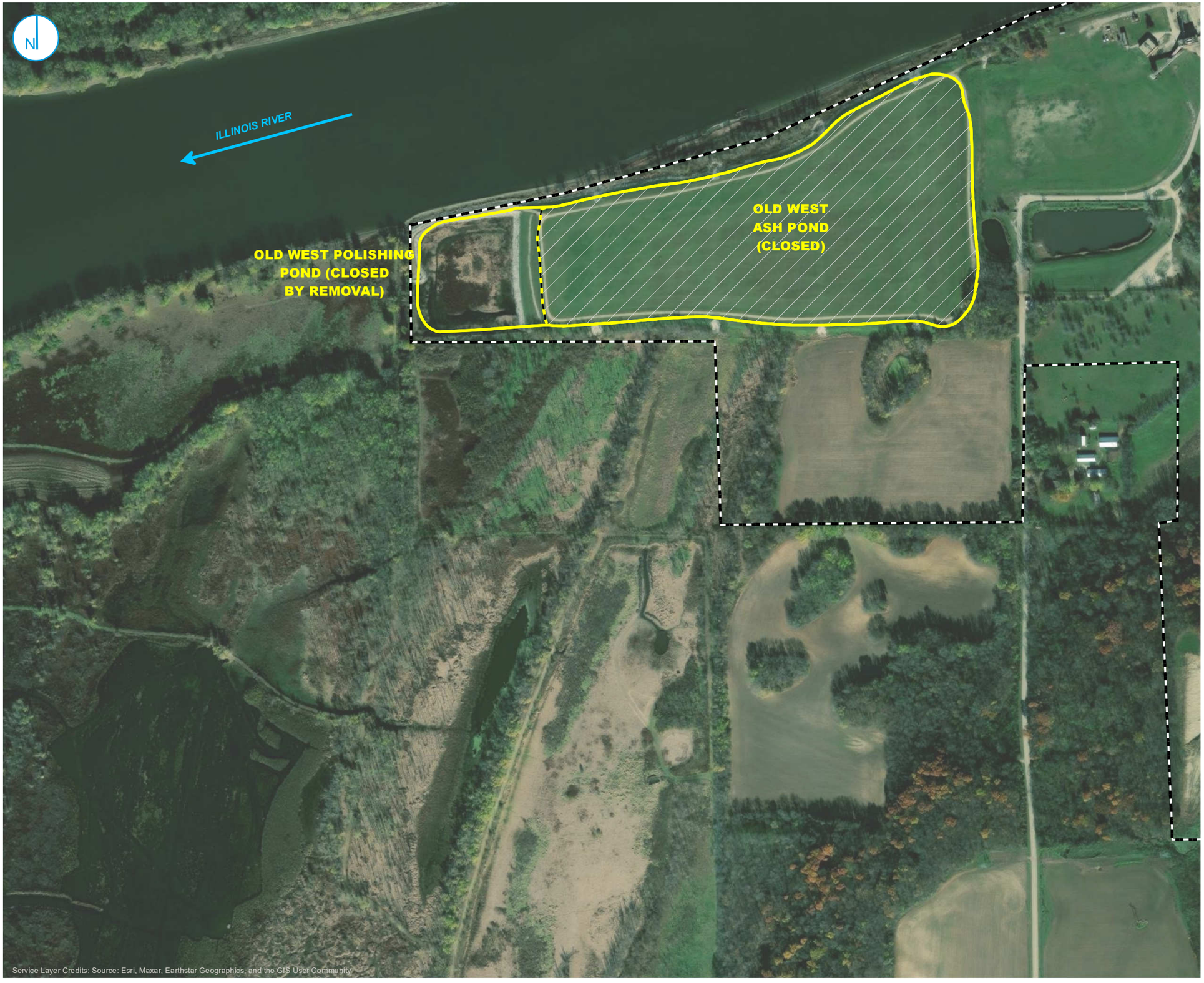
Chicago, Illinois | April 2024

Figure 13

Geosyntec\Vistra - Groundwater Compliance - Documents\General\GCSM\Hennepin

ATTACHMENT A
Site Layout Figure

Y:\Mapping\Projects\222285\MXD\Nature_and_Extent\HEN\Nature_and_Extent_Report_HenWest\Figure 2-2_Ste Map.mxd



REGULATED UNIT (SUBJECT UNIT)

LIMITS OF FINAL COVER

PROPERTY BOUNDARY

0 200 400 Feet

SITE MAP

NATURE AND EXTENT REPORT
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 4/24/2024 | DESIGNER: galammc

ATTACHMENT B
Proposed Part 845 Groundwater Monitoring Network

BACKGROUND WELL
COMPLIANCE WELL
PART 845 REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 200 400 Feet

PROPOSED PART 845 GROUNDWATER MONITORING WELL NETWORK

ADDENDUM TO THE GROUNDWATER MONITORING PLAN WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\222285\MXD\845_Operating_Permit\Hennepin\GMP_804\Figure 2-1_Proposed Monitoring Well Network.mxd
PROJECT: 1690000XXXX | DATED: 9/29/2021 | DESIGNER: STOLZSD

ATTACHMENT C
Monitoring Well Construction Information

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
ADDENDUM TO THE GROUNDWATER MONITORING PLAN
HENNEPIN POWER PLANT
WEST ASH POND SYSTEM
HENNEPIN, ILLINOIS

Well Number	Type	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
21R	C	UA	02/06/2020	452.05	452.05	Top of PVC	449.37	37.60	47.60	411.77	401.77	50.00	399.40	10	2	41.299866	-89.328914
22	C	UA	12/09/1982	464.45	464.45	Top of PVC	461.46	24.40	34.40	437.06	427.06	34.60	426.90	10	2	41.302032	-89.321512
22D	C	UA	08/07/2019	465.43	465.43	Top of PVC	461.83	49.70	59.70	412.16	402.16	59.67	401.80	10	2	41.302017	-89.321572
23	C	UA	12/10/1982	463.39	463.39	Top of PVC	460.88	34.00	44.00	426.88	416.88	45.20	415.70	10	2	41.300881	-89.325376
27	C	UA	09/11/1995	450.58	450.58	Top of PVC	448.21	30.00	35.00	418.21	413.21	36.30	412.00	5	2	41.296911	-89.328898
32	B	UA	08/21/1996	451.38	451.38	Top of PVC	448.75	7.00	17.00	441.75	431.75	17.30	431.40	10	2	41.292128	-89.328563
34	B	UA	08/22/1996	449.56	449.56	Top of PVC	448.23	30.00	35.00	418.23	413.23	35.00	413.20	5	2	41.299538	-89.33249
35	C	UA	09/08/1999	454.83	454.83	Top of PVC	451.51	8.00	18.00	443.51	433.51	17.60	433.90	10	2	41.29916	-89.324145
49	C	UA	07/06/2015	468.17	468.17	Top of PVC	465.76	35.00	45.00	430.76	420.76	45.00	420.80	10	2	41.301182	-89.32333
50	C	UA	08/07/2019	463.94	463.94	Top of PVC	460.59	19.60	29.60	440.99	430.99	29.60	430.60	10	2	41.302243	-89.320647
51	C	UA	02/04/2020	464.80	464.80	Top of PVC	461.50	56.00	66.00	405.50	395.50	66.30	394.50	10	2	41.300639	-89.326953

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
Type refers to the role of the well in the monitoring network: background (B), compliance (C), or water level measurements only (WLO)
WLO wells are temporary pending implementation of impoundment closure per an approved Construction Permit application
BGS = below ground surface
ft = foot or feet
HSU = Hydrostratigraphic Unit
PVC = polyvinyl chloride
UA = uppermost aquifer

generated 10/05/2021, 3:14:31 PM CDT

RAMBOLL

ATTACHMENT D
Boring Logs

PROJECT Hydrogeologic Study
Hennepin Power Plant
JOB NO. 82-1293

BORING W-2
SHEET 1 OF 1

22

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Soil Classification System Unified Surface Elevation 461.4'		
	1	AS			Brown Sandy CLAY, CL		
-5-	2	SS	18/9		Gray - Brown Silty CLAY Trace Sand, CL	3-5-5	
					Brown Fine SAND w/Silt Trace Gravel, SM		
-10-	3	SS	18/16			5-7-5	
-15-	4	SS	18/16			19-20-28	
					Gray-Brown GRAVEL w/Sand Trace Clay, GP		
-20-	5	SS	18/18			17-27-38	
-25-	6	SS	18/13		-Coal @ 25.4'	23-18-12	
					Brown Fine SAND, SP		
-30-	7	SS	18/15			6-11-11	
					Brown GRAVEL w/Sand Trace Clay, GP-GC		
-35-	8	SS	18/6		TOB	0-4-6	

Shear Strength, tsf
SV△ QP/2□ QU/2○
0 ½ 1 1½ 2 2½
PL + NMC • LL x
0 50 100
Rock Quality Designation
0 50 100

DRILLING METHOD Hollow Auger
DATE DRILLED 12/9/82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at 8.0 Feet
___ Hours after completion ___ Feet
6 Days after completion 8.0 Feet
___ after completion ___ Feet

NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

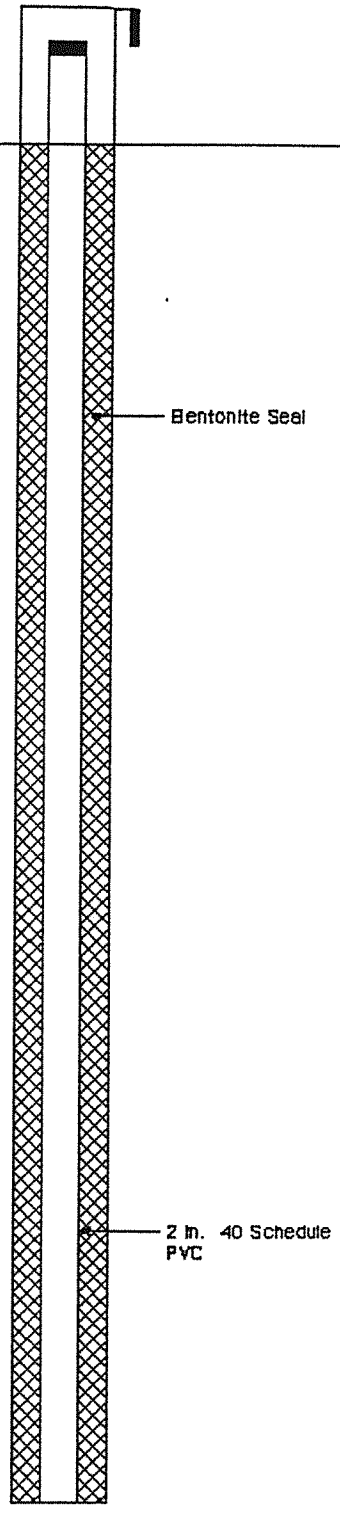
Monitoring Well No. 34

PROJECT Title: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-22-96
HOLE DIA.: 7 in.
FINAL GW: 7.54 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 448.19 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE
Silty clay, trace of plant debris, little fine-grained sand, very dark brown in color, medium to high plasticity (alluvium).			0	C-1A
			5	C-1B
			10	C-1C
			15	C-1D
			20	



STMI
2511 N. 124th St. Suite 205
Brookfield, Wisconsin 53005-8208

Notes:

Project No. 135-1.31

Monitoring Well No. 34

PROJECT TITLE: Hennepin West Ash Impoundment
DRILL RIG: Hollow Stem Auger
DRILLER: Boart Longyear

DATE: 8-22-96
HOLE DIA.: 7 in.
FINAL GW: 7.54 ft.

LOGGED BY: Mueller/Tu
SAMPLER: Split Spoon
HOLE ELEV.: 448.19 ft. MSL

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	WELL CONSTRUCTION DETAIL
Clayey silt, trace to little fine-grained sand and shell fragments, soft, olive-gray. Wet.			20–26	C-1E, C-1F	Bentonite Seal; 2 in. 40 Schedule PVC
Sand, fine-grained to medium-grained, well-sorted, quartz, trace of silt, loose. Yellowish brown color grades to olive gray below 31 ft.			27–38	C-1G	#7 Fine Sand; #5 Fine Sand; 0.01 Slotted Well Screen; Holeplug

STMI
2511 N. 124th St. Suite 205
Brookfield, Wisconsin 53005-8208

Notes:

Project No. 135-1.31

Geosyntec consultants

1 McBride and Sons Center Dr
Suite 202
Chesterfield, MO 63005

GS FORM: WELL BORE 01/04

BOREHOLE LOG

BORING	**MW-51**	**SHEET**	**1 OF 3**
START DRILL DATE	February 4, 2020	**ELEVATION DATA:**	
FINISH DRILL DATE	February 4, 2020	**GROUND SURF. (Ft)**	461.50
LOCATION	PUTNAM COUNTY, HENNEPIN IL	**TOP OF CASING (Ft)**	464.80
PROJECT	HENNEPIN POWER STATION	**DATUM**	NAVD 1988
NUMBER	CHE8400		

DEPTH (ft-bgs)	DESCRIPTION 1) Unit/Formation, Mem. 6) Plasticity 2) USCS Name 7) Density/Consistency 3) Color 8) Structure 4) Moisture 9) Other (Mineralization, Discoloration, Odor, etc.) 5) Percent Grain Size	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE NO.	TYPE	BLOW COUNT	N-Value	RECOVERY (%)	COMMENTS 1) Rig Behavior 2) Air Monitoring
0	Brown/red, clayey gravel, GC, fill material				460	01		2 4 4 3	8	17/24	
						02		5 3 11 12	14	18/24	
5	Brown/red, clayey sand with trace coarse sand, SC, low plasticity				455	03		5 6 9 5	15	16/24	
						04		6 3 4 5	7	2/24	
	Dark gray, fly ash, ML, non-plastic, non-cohesive					05		3 4 5 9	9	21/24	
10					450	06		3 3 3 4	6	24/24	
						07		2 1 1 2	2	24/24	
	@14 ft changes to dark gray/black					08		4 4 32 40	36	24/24	
15					445	09		3 3 3 4	6	24/24	
	Dark gray/black silty clay, CL, medium plasticity, damp					10		2 3 3 3	6	24/24	
20						11		2 1 3 2	4	18/24	
					440	12		0 1 2 2	3	24/24	
	@ 24 ft red brown coarse gravel lens					13		0 2 3 4	5	24/24	
25	@ 26 ft changes to dark gray				435	14		0 1 1 1	2	24/24	
	@ 28 ft changes to medium stiff					15		1 2 2 3	4	18/24	
30											

CONTRACTOR TSC
EQUIPMENT CME 75
DRILL MTHD HOLLOWSTEM AUGER
DIAMETER 6-inch
LOGGER C. CHRISTENSON
REVIEWER L. CARR

NORTHING 1688814.68
EASTING 2527303.58
COORDINATE SYSTEM: STATE PLANE ILLINOIS WEST

NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

07-WELL BORE CHICAGO PROJECT.GPJ GEOSNTEC.GDT 2/24/20

Geosyntec consultants

1 McBride and Sons Center Dr
Suite 202
Chesterfield, MO 63005

GS FORM: WELL BORE 01/04

BOREHOLE LOG

BORING MW-51 **SHEET** 2 OF 3
START DRILL DATE February 4, 2020 **ELEVATION DATA:**
FINISH DRILL DATE February 4, 2020 **GROUND SURF. (Ft)** 461.50
LOCATION PUTNAM COUNTY, HENNEPIN IL **TOP OF CASING (Ft)** 464.80
PROJECT HENNEPIN POWER STATION **DATUM** NAVD 1988
NUMBER CHE8400

DEPTH (ft-bgs)	DESCRIPTION 1) Unit/Formation, Mem. 6) Plasticity 2) USCS Name 7) Density/Consistency 3) Color 8) Structure 4) Moisture 9) Other (Mineralization, Discoloration, Odor, etc.) 5) Percent Grain Size	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE NO.	TYPE	BLOW COUNT	N-Value	RECOVERY (%)	COMMENTS 1) Rig Behavior 2) Air Monitoring
35	@ 31 ft medium gravel lens				430	16		3 4 5 5	8	6/24	
						17		0 1 2 2 2	3	19/24	
						18		2 3 4 5	7	24/24	
	Dark gray clay and gravel mixture, wet, GC				425	19		2 2 3 5	5	6/24	
	Dark gray, silt with trace clay, ML, low plasticity, damp					20		0 0 2 2	2	24/24	
40	Dark gray silt with trace clay, ML, low plasticity, damp					21		2 1 1 2	2	24/24	
	Dark gray silty clay, CL, medium plasticity, damp, medium stiff				420						
	Dark gray silt with trace clay, ML, low plasticity, damp, medium stiff					22		2 2 2 3	4	24/24	
45						23		1 1 2 3	3	24/24	
	@ 47 ft few diatomaceous/shells				415	24		0 0 2 2	2	24/24	
						25		0 1 2 2	3	10/24	
50						26		3 4 4 7	8	14/24	
	Dark gray, fine to medium sand, trace coarse sand, SM				410	27			0	24/24	
						28		1 3 5 7	8	24/24	
55	@ 56 ft changes to some coarse sand, SM-SP				405	29		7 6 7 6	13	24/24	
	Dark gray, medium sand with some fine and coarse sand, SP, wet					30		3 3 9 1	12	24/24	
60											

CONTRACTOR TSC
EQUIPMENT CME 75
DRILL MTHD HOLLOWSTEM AUGER
DIAMETER 6-inch
LOGGER C. CHRISTENSON **REVIEWER** L. CARR

NORTHING 1688814.68
EASTING 2527303.58
COORDINATE SYSTEM:
STATE PLANE ILLINOIS WEST

NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

07-WELL BORE CHICAGO PROJECT.GPJ GEOSNTEC.GDT 2/24/20

Geosyntec consultants

1 McBride and Sons Center Dr
Suite 202
Chesterfield, MO 63005

GS FORM: WELL BORE 01/04

BOREHOLE LOG

BORING MW-51 **SHEET** 3 OF 3
START DRILL DATE February 4, 2020 **ELEVATION DATA:**
FINISH DRILL DATE February 4, 2020 **GROUND SURF. (Ft)** 461.50
LOCATION PUTNAM COUNTY, HENNEPIN IL **TOP OF CASING (Ft)** 464.80
PROJECT HENNEPIN POWER STATION **DATUM** NAVD 1988
NUMBER CHE8400

DEPTH (ft-bgs)	DESCRIPTION 1) Unit/Formation, Mem. 6) Plasticity 2) USCS Name 7) Density/Consistency 3) Color 8) Structure 4) Moisture 9) Other (Mineralization, Discoloration, Odor, etc.) 5) Percent Grain Size	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE NO.	TYPE	BLOW COUNT	N-Value	RECOVERY (%)	COMMENTS 1) Rig Behavior 2) Air Monitoring
	Dark gray, medium sand with some fine and coarse sand, SP, wet							1 1 3 4			
					400	31			4	2/24	
	@ 62 ft, changes to few fine gravel, fine sand absent, SW							5 7 13 18			
						32			20	24/24	
65								5 8 14 17			
						33			22	24/24	
	Dark gray, medium-fine sand with some coarse sand, SW				395	34		3 10			
	@ 67 ft lens of medium gravel								13	12/12	
	End of boring at 67 ft.										
70					390						
75					385						
80					380						
85					375						
90											

CONTRACTOR TSC
EQUIPMENT CME 75
DRILL MTHD HOLLOWSTEM AUGER
DIAMETER 6-inch
LOGGER C. CHRISTENSON **REVIEWER** L. CARR

NORTHING 1688814.68
EASTING 2527303.58
COORDINATE SYSTEM:
STATE PLANE ILLINOIS WEST

NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

07-WELL BORE CHICAGO PROJECT.GPJ GEOSNTEC.GDT 2/24/20

ATTACHMENT E
Site Solids Bulk Characterization and Total Metals Analytical Data

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : Hennepin MNA

06-April-2021

SiREM Laboratory
Attn : Michael Healey

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

Phone: 519-822-2265
Fax:519-822-3151

Date Rec. : 05 March 2021
LR Report: **CA14198-MAR21**
Reference: P.O# 80003210A

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
Sample Date & Time					04-Mar-21 12:15	04-Mar-21 12:30	04-Mar-21 12:40	04-Mar-21 13:00
Sulphide [%]	22-Mar-21	12:31	22-Mar-21	17:06	0.09	0.18	< 0.04	0.06
SO4 [%]	23-Mar-21	07:20	25-Mar-21	09:13	< 0.1	< 0.1	< 0.1	< 0.1
TOC [%]	22-Mar-21	02:08	22-Mar-21	17:06	1.92	3.55	0.339	4.55
TS LOI [mg/L]	11-Mar-21	19:34	16-Mar-21	09:39	64100	70500	15400	74800
Ag [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	< 0.05	0.06	< 0.05	0.08
Al [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	5000	8200	2800	3700
As [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	2.7	3.5	5.1	8.4
Ba [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	47	84	20	31
Be [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	0.29	0.50	0.20	0.87
B [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	5	10	6	7
Bi [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	0.23	0.59	0.13	0.26
Ca [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	52000	91000	56000	36000
Cd [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	0.53	0.89	0.76	2.9
Co [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	6.9	9.3	5.2	9.8
Cr [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	45	27	79	130
Cu [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	8	14	11	25
Fe [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	10000	14000	9400	12000
K [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	1200	1900	910	1200
Li [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	6	12	4	6
Mg [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	13000	15000	21000	16000
Mn [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	260	350	310	220
Mo [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	0.9	2.0	3.1	5.0
Na [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	180	170	190	160
Ni [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	12	19	15	43
Pb [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	6.1	11	7.7	28
P [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	380	430	350	330
Se [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	< 0.7	1.1	< 0.7	0.8
Si [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	7200	4500	5400	1600
Sb [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	< 0.8	< 0.8	< 0.8	< 0.8
Sn [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	1.1	0.6	< 0.5	0.5
Tl [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	0.16	0.25	0.13	0.26
U [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	0.65	1.2	1.3	1.8
V [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	12	18	17	41

OnLine LIMS

0002451834

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.
SGS Canada Inc. Environment-Health & Safety statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : Hennepin MNA

LR Report : **CA14198-MAR21**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
W [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	0.06	0.05	0.07	0.10
Y [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	5.7	8.0	6.1	7.6
Zn [µg/g]	05-Apr-21	14:43	06-Apr-21	11:29	40	67	46	91

Catharine Arnold

CHARTERED CATHARINE ARNOLD CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0002451834

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ATTACHMENT F
Sequential Extraction Procedure Analytical Data

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

water soluble

Project : Hennepin MNA

30-March-2021

SiREM Laboratory
Attn : Michael Healey

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

Phone: 519-822-2265
Fax:519-822-3151

Date Rec. : 05 March 2021
LR Report: **CA14201-MAR21**
Reference: P.O# 800003210A

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CERTIFICATE OF ANALYSIS
Final Report

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Sample Date & Time					04-Mar-21 12:15	04-Mar-21 12:30	04-Mar-21 12:40	04-Mar-21 13:00
Ag [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	120	140	32	310
As [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	0.8	0.9	0.2	1.5
Be [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.02	< 0.02	< 0.02	0.02
B [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 1	1	< 1	1
Bi [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	500	600	220	410
Cd [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.02	< 0.02	< 0.02	0.04
Co [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	0.03	0.04	0.02	0.23
Cr [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.5	< 0.5	< 0.5	1.6
Cu [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.1	< 0.1	< 0.1	0.5
Fe [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	72	68	22	310
K [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	110	140	99	220
Li [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 2	< 2	< 2	< 2

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000246249

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

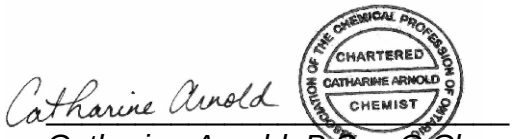
water soluble

Project : Hennepin MNA

LR Report : **CA14201-MAR21**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
Mg [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	89	120	100	140
Mn [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	1.4	1.3	0.5	4.0
Mo [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	0.1	0.6	0.1	0.3
Na [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	28	35	40	52
Ni [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.5	< 0.5	< 0.5	0.7
P [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	4	4	< 3	10
Pb [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.1	< 0.1	< 0.1	0.7
Si [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	300	290	120	740
Sb [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.7	< 0.7	< 0.7	< 0.7
Sn [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.5	< 0.5	< 0.5	< 0.5
Tl [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.02	< 0.02	< 0.02	< 0.02
U [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	0.016	0.043	0.004	0.069
V [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 3	< 3	< 3	4
W [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.04	< 0.04	< 0.04	< 0.04
Y [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	0.045	0.042	0.029	0.15
Zn [µg/g]	26-Mar-21	11:11	26-Mar-21	17:50	< 0.7	< 0.7	< 0.7	2.5

Fraction 1 - Water Soluble



Catharine Arnold, B.Sc., C.Chem
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Environment, Health & Safety

OnLine LIMS

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Fraction 1 Exchangeable Metals

Project : Hennepin MNA

30-March-2021

SiREM Laboratory
Attn : Michael Healey

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Date Rec. : 05 March 2021
LR Report: **CA14202-MAR21**
Reference: P.O# 800003210A

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Final Report

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Sample Date & Time					04-Mar-21 12:15	04-Mar-21 12:30	04-Mar-21 12:40	04-Mar-21 13:00
Ag [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	3	4	< 1	3
As [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	4.0	4.7	1.5	5.0
Be [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.02	< 0.02	< 0.02	< 0.02
B [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 1	< 1	< 1	< 1
Bi [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	2200	3200	1000	3500
Cd [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.02	< 0.02	< 0.02	0.24
Co [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	0.02	0.03	< 0.01	0.10
Cr [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.5	< 0.5	< 0.5	< 0.5
Cu [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	0.1	< 0.1	< 0.1	< 0.1
Fe [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	5	6	< 1	2
K [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	57	88	58	92
Li [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 2	< 2	< 2	< 2

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000244625

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Fraction 1 Exchangeable Metals

Project : Hennepin MNA

LR Report : **CA14202-MAR21**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
Mn [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	6.5	8.5	1.5	17
Mo [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.1	0.1	< 0.1	< 0.1
Na [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	8	9	11	12
Ni [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.5	< 0.5	< 0.5	< 0.5
Pb [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.1	< 0.1	< 0.1	< 0.1
P [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 3	< 3	< 3	< 3
Sb [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.7	< 0.7	< 0.7	< 0.7
Si [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	32	30	45	30
Sn [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.5	< 0.5	< 0.5	< 0.5
Tl [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.02	< 0.02	< 0.02	< 0.02
U [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	0.017	0.061	0.021	0.024
V [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 3	< 3	< 3	< 3
W [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.04	< 0.04	< 0.04	< 0.04
Y [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	0.006	0.006	0.004	0.008
Zn [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.7	< 0.7	< 0.7	< 0.7

Exchangeable Metals

Catharine Arnold

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

000244625

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SGS Canada Inc.
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Lakefield - Ontario - KOL 2HO
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Fraction 2 Metals Bound to Carbonates

Project : Hennepin MNA

30-March-2021

SiREM Laboratory
Attn : Michael Healey

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Date Rec. : 05 March 2021
LR Report: **CA14203-MAR21**
Reference: P.O# 800003210A

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Final Report

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Sample Date & Time					04-Mar-21 12:15	04-Mar-21 12:30	04-Mar-21 12:40	04-Mar-21 13:00
Ag [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	5	2	28	6
As [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	20	22	6.0	7.5
Be [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.02	< 0.02	< 0.02	0.03
B [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 1	< 1	< 1	1
Bi [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	30000	30000	24000	13000
Cd [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	0.12	0.11	0.37	0.69
Co [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	0.39	0.39	1.1	1.1
Cr [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.5	< 0.5	2.6	9.6
Cu [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.1	< 0.1	0.2	< 0.1
Fe [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	8	4	41	32
K [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	41	49	45	67
Li [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 2	< 2	< 2	< 2

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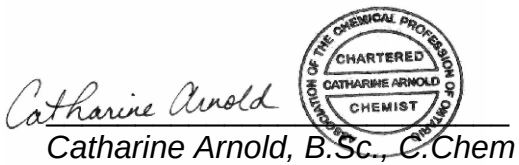
Fraction 2 Metals Bound to Carbonates

Project : Hennepin MNA

LR Report : CA14203-MAR21

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
Mg [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	2800	4700	2200	7000
Mn [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	78	74	140	69
Mo [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.1	< 0.1	< 0.1	< 0.1
Ni [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.5	< 0.5	2.7	1.9
Pb [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	0.2	0.2	0.3	0.6
P [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 3	< 3	< 3	< 3
Sb [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.7	< 0.7	< 0.7	< 0.7
Si [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	90	77	70	110
Sn [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.5	< 0.5	< 0.5	< 0.5
Tl [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.02	< 0.02	< 0.02	< 0.02
U [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	0.039	0.15	0.089	0.030
V [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 3	< 3	< 3	< 3
W [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	< 0.04	< 0.04	< 0.04	< 0.04
Y [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	0.57	0.26	1.0	0.23
Zn [µg/g]	26-Mar-21	11:11	26-Mar-21	17:51	1.4	1.4	1.6	1.7

Fraction 2 Metals Bound to Carbonates



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Fax:519-822-3151

Fraction 3 Metals Bound to Fe and Mn Oxides

Project : Hennepin MNA

30-March-2021

Date Rec. : 05 March 2021
LR Report: **CA14204-MAR21**
Reference: P.O# 800003210A

Copy: #1

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Final Report

Analysis	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
Sample Date & Time			04-Mar-21 12:15	04-Mar-21 12:30	04-Mar-21 12:40	04-Mar-21 13:00
Ag [µg/g]	26-Mar-21	17:51	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	26-Mar-21	17:51	270	320	270	230
As [µg/g]	26-Mar-21	17:51	0.8	0.9	< 0.5	< 0.5
Ba [µg/g]	26-Mar-21	17:51	8.6	29	3.4	5.9
Be [µg/g]	26-Mar-21	17:51	0.14	0.22	0.07	0.48
B [µg/g]	26-Mar-21	17:51	1	2	2	2
Bi [µg/g]	26-Mar-21	17:51	0.12	0.29	< 0.09	< 0.09
Ca [µg/g]	26-Mar-21	17:51	18000	49000	30000	18000
Cd [µg/g]	26-Mar-21	17:51	0.25	0.59	0.16	1.1
Co [µg/g]	26-Mar-21	17:51	1.4	2.2	0.70	2.6
Cr [µg/g]	26-Mar-21	17:51	14	5.3	30	28
Cu [µg/g]	26-Mar-21	17:51	0.1	< 0.1	1.6	0.3
Fe [µg/g]	26-Mar-21	17:51	3100	2500	1600	1100
K [µg/g]	26-Mar-21	17:51	54	73	61	82
Li [µg/g]	26-Mar-21	17:51	< 2	< 2	< 2	< 2

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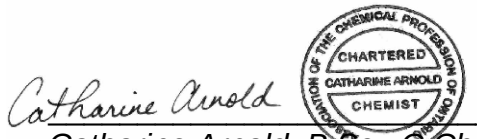
Project : Hennepin MNA

LR Report : CA14204-MAR21

Analysis	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
Mg [µg/g]	26-Mar-21	17:51	9000	7000	17000	10000
Mn [µg/g]	26-Mar-21	17:51	110	170	90	65
Mo [µg/g]	26-Mar-21	17:51	0.1	0.2	0.5	0.2
Na [µg/g]	26-Mar-21	17:51	850	3700	540	2200
Ni [µg/g]	26-Mar-21	17:51	2.9	3.7	3.1	9.9
Pb [µg/g]	26-Mar-21	17:51	3.1	5.7	3.1	7.7
P [µg/g]	26-Mar-21	17:51	100	71	59	35
Sb [µg/g]	26-Mar-21	17:51	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	26-Mar-21	17:51	< 0.7	< 0.7	< 0.7	< 0.7
Si [µg/g]	26-Mar-21	17:51	480	450	410	410
Sn [µg/g]	26-Mar-21	17:51	< 0.5	< 0.5	< 0.5	< 0.5
Tl [µg/g]	26-Mar-21	17:51	0.02	0.03	0.03	< 0.02
U [µg/g]	26-Mar-21	17:51	0.095	0.19	0.27	0.31
V [µg/g]	26-Mar-21	17:51	< 3	< 3	< 3	4
W [µg/g]	26-Mar-21	17:51	< 0.04	< 0.04	< 0.04	< 0.04
Y [µg/g]	26-Mar-21	17:51	1.8	2.6	1.8	1.4
Zn [µg/g]	26-Mar-21	17:51	14	24	7.4	26

Fraction 3 Metals Bound to Fe and Mn Oxides



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30-March-2021

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Phone: 519-822-2265
Fax:519-822-3151

Date Rec. : 08 March 2021
LR Report: **CA14205-MAR21**
Reference: P.O# 800003210A

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
Sample Date & Time			04-Mar-21 12:15	04-Mar-21 12:30	04-Mar-21 12:40	04-Mar-21 13:00
Ag [µg/g]	26-Mar-21	17:51	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	26-Mar-21	17:51	77	120	150	630
As [µg/g]	26-Mar-21	17:51	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	26-Mar-21	17:51	1.5	5.5	1.1	2.4
Be [µg/g]	26-Mar-21	17:51	< 0.02	< 0.02	< 0.02	0.18
B [µg/g]	26-Mar-21	17:51	< 1	1	< 1	< 1
Bi [µg/g]	26-Mar-21	17:51	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	26-Mar-21	17:51	1800	3700	600	1300
Cd [µg/g]	26-Mar-21	17:51	0.03	0.03	0.03	0.25
Co [µg/g]	26-Mar-21	17:51	1.0	0.87	0.12	1.1
Cr [µg/g]	26-Mar-21	17:51	3.8	2.5	3.3	20
Cu [µg/g]	26-Mar-21	17:51	2.0	3.4	1.0	11
Fe [µg/g]	26-Mar-21	17:51	170	180	34	1100
K [µg/g]	26-Mar-21	17:51	12	22	24	45
Li [µg/g]	26-Mar-21	17:51	< 2	< 2	< 2	< 2

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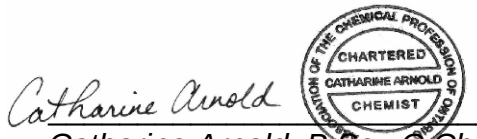
LR Report : **CA14205-MAR21**

Analysis	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
Mg [µg/g]	26-Mar-21	17:51	1800	3400	240	490
Mn [µg/g]	26-Mar-21	17:51	5.1	7.5	3.5	11
Mo [µg/g]	26-Mar-21	17:51	0.2	0.1	0.3	1.0
Na [µg/g]	26-Mar-21	17:51	10	65	15	36
Ni [µg/g]	26-Mar-21	17:51	1.1	1.8	0.7	15
Pb [µg/g]	26-Mar-21	17:51	0.2	0.2	0.2	1.9
P [µg/g]	26-Mar-21	17:51	70	51	23	24
Sb [µg/g]	26-Mar-21	17:51	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	26-Mar-21	17:51	< 0.7	0.9	< 0.7	< 0.7
Si [µg/g]	26-Mar-21	17:51	130	160	220	480
Sn [µg/g]	26-Mar-21	17:51	< 0.5	< 0.5	< 0.5	< 0.5
Tl [µg/g]	26-Mar-21	17:51	0.03	0.04	< 0.02	0.02
U [µg/g]	26-Mar-21	17:51	0.097	0.086	0.12	0.48
V [µg/g]	26-Mar-21	17:51	< 3	< 3	< 3	8
W [µg/g]	26-Mar-21	17:51	< 0.04	< 0.04	< 0.04	< 0.04
Y [µg/g]	26-Mar-21	17:51	0.42	0.31	1.0	3.0
Zn [µg/g]	26-Mar-21	17:51	2.5	2.8	1.7	9.7

Fraction 4 Bound to Organic Material



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Fraction 5 Residual metals

Project : Hennepin MNA

30-March-2021

Date Rec. : 05 March 2021
LR Report: **CA14206-MAR21**
Reference: P.O# 800003210A

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
Sample Date & Time			04-Mar-21 12:15	04-Mar-21 12:30	04-Mar-21 12:40	04-Mar-21 13:00
Ag [µg/g]	26-Mar-21	17:52	0.06	0.09	0.07	0.09
Al [µg/g]	26-Mar-21	17:52	22000	24000	14000	17000
As [µg/g]	26-Mar-21	17:52	1.9	2.7	3.9	6.6
Ba [µg/g]	26-Mar-21	17:52	190	170	130	130
Be [µg/g]	26-Mar-21	17:52	0.46	0.74	0.29	0.47
B [µg/g]	26-Mar-21	17:52	13	26	10	18
Bi [µg/g]	26-Mar-21	17:52	< 0.09	0.21	< 0.09	0.16
Ca [µg/g]	26-Mar-21	17:52	3000	4400	1800	1700
Cd [µg/g]	26-Mar-21	17:52	0.05	0.07	0.10	0.23
Co [µg/g]	26-Mar-21	17:52	3.9	5.4	2.9	3.9
Cr [µg/g]	26-Mar-21	17:52	37	39	54	98
Cu [µg/g]	26-Mar-21	17:52	5.7	9.6	7.4	9.7
Fe [µg/g]	26-Mar-21	17:52	8800	14000	8500	10000
K [µg/g]	26-Mar-21	17:52	9500	10000	6500	7500
Li [µg/g]	26-Mar-21	17:52	11	18	5	13

OnLine LIMS

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Phone: 705-652-2000 FAX: 705-652-6365

Analysis	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-34 32-33'	6: SB-51 42-43'	7: SB-22 26-27'	8: SB-22 29-30'
Mg [µg/g]	26-Mar-21	17:52	1900	2300	1100	1100
Mn [µg/g]	26-Mar-21	17:52	68	95	60	54
Mo [µg/g]	26-Mar-21	17:52	0.5	0.9	1.8	3.4
Na [µg/g]	26-Mar-21	17:52	4100	3200	3600	3900
Ni [µg/g]	26-Mar-21	17:52	8.2	14	7.4	11
Pb [µg/g]	26-Mar-21	17:52	5.2	6.5	5.3	17
P [µg/g]	26-Mar-21	17:52	130	210	160	200
Sb [µg/g]	26-Mar-21	17:52	< 0.8	< 0.8	< 0.8	1.0
Se [µg/g]	26-Mar-21	17:52	< 0.7	< 0.7	< 0.7	< 0.7
Si [µg/g]	26-Mar-21	17:52	8500	25000	34000	31000
Sn [µg/g]	26-Mar-21	17:52	2.9	3.6	2.9	4.3
Tl [µg/g]	26-Mar-21	17:52	0.23	0.34	0.15	0.29
U [µg/g]	26-Mar-21	17:52	0.84	1.4	1.0	1.3
V [µg/g]	26-Mar-21	17:52	28	49	25	78
W [µg/g]	26-Mar-21	17:52	0.24	0.40	0.15	0.23
Y [µg/g]	26-Mar-21	17:52	4.1	4.1	3.3	3.1
Zn [µg/g]	26-Mar-21	17:52	24	39	33	62

Fraction 5 Residual metals

Catharine Arnold

CHARTERED CHEMIST CATHARINE ARNOLD — THE CHEMICAL PROFESSION OF ONTARIO

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Project Specialist,
Environment, Health & Safety

OnLine LIMS

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ATTACHMENT G
X-Ray Diffraction Analytical Data

Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for:	*Environmental Services*
Project Number/ LIMS No.	*Custom XRD/MI4516-MAR21*
Sample Receipt:	*March 12, 2021*
Sample Analysis:	*March 25, 2021*
Reporting Date:	*April 8, 2021*

Instrument:	BRUKER AXS D8 Advance Diffractometer
Test Conditions:	Co radiation, 35 kV, 40 mA Regular Scanning: Step: 0.02°, Step time: 1s, 2θ range: 3-80°
Interpretations :	PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva and Topas software.
Detection Limit :	0.5-2%. Strongly dependent on crystallinity.

Contents:

1) Method Summary
2) Quantitative XRD Results
3) XRD Pattern(s)

Kim Gibbs, H.B.Sc., P.Geo.
Senior Mineralogist

Huyun Zhou, Ph.D., P.Geo.
Senior Mineralogist

ACCREDITATION: SGS Minerals Services Lakefield is accredited to the requirements of ISO/IEC 17025 for specific tests as listed on our scope of accreditation, including geochemical, mineralogical and trade mineral tests. To view a list of the accredited methods, please visit the following website and search SGS Canada - Minerals Services - Lakefield: http://palcan.scc.ca/SpecsSearch/GLSearchForm.do.

Method Summary

The Rietveld Method of Mineral Identification by XRD (ME-LR-MIN-MET-MN-D05) method used by SGS Minerals Services is accredited to the requirements of ISO/IEC 17025.

Mineral Identification and Interpretation:

Mineral identification and interpretation involves matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Quantitative Rietveld Analysis:

Quantitative Rietveld Analysis is performed by using Topas 4.2 (Bruker AXS), a graphics based profile analysis program built around a non-linear least squares fitting system, to determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile until it matches the obtained experimental patterns.

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.05wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

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SGS Minerals
a division of SGS Canada Inc.
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Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results

Mineral/Compound	SB-34 32-33' MAR4516-01 (wt %)	SB-51 42-43' MAR4516-02 (wt %)	SB-22 26-27' MAR4516-03 (wt %)	SB-22 29-30' MAR4516-04 (wt %)
Quartz	53.0	33.1	57.0	54.5
Microcline	5.1	9.8	5.2	5.2
Chlorite	3.4	6.8	1.9	2.7
Kaolinite	3.4	3.4	0.6	2.5
Muscovite	7.9	12.5	2.1	7.4
Calcite	11.1	20.9	7.2	3.3
Dolomite	2.6	5.0	14.4	11.4
Ankerite	6.0	1.3	2.9	2.8
Pyrite	0.2	0.3	-	-
Magnetite	0.4	0.2	0.5	0.4
Albite	7.1	6.6	7.3	9.8
Actinolite	-	-	0.8	-
TOTAL	100	100	100	100

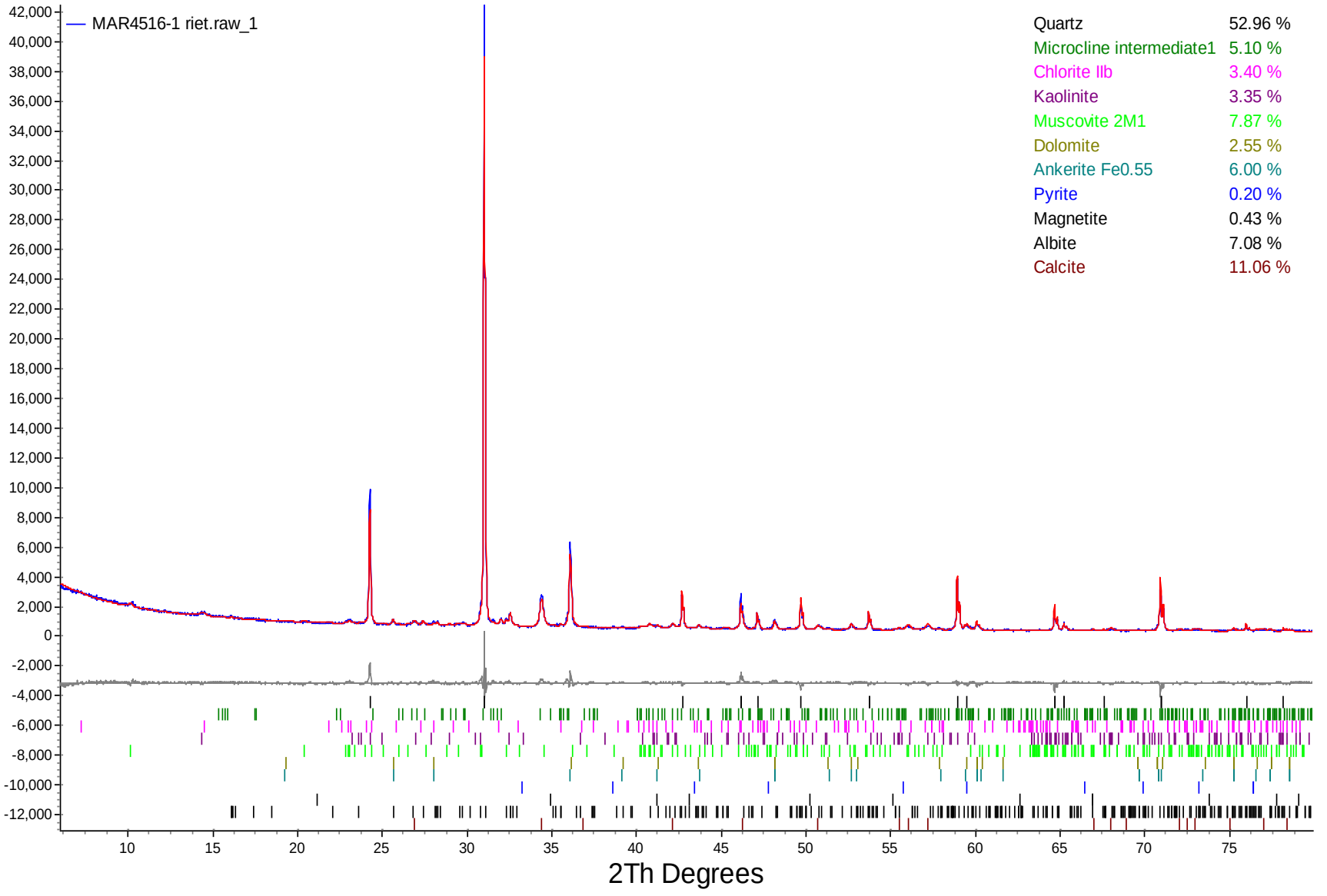
Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

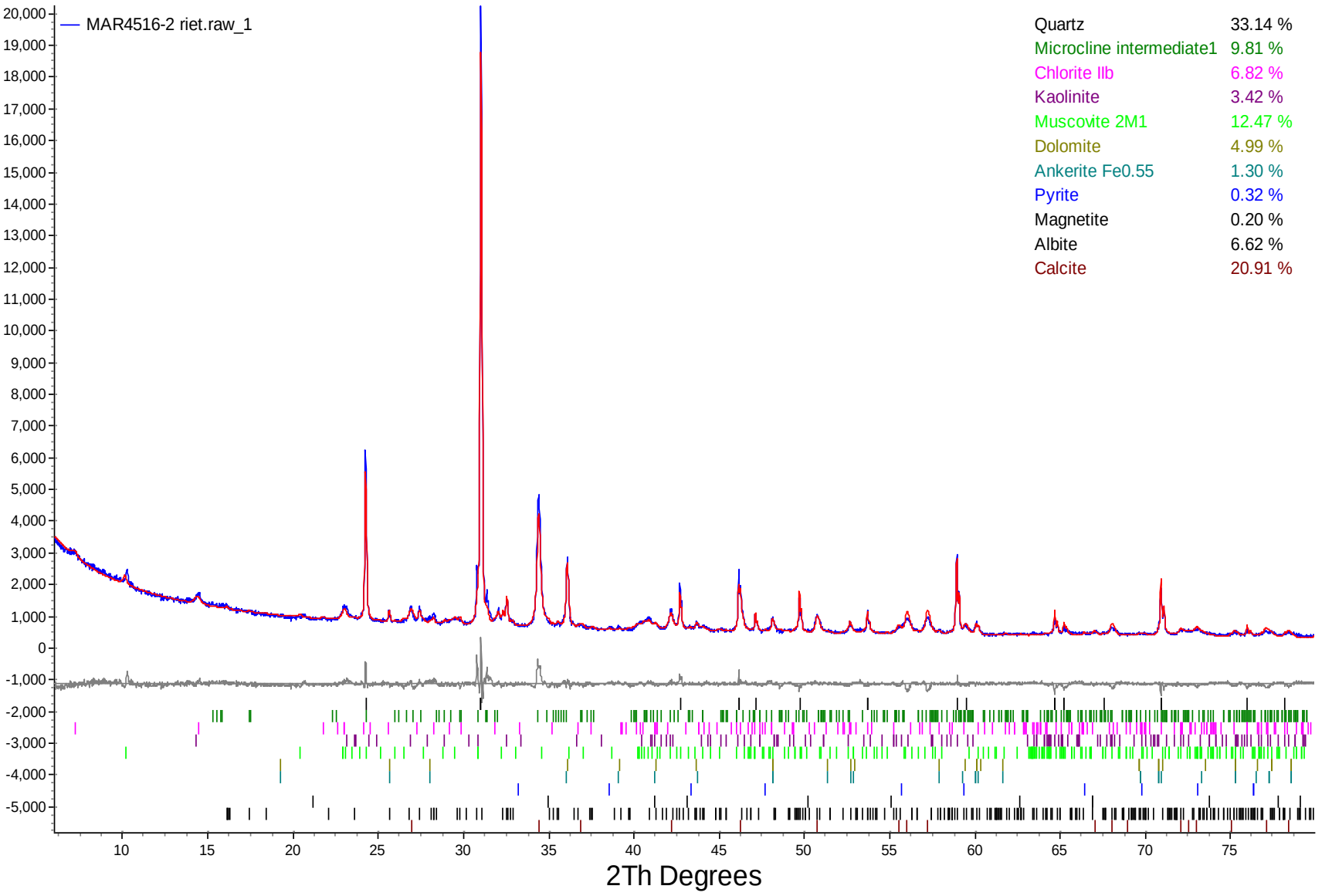
Mineral/Compound	Formula
Quartz	SiO_2
Microcline	$KAlSi_3O_8$
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$
Kaolinite	$Al_2Si_2O_5(OH)_4$
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
Calcite	$CaCO_3$
Dolomite	$CaMg(CO_3)_2$
Ankerite	$CaFe(CO_3)_2$
Pyrite	FeS_2
Magnetite	Fe_3O_4
Albite	$NaAlSi_3O_8$
Actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$

SB-34 32-33'



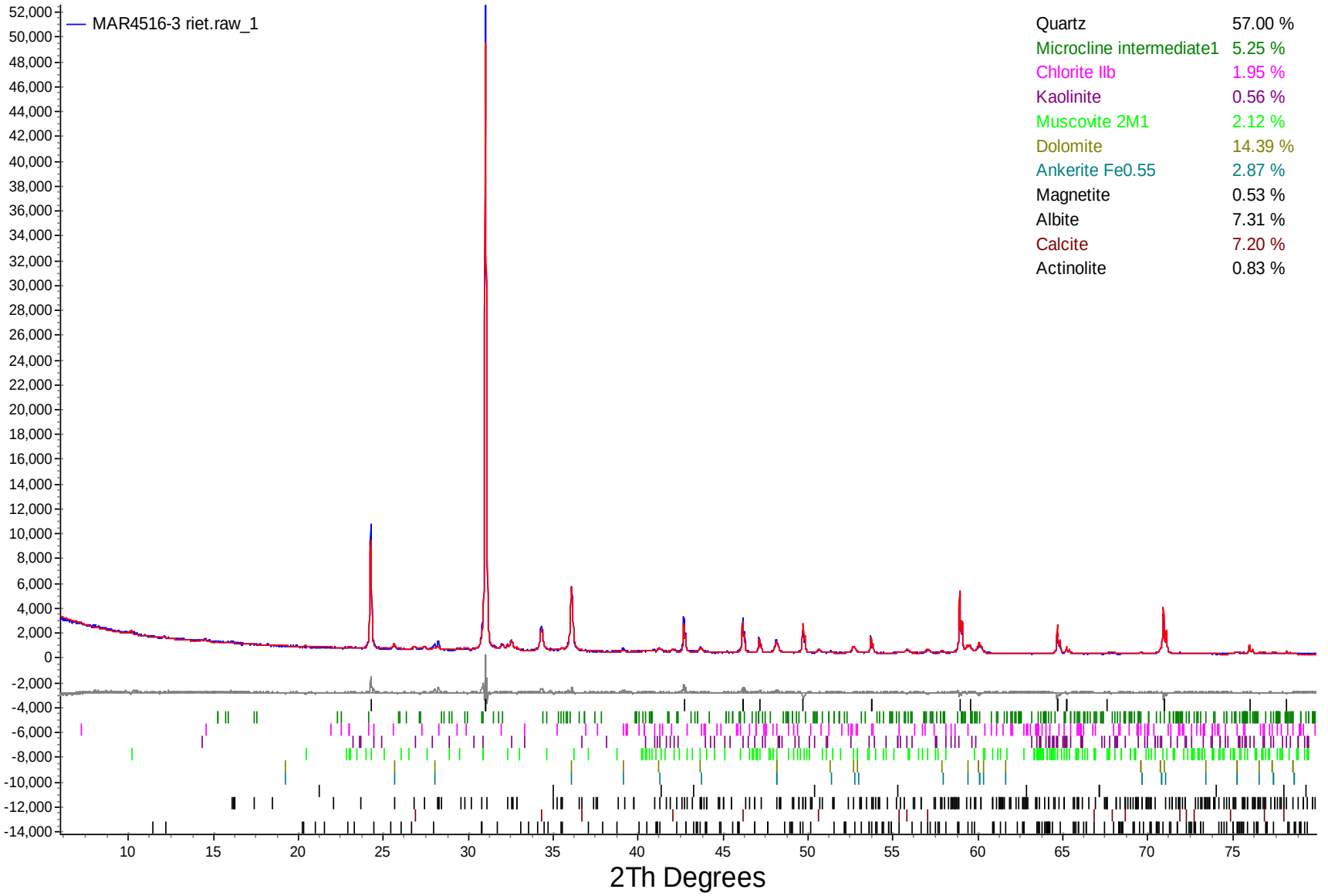
Quartz	52.96 %
Microcline intermediate1	5.10 %
Chlorite IIb	3.40 %
Kaolinite	3.35 %
Muscovite 2M1	7.87 %
Dolomite	2.55 %
Ankerite Fe0.55	6.00 %
Pyrite	0.20 %
Magnetite	0.43 %
Albite	7.08 %
Calcite	11.06 %

SB-51 42-43'



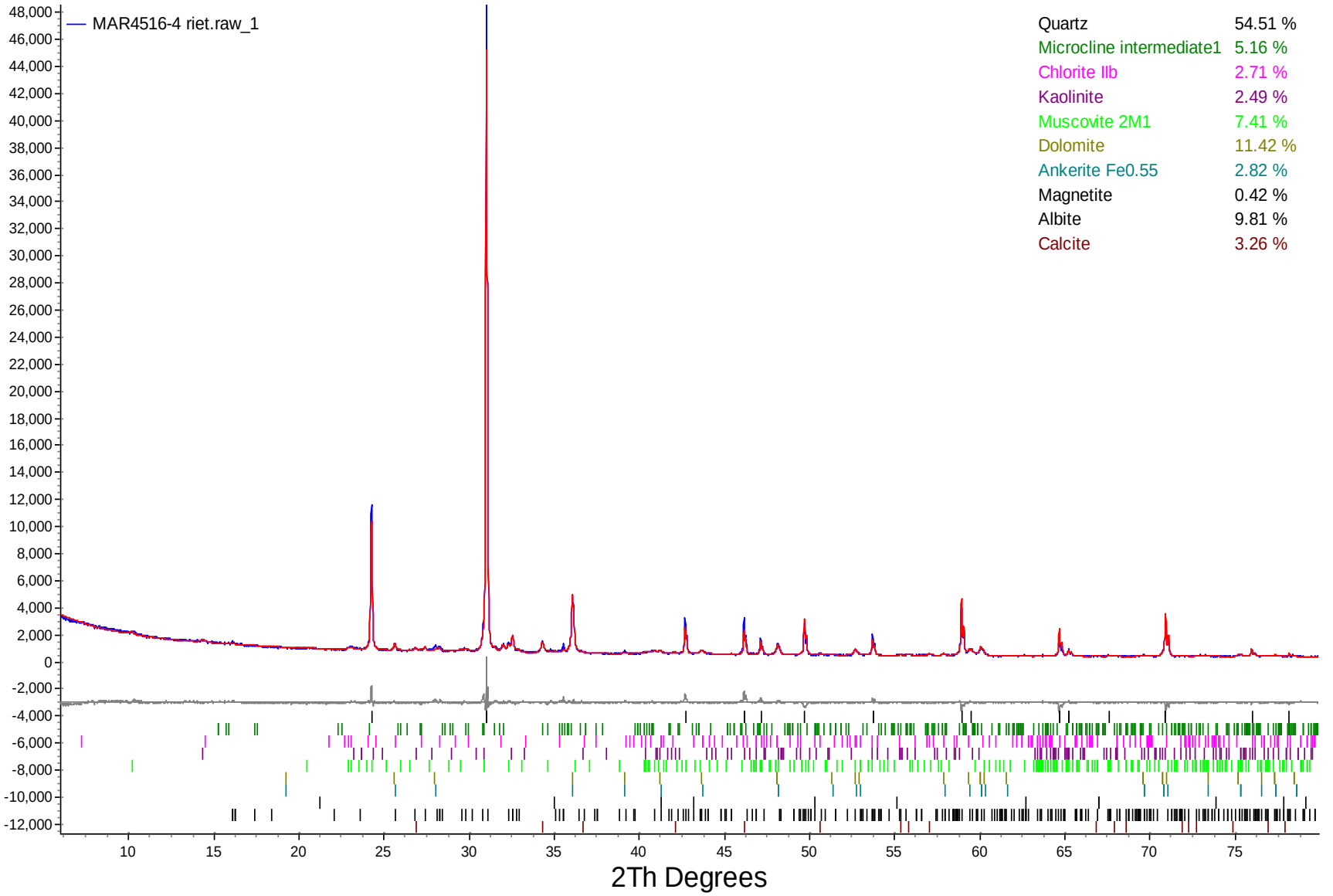
Quartz	33.14 %
Microcline intermediate1	9.81 %
Chlorite IIb	6.82 %
Kaolinite	3.42 %
Muscovite 2M1	12.47 %
Dolomite	4.99 %
Ankerite Fe0.55	1.30 %
Pyrite	0.32 %
Magnetite	0.20 %
Albite	6.62 %
Calcite	20.91 %

SB-22 26-27'



Quartz	57.00 %
Microcline intermediate1	5.25 %
Chlorite IIb	1.95 %
Kaolinite	0.56 %
Muscovite 2M1	2.12 %
Dolomite	14.39 %
Ankerite Fe0.55	2.87 %
Magnetite	0.53 %
Albite	7.31 %
Calcite	7.20 %
Actinolite	0.83 %

SB-22 29-30'



Quartz	54.51 %
Microcline intermediate1	5.16 %
Chlorite IIb	2.71 %
Kaolinite	2.49 %
Muscovite 2M1	7.41 %
Dolomite	11.42 %
Ankerite Fe0.55	2.82 %
Magnetite	0.42 %
Albite	9.81 %
Calcite	3.26 %

ATTACHMENT H
Groundwater Data Summary

Attachment H. Groundwater Data Summary
Geochemical Conceptual Site Model
Hennepin West Ash Pond System
Hennepin Power Plant
Hennepin, IL

HSU	Location	Well Type	Date	Parameter	Unit	Result
UA	32	B	2013/03/08	pH (field)	SU	7.2
UA	32	B	2013/06/26	pH (field)	SU	7.5
UA	32	B	2013/09/03	pH (field)	SU	7.4
UA	32	B	2013/12/10	pH (field)	SU	7.3
UA	32	B	2014/03/25	pH (field)	SU	7.2
UA	32	B	2014/08/19	pH (field)	SU	7.5
UA	32	B	2014/09/30	pH (field)	SU	7.4
UA	32	B	2015/03/18	pH (field)	SU	7.3
UA	32	B	2015/09/16	pH (field)	SU	7.2
UA	32	B	2015/12/10	pH (field)	SU	7.1
UA	32	B	2016/03/08	pH (field)	SU	7.1
UA	32	B	2016/06/07	pH (field)	SU	6.9
UA	32	B	2016/09/15	pH (field)	SU	7.2
UA	32	B	2016/12/07	pH (field)	SU	6.8
UA	32	B	2017/02/21	pH (field)	SU	7.2
UA	32	B	2017/04/25	pH (field)	SU	7.3
UA	32	B	2017/06/08	pH (field)	SU	7.1
UA	32	B	2017/09/06	pH (field)	SU	7.0
UA	32	B	2017/11/15	pH (field)	SU	7.2
UA	32	B	2018/03/26	pH (field)	SU	7.3
UA	32	B	2018/06/13	pH (field)	SU	6.2
UA	32	B	2018/09/12	pH (field)	SU	7.0
UA	32	B	2018/12/12	pH (field)	SU	7.2
UA	32	B	2019/03/13	pH (field)	SU	7.2
UA	32	B	2019/09/18	pH (field)	SU	7.1
UA	32	B	2019/12/11	pH (field)	SU	7.1
UA	32	B	2020/03/11	pH (field)	SU	7.2
UA	32	B	2020/06/25	pH (field)	SU	7.2
UA	32	B	2020/09/02	pH (field)	SU	7.3
UA	32	B	2020/12/09	pH (field)	SU	7.2
UA	32	B	2021/03/17	pH (field)	SU	7.1
UA	32	B	2021/06/24	pH (field)	SU	6.9
UA	32	B	2021/09/09	pH (field)	SU	7.0
UA	32	B	2021/12/08	pH (field)	SU	7.0
UA	32	B	2022/03/22	pH (field)	SU	7.0
UA	32	B	2022/06/07	pH (field)	SU	7.1
UA	32	B	2022/09/13	pH (field)	SU	7.0
UA	32	B	2022/12/27	pH (field)	SU	7.1
UA	32	B	2023/02/28	pH (field)	SU	7.0
UA	32	B	2023/05/31	pH (field)	SU	6.9
UA	32	B	2023/08/22	pH (field)	SU	7.1
UA	32	B	2023/11/14	pH (field)	SU	7.2
UA	32	B	2015/12/10	Oxidation Reduction Potential	mV	182
UA	32	B	2016/03/08	Oxidation Reduction Potential	mV	54.0
UA	32	B	2016/06/07	Oxidation Reduction Potential	mV	193
UA	32	B	2016/09/15	Oxidation Reduction Potential	mV	157
UA	32	B	2016/12/07	Oxidation Reduction Potential	mV	217
UA	32	B	2017/02/21	Oxidation Reduction Potential	mV	-9.00
UA	32	B	2017/04/25	Oxidation Reduction Potential	mV	34.0
UA	32	B	2017/06/08	Oxidation Reduction Potential	mV	125
UA	32	B	2017/11/15	Oxidation Reduction Potential	mV	159
UA	32	B	2018/06/13	Oxidation Reduction Potential	mV	187
UA	32	B	2018/09/12	Oxidation Reduction Potential	mV	119
UA	32	B	2018/12/12	Oxidation Reduction Potential	mV	46.0
UA	32	B	2019/03/13	Oxidation Reduction Potential	mV	94.0

UA	32	B	2019/09/18	Oxidation Reduction Potential	mV	118
UA	32	B	2019/12/11	Oxidation Reduction Potential	mV	32.0
UA	32	B	2020/03/11	Oxidation Reduction Potential	mV	63.0
UA	32	B	2020/06/25	Oxidation Reduction Potential	mV	185
UA	32	B	2020/09/02	Oxidation Reduction Potential	mV	100
UA	32	B	2020/12/09	Oxidation Reduction Potential	mV	30.0
UA	32	B	2021/03/17	Oxidation Reduction Potential	mV	21.0
UA	32	B	2021/06/24	Oxidation Reduction Potential	mV	34.0
UA	32	B	2021/09/09	Oxidation Reduction Potential	mV	71.0
UA	32	B	2021/12/08	Oxidation Reduction Potential	mV	27.0
UA	32	B	2022/03/22	Oxidation Reduction Potential	mV	13.0
UA	32	B	2022/06/07	Oxidation Reduction Potential	mV	78.0
UA	32	B	2022/09/13	Oxidation Reduction Potential	mV	118
UA	32	B	2022/12/27	Oxidation Reduction Potential	mV	33.0
UA	32	B	2023/02/28	Oxidation Reduction Potential	mV	116
UA	32	B	2023/05/31	Oxidation Reduction Potential	mV	86.0
UA	32	B	2023/08/22	Oxidation Reduction Potential	mV	152
UA	32	B	2023/11/14	Oxidation Reduction Potential	mV	46.9
UA	32	B	2015/12/10	Eh	V	0.38
UA	32	B	2016/03/08	Eh	V	0.25
UA	32	B	2016/06/07	Eh	V	0.39
UA	32	B	2016/09/15	Eh	V	0.35
UA	32	B	2016/12/07	Eh	V	0.41
UA	32	B	2017/02/21	Eh	V	0.19
UA	32	B	2017/04/25	Eh	V	0.23
UA	32	B	2017/06/08	Eh	V	0.32
UA	32	B	2017/11/15	Eh	V	0.36
UA	32	B	2018/06/13	Eh	V	0.38
UA	32	B	2018/09/12	Eh	V	0.32
UA	32	B	2018/12/12	Eh	V	0.24
UA	32	B	2019/03/13	Eh	V	0.29
UA	32	B	2019/09/18	Eh	V	0.31
UA	32	B	2019/12/11	Eh	V	0.23
UA	32	B	2020/03/11	Eh	V	0.26
UA	32	B	2020/06/25	Eh	V	0.38
UA	32	B	2020/09/02	Eh	V	0.30
UA	32	B	2020/12/09	Eh	V	0.23
UA	32	B	2021/03/17	Eh	V	0.22
UA	32	B	2021/06/24	Eh	V	0.23
UA	32	B	2021/09/09	Eh	V	0.27
UA	32	B	2021/12/08	Eh	V	0.22
UA	32	B	2022/03/22	Eh	V	0.21
UA	32	B	2022/06/07	Eh	V	0.28
UA	32	B	2022/09/13	Eh	V	0.31
UA	32	B	2022/12/27	Eh	V	0.23
UA	32	B	2023/02/28	Eh	V	0.31
UA	32	B	2023/05/31	Eh	V	0.28
UA	32	B	2023/08/22	Eh	V	0.35
UA	32	B	2023/11/14	Eh	V	0.24
UA	32	B	2019/09/18	Alkalinity, bicarbonate	mg/L CaCO3	294
UA	32	B	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	324
UA	32	B	2021/03/17	Alkalinity, bicarbonate	mg/L CaCO3	324
UA	32	B	2021/09/09	Alkalinity, bicarbonate	mg/L CaCO3	335
UA	32	B	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	317
UA	32	B	2022/09/13	Alkalinity, bicarbonate	mg/L CaCO3	326
UA	32	B	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	341
UA	32	B	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	329
UA	32	B	2023/08/22	Alkalinity, bicarbonate	mg/L CaCO3	320
UA	32	B	2023/11/14	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	32	B	2013/06/26	Arsenic, total	mg/L	<0.0007
UA	32	B	2013/09/03	Arsenic, total	mg/L	<0.0007
UA	32	B	2015/12/10	Arsenic, total	mg/L	<0.0002

UA	32	B	2016/03/08	Arsenic, total	mg/L	<0.0002
UA	32	B	2016/06/07	Arsenic, total	mg/L	<0.0002
UA	32	B	2016/09/15	Arsenic, total	mg/L	<0.0002
UA	32	B	2016/12/07	Arsenic, total	mg/L	<0.0002
UA	32	B	2017/02/21	Arsenic, total	mg/L	<0.0002
UA	32	B	2017/04/25	Arsenic, total	mg/L	<0.0002
UA	32	B	2017/06/08	Arsenic, total	mg/L	<0.0002
UA	32	B	2018/06/13	Arsenic, total	mg/L	<0.0004
UA	32	B	2018/09/12	Arsenic, total	mg/L	<0.0004
UA	32	B	2018/12/12	Arsenic, total	mg/L	<0.0004
UA	32	B	2019/03/13	Arsenic, total	mg/L	0.00100
UA	32	B	2019/09/18	Arsenic, total	mg/L	<0.0004
UA	32	B	2019/12/11	Arsenic, total	mg/L	<0.0004
UA	32	B	2020/03/11	Arsenic, total	mg/L	<0.0004
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UA	32	B	2020/09/02	Arsenic, total	mg/L	<0.0004
UA	32	B	2020/12/09	Arsenic, total	mg/L	<0.0004
UA	32	B	2021/03/17	Arsenic, total	mg/L	<0.0004
UA	32	B	2021/06/24	Arsenic, total	mg/L	<0.0004
UA	32	B	2021/09/09	Arsenic, total	mg/L	<0.0004
UA	32	B	2021/12/08	Arsenic, total	mg/L	<0.0004
UA	32	B	2022/03/22	Arsenic, total	mg/L	<0.0004
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UA	32	B	2022/09/13	Arsenic, total	mg/L	<0.0004
UA	32	B	2022/12/27	Arsenic, total	mg/L	<0.0004
UA	32	B	2023/02/28	Arsenic, total	mg/L	<0.0004
UA	32	B	2023/05/31	Arsenic, total	mg/L	<0.0087
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UA	32	B	2023/11/14	Arsenic, total	mg/L	0.000370
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UA	32	B	2013/09/03	Barium, total	mg/L	0.0438
UA	32	B	2015/12/10	Barium, total	mg/L	0.0332
UA	32	B	2016/03/08	Barium, total	mg/L	0.0340
UA	32	B	2016/06/07	Barium, total	mg/L	0.0290
UA	32	B	2016/09/15	Barium, total	mg/L	0.0347
UA	32	B	2016/12/07	Barium, total	mg/L	0.0387
UA	32	B	2017/02/21	Barium, total	mg/L	0.0317
UA	32	B	2017/04/25	Barium, total	mg/L	0.0329
UA	32	B	2017/06/08	Barium, total	mg/L	0.0340
UA	32	B	2018/06/13	Barium, total	mg/L	0.0338
UA	32	B	2018/09/12	Barium, total	mg/L	0.0403
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UA	32	B	2020/03/11	Barium, total	mg/L	0.0419
UA	32	B	2020/06/25	Barium, total	mg/L	0.0426
UA	32	B	2020/09/02	Barium, total	mg/L	0.0449
UA	32	B	2020/12/09	Barium, total	mg/L	0.0577
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UA	32	B	2022/09/13	Barium, total	mg/L	0.0380
UA	32	B	2022/12/27	Barium, total	mg/L	0.0406
UA	32	B	2023/02/28	Barium, total	mg/L	0.0590
UA	32	B	2023/05/31	Barium, total	mg/L	0.0410
UA	32	B	2023/08/22	Barium, total	mg/L	0.0390
UA	32	B	2023/11/14	Barium, total	mg/L	0.0430
UA	32	B	2013/06/26	Boron, total	mg/L	0.0833

UA	32	B	2013/09/03	Boron, total	mg/L	0.0859
UA	32	B	2015/12/10	Boron, total	mg/L	0.101
UA	32	B	2016/03/08	Boron, total	mg/L	0.101
UA	32	B	2016/06/07	Boron, total	mg/L	0.0749
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UA	32	B	2016/12/07	Boron, total	mg/L	0.108
UA	32	B	2017/02/21	Boron, total	mg/L	0.0681
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UA	32	B	2019/03/13	Boron, total	mg/L	0.115
UA	32	B	2019/09/18	Boron, total	mg/L	0.150
UA	32	B	2019/12/11	Boron, total	mg/L	0.110
UA	32	B	2020/03/11	Boron, total	mg/L	0.110
UA	32	B	2020/06/25	Boron, total	mg/L	0.132
UA	32	B	2020/09/02	Boron, total	mg/L	0.117
UA	32	B	2020/12/09	Boron, total	mg/L	0.124
UA	32	B	2021/03/17	Boron, total	mg/L	0.107
UA	32	B	2021/06/24	Boron, total	mg/L	0.109
UA	32	B	2021/09/09	Boron, total	mg/L	0.162
UA	32	B	2021/12/08	Boron, total	mg/L	0.154
UA	32	B	2022/03/22	Boron, total	mg/L	0.183
UA	32	B	2022/06/07	Boron, total	mg/L	0.188
UA	32	B	2022/09/13	Boron, total	mg/L	0.152
UA	32	B	2022/12/27	Boron, total	mg/L	0.151
UA	32	B	2023/02/28	Boron, total	mg/L	0.199
UA	32	B	2023/05/31	Boron, total	mg/L	0.143
UA	32	B	2023/08/22	Boron, total	mg/L	0.140
UA	32	B	2023/11/14	Boron, total	mg/L	0.180
UA	32	B	2013/06/26	Cadmium, total	mg/L	<0.0003
UA	32	B	2013/09/03	Cadmium, total	mg/L	<0.0003
UA	32	B	2015/12/10	Cadmium, total	mg/L	<0.0002
UA	32	B	2016/03/08	Cadmium, total	mg/L	<0.0002
UA	32	B	2016/06/07	Cadmium, total	mg/L	<0.0002
UA	32	B	2016/09/15	Cadmium, total	mg/L	<0.0002
UA	32	B	2016/12/07	Cadmium, total	mg/L	<0.0002
UA	32	B	2017/02/21	Cadmium, total	mg/L	<0.0002
UA	32	B	2017/04/25	Cadmium, total	mg/L	<0.0002
UA	32	B	2017/06/08	Cadmium, total	mg/L	<0.0002
UA	32	B	2018/06/13	Cadmium, total	mg/L	<0.0002
UA	32	B	2018/09/12	Cadmium, total	mg/L	<0.0002
UA	32	B	2018/12/12	Cadmium, total	mg/L	<0.0002
UA	32	B	2019/03/13	Cadmium, total	mg/L	<0.0002
UA	32	B	2019/09/18	Cadmium, total	mg/L	<0.0002
UA	32	B	2019/12/11	Cadmium, total	mg/L	<0.0002
UA	32	B	2020/03/11	Cadmium, total	mg/L	<0.0002
UA	32	B	2020/06/25	Cadmium, total	mg/L	<0.0002
UA	32	B	2020/09/02	Cadmium, total	mg/L	<0.0002
UA	32	B	2020/12/09	Cadmium, total	mg/L	<0.0002
UA	32	B	2021/03/17	Cadmium, total	mg/L	<0.0002
UA	32	B	2021/06/24	Cadmium, total	mg/L	<0.0002
UA	32	B	2021/09/09	Cadmium, total	mg/L	<0.0002
UA	32	B	2021/12/08	Cadmium, total	mg/L	<0.0002
UA	32	B	2022/03/22	Cadmium, total	mg/L	<0.0002
UA	32	B	2022/06/07	Cadmium, total	mg/L	0.000200
UA	32	B	2022/09/13	Cadmium, total	mg/L	<0.0002
UA	32	B	2022/12/27	Cadmium, total	mg/L	<0.0002
UA	32	B	2023/02/28	Cadmium, total	mg/L	0.000200
UA	32	B	2023/05/31	Cadmium, total	mg/L	<0.0005

UA	32	B	2023/08/22	Cadmium, total	mg/L	0.000210
UA	32	B	2023/11/14	Cadmium, total	mg/L	<0.00017
UA	32	B	2015/12/10	Calcium, total	mg/L	93.2
UA	32	B	2016/03/08	Calcium, total	mg/L	99.1
UA	32	B	2016/06/07	Calcium, total	mg/L	94.3
UA	32	B	2016/09/15	Calcium, total	mg/L	96.0
UA	32	B	2016/12/07	Calcium, total	mg/L	95.0
UA	32	B	2017/02/21	Calcium, total	mg/L	102
UA	32	B	2017/04/25	Calcium, total	mg/L	84.9
UA	32	B	2017/06/08	Calcium, total	mg/L	92.1
UA	32	B	2017/11/15	Calcium, total	mg/L	107
UA	32	B	2018/06/13	Calcium, total	mg/L	96.8
UA	32	B	2018/09/12	Calcium, total	mg/L	107
UA	32	B	2018/12/12	Calcium, total	mg/L	115
UA	32	B	2019/03/13	Calcium, total	mg/L	104
UA	32	B	2019/09/18	Calcium, total	mg/L	95.9
UA	32	B	2019/12/11	Calcium, total	mg/L	98.6
UA	32	B	2020/03/11	Calcium, total	mg/L	98.0
UA	32	B	2020/06/25	Calcium, total	mg/L	89.5
UA	32	B	2020/09/02	Calcium, total	mg/L	96.3
UA	32	B	2020/12/09	Calcium, total	mg/L	141
UA	32	B	2021/03/17	Calcium, total	mg/L	101
UA	32	B	2021/06/24	Calcium, total	mg/L	106
UA	32	B	2021/09/09	Calcium, total	mg/L	115
UA	32	B	2021/12/08	Calcium, total	mg/L	101
UA	32	B	2022/03/22	Calcium, total	mg/L	110
UA	32	B	2022/06/07	Calcium, total	mg/L	115
UA	32	B	2022/09/13	Calcium, total	mg/L	113
UA	32	B	2022/12/27	Calcium, total	mg/L	112
UA	32	B	2023/02/28	Calcium, total	mg/L	122
UA	32	B	2023/05/31	Calcium, total	mg/L	102
UA	32	B	2023/08/22	Calcium, total	mg/L	100
UA	32	B	2023/11/14	Calcium, total	mg/L	110
UA	32	B	2013/03/08	Chloride, total	mg/L	119
UA	32	B	2013/06/26	Chloride, total	mg/L	69.0
UA	32	B	2013/09/03	Chloride, total	mg/L	54.0
UA	32	B	2013/12/10	Chloride, total	mg/L	109
UA	32	B	2014/03/25	Chloride, total	mg/L	107
UA	32	B	2014/09/30	Chloride, total	mg/L	41.0
UA	32	B	2015/03/18	Chloride, total	mg/L	53.0
UA	32	B	2015/09/16	Chloride, total	mg/L	38.0
UA	32	B	2015/12/10	Chloride, total	mg/L	42.0
UA	32	B	2016/03/08	Chloride, total	mg/L	51.0
UA	32	B	2016/06/07	Chloride, total	mg/L	47.0
UA	32	B	2016/09/15	Chloride, total	mg/L	47.0
UA	32	B	2016/12/07	Chloride, total	mg/L	48.0
UA	32	B	2017/02/21	Chloride, total	mg/L	44.0
UA	32	B	2017/04/25	Chloride, total	mg/L	51.0
UA	32	B	2017/06/08	Chloride, total	mg/L	47.0
UA	32	B	2017/09/06	Chloride, total	mg/L	48.0
UA	32	B	2017/11/15	Chloride, total	mg/L	57.0
UA	32	B	2018/03/26	Chloride, total	mg/L	59.0
UA	32	B	2018/06/13	Chloride, total	mg/L	64.0
UA	32	B	2018/09/12	Chloride, total	mg/L	73.0
UA	32	B	2018/12/12	Chloride, total	mg/L	61.0
UA	32	B	2019/03/13	Chloride, total	mg/L	61.0
UA	32	B	2019/09/18	Chloride, total	mg/L	56.0
UA	32	B	2019/12/11	Chloride, total	mg/L	61.0
UA	32	B	2020/03/11	Chloride, total	mg/L	57.0
UA	32	B	2020/06/25	Chloride, total	mg/L	52.0
UA	32	B	2020/09/02	Chloride, total	mg/L	52.0
UA	32	B	2020/12/09	Chloride, total	mg/L	56.0

UA	32	B	2021/03/17	Chloride, total	mg/L	54.0
UA	32	B	2021/06/24	Chloride, total	mg/L	57.0
UA	32	B	2021/09/09	Chloride, total	mg/L	57.0
UA	32	B	2021/12/08	Chloride, total	mg/L	68.0
UA	32	B	2022/03/22	Chloride, total	mg/L	68.0
UA	32	B	2022/06/07	Chloride, total	mg/L	73.0
UA	32	B	2022/09/13	Chloride, total	mg/L	74.0
UA	32	B	2022/12/27	Chloride, total	mg/L	80.0
UA	32	B	2023/02/28	Chloride, total	mg/L	83.0
UA	32	B	2023/05/31	Chloride, total	mg/L	70.0
UA	32	B	2023/08/22	Chloride, total	mg/L	68.0
UA	32	B	2023/11/14	Chloride, total	mg/L	67.0
UA	32	B	2013/03/08	Iron, dissolved	mg/L	0.100
UA	32	B	2013/12/10	Iron, dissolved	mg/L	0.294
UA	32	B	2014/03/25	Iron, dissolved	mg/L	<0.007
UA	32	B	2014/08/19	Iron, dissolved	mg/L	<0.007
UA	32	B	2014/09/30	Iron, dissolved	mg/L	<0.007
UA	32	B	2015/03/18	Iron, dissolved	mg/L	<0.007
UA	32	B	2015/09/16	Iron, dissolved	mg/L	<0.007
UA	32	B	2016/03/08	Iron, dissolved	mg/L	<0.007
UA	32	B	2016/09/15	Iron, dissolved	mg/L	<0.007
UA	32	B	2017/02/21	Iron, dissolved	mg/L	<0.007
UA	32	B	2017/09/06	Iron, dissolved	mg/L	<0.007
UA	32	B	2018/03/26	Iron, dissolved	mg/L	<0.007
UA	32	B	2023/05/31	Iron, dissolved	mg/L	<0.02
UA	32	B	2023/08/22	Iron, dissolved	mg/L	<0.047
UA	32	B	2015/12/10	Lithium, total	mg/L	0.00260
UA	32	B	2016/03/08	Lithium, total	mg/L	0.00250
UA	32	B	2016/06/07	Lithium, total	mg/L	0.00220
UA	32	B	2016/09/15	Lithium, total	mg/L	0.00380
UA	32	B	2016/12/07	Lithium, total	mg/L	0.00290
UA	32	B	2017/02/21	Lithium, total	mg/L	0.00250
UA	32	B	2017/04/25	Lithium, total	mg/L	0.00340
UA	32	B	2017/06/08	Lithium, total	mg/L	0.00250
UA	32	B	2018/06/13	Lithium, total	mg/L	0.00300
UA	32	B	2018/09/12	Lithium, total	mg/L	0.00370
UA	32	B	2018/12/12	Lithium, total	mg/L	0.00280
UA	32	B	2019/03/13	Lithium, total	mg/L	0.00400
UA	32	B	2019/09/18	Lithium, total	mg/L	0.00450
UA	32	B	2019/12/11	Lithium, total	mg/L	0.00450
UA	32	B	2020/03/11	Lithium, total	mg/L	0.00430
UA	32	B	2020/06/25	Lithium, total	mg/L	0.00430
UA	32	B	2020/09/02	Lithium, total	mg/L	0.00410
UA	32	B	2020/12/09	Lithium, total	mg/L	0.00360
UA	32	B	2021/03/17	Lithium, total	mg/L	0.00340
UA	32	B	2021/06/24	Lithium, total	mg/L	0.00370
UA	32	B	2021/09/09	Lithium, total	mg/L	0.00370
UA	32	B	2021/12/08	Lithium, total	mg/L	0.00400
UA	32	B	2022/03/22	Lithium, total	mg/L	0.00400
UA	32	B	2022/06/07	Lithium, total	mg/L	0.00390
UA	32	B	2022/09/13	Lithium, total	mg/L	0.00320
UA	32	B	2022/12/27	Lithium, total	mg/L	0.00390
UA	32	B	2023/02/28	Lithium, total	mg/L	0.00310
UA	32	B	2023/05/31	Lithium, total	mg/L	0.00290
UA	32	B	2023/08/22	Lithium, total	mg/L	0.00480
UA	32	B	2023/11/14	Lithium, total	mg/L	0.00510
UA	32	B	2019/09/18	Magnesium, total	mg/L	33.6
UA	32	B	2020/03/11	Magnesium, total	mg/L	36.1
UA	32	B	2020/06/25	Magnesium, total	mg/L	34.9
UA	32	B	2021/03/17	Magnesium, total	mg/L	36.8
UA	32	B	2021/09/09	Magnesium, total	mg/L	42.0
UA	32	B	2022/03/22	Magnesium, total	mg/L	39.0

UA	32	B	2022/09/13	Magnesium, total	mg/L	39.6
UA	32	B	2023/02/28	Magnesium, total	mg/L	42.4
UA	32	B	2023/05/31	Magnesium, total	mg/L	39.5
UA	32	B	2023/08/22	Magnesium, total	mg/L	39.0
UA	32	B	2023/11/14	Magnesium, total	mg/L	38.0
UA	32	B	2013/03/08	Manganese, dissolved	mg/L	1.19
UA	32	B	2013/12/10	Manganese, dissolved	mg/L	0.411
UA	32	B	2014/03/25	Manganese, dissolved	mg/L	0.266
UA	32	B	2014/08/19	Manganese, dissolved	mg/L	<0.0016
UA	32	B	2014/09/30	Manganese, dissolved	mg/L	<0.0005
UA	32	B	2015/03/18	Manganese, dissolved	mg/L	0.00540
UA	32	B	2015/09/16	Manganese, dissolved	mg/L	0.0504
UA	32	B	2016/03/08	Manganese, dissolved	mg/L	<0.0005
UA	32	B	2016/09/15	Manganese, dissolved	mg/L	0.00720
UA	32	B	2017/02/21	Manganese, dissolved	mg/L	0.00700
UA	32	B	2017/09/06	Manganese, dissolved	mg/L	0.00860
UA	32	B	2018/03/26	Manganese, dissolved	mg/L	0.00700
UA	32	B	2023/05/31	Manganese, dissolved	mg/L	0.0495
UA	32	B	2023/08/22	Manganese, dissolved	mg/L	0.0920
UA	32	B	2023/05/31	Phosphate, dissolved	mg/L	0.175
UA	32	B	2023/08/22	Phosphate, dissolved	mg/L	<0.073
UA	32	B	2019/09/18	Potassium, total	mg/L	2.30
UA	32	B	2020/03/11	Potassium, total	mg/L	2.27
UA	32	B	2020/06/25	Potassium, total	mg/L	2.34
UA	32	B	2021/03/17	Potassium, total	mg/L	2.06
UA	32	B	2021/09/09	Potassium, total	mg/L	2.37
UA	32	B	2022/03/22	Potassium, total	mg/L	2.08
UA	32	B	2022/09/13	Potassium, total	mg/L	2.24
UA	32	B	2023/02/28	Potassium, total	mg/L	1.95
UA	32	B	2023/05/31	Potassium, total	mg/L	2.22
UA	32	B	2023/08/22	Potassium, total	mg/L	2.10
UA	32	B	2023/11/14	Potassium, total	mg/L	2.10
UA	32	B	2023/05/31	Silicon, dissolved	mg/L	5.65
UA	32	B	2023/08/22	Silicon, dissolved	mg/L	6.90
UA	32	B	2019/09/18	Sodium, total	mg/L	29.9
UA	32	B	2020/03/11	Sodium, total	mg/L	33.0
UA	32	B	2020/06/25	Sodium, total	mg/L	32.4
UA	32	B	2021/03/17	Sodium, total	mg/L	34.5
UA	32	B	2021/09/09	Sodium, total	mg/L	33.4
UA	32	B	2022/03/22	Sodium, total	mg/L	38.0
UA	32	B	2022/09/13	Sodium, total	mg/L	38.6
UA	32	B	2023/02/28	Sodium, total	mg/L	39.7
UA	32	B	2023/05/31	Sodium, total	mg/L	40.1
UA	32	B	2023/08/22	Sodium, total	mg/L	38.0
UA	32	B	2023/11/14	Sodium, total	mg/L	39.0
UA	32	B	2013/03/08	Sulfate, total	mg/L	146
UA	32	B	2013/06/26	Sulfate, total	mg/L	102
UA	32	B	2013/09/03	Sulfate, total	mg/L	83.0
UA	32	B	2013/12/10	Sulfate, total	mg/L	128
UA	32	B	2014/03/25	Sulfate, total	mg/L	97.0
UA	32	B	2014/09/30	Sulfate, total	mg/L	71.0
UA	32	B	2015/03/18	Sulfate, total	mg/L	78.0
UA	32	B	2015/09/16	Sulfate, total	mg/L	62.0
UA	32	B	2015/12/10	Sulfate, total	mg/L	60.0
UA	32	B	2016/03/08	Sulfate, total	mg/L	62.0
UA	32	B	2016/06/07	Sulfate, total	mg/L	62.0
UA	32	B	2016/09/15	Sulfate, total	mg/L	61.0
UA	32	B	2016/12/07	Sulfate, total	mg/L	61.0
UA	32	B	2017/02/21	Sulfate, total	mg/L	57.0
UA	32	B	2017/04/25	Sulfate, total	mg/L	61.0
UA	32	B	2017/06/08	Sulfate, total	mg/L	58.0
UA	32	B	2017/09/06	Sulfate, total	mg/L	57.0

UA	32	B	2017/11/15	Sulfate, total	mg/L	56.0
UA	32	B	2018/03/26	Sulfate, total	mg/L	66.0
UA	32	B	2018/06/13	Sulfate, total	mg/L	54.0
UA	32	B	2018/09/12	Sulfate, total	mg/L	60.0
UA	32	B	2018/12/12	Sulfate, total	mg/L	55.0
UA	32	B	2019/03/13	Sulfate, total	mg/L	51.0
UA	32	B	2019/09/18	Sulfate, total	mg/L	37.0
UA	32	B	2019/12/11	Sulfate, total	mg/L	42.0
UA	32	B	2020/03/11	Sulfate, total	mg/L	42.0
UA	32	B	2020/06/25	Sulfate, total	mg/L	52.0
UA	32	B	2020/09/02	Sulfate, total	mg/L	41.0
UA	32	B	2020/12/09	Sulfate, total	mg/L	44.0
UA	32	B	2021/03/17	Sulfate, total	mg/L	45.0
UA	32	B	2021/06/24	Sulfate, total	mg/L	50.0
UA	32	B	2021/09/09	Sulfate, total	mg/L	50.0
UA	32	B	2021/12/08	Sulfate, total	mg/L	64.0
UA	32	B	2022/03/22	Sulfate, total	mg/L	60.0
UA	32	B	2022/06/07	Sulfate, total	mg/L	62.0
UA	32	B	2022/09/13	Sulfate, total	mg/L	62.0
UA	32	B	2022/12/27	Sulfate, total	mg/L	65.0
UA	32	B	2023/02/28	Sulfate, total	mg/L	82.0
UA	32	B	2023/05/31	Sulfate, total	mg/L	63.0
UA	32	B	2023/08/22	Sulfate, total	mg/L	66.0
UA	32	B	2023/11/14	Sulfate, total	mg/L	65.0
UA	32	B	2013/03/08	Temperature (Celsius)	degrees C	6.50
UA	32	B	2013/06/26	Temperature (Celsius)	degrees C	12.8
UA	32	B	2013/09/03	Temperature (Celsius)	degrees C	12.9
UA	32	B	2013/12/10	Temperature (Celsius)	degrees C	10.5
UA	32	B	2014/03/25	Temperature (Celsius)	degrees C	5.90
UA	32	B	2014/08/19	Temperature (Celsius)	degrees C	12.0
UA	32	B	2014/09/30	Temperature (Celsius)	degrees C	12.0
UA	32	B	2015/03/18	Temperature (Celsius)	degrees C	8.50
UA	32	B	2015/09/16	Temperature (Celsius)	degrees C	13.1
UA	32	B	2015/12/10	Temperature (Celsius)	degrees C	13.5
UA	32	B	2016/03/08	Temperature (Celsius)	degrees C	10.4
UA	32	B	2016/06/07	Temperature (Celsius)	degrees C	11.2
UA	32	B	2016/09/15	Temperature (Celsius)	degrees C	15.1
UA	32	B	2016/12/07	Temperature (Celsius)	degrees C	12.1
UA	32	B	2017/02/21	Temperature (Celsius)	degrees C	11.8
UA	32	B	2017/04/25	Temperature (Celsius)	degrees C	14.6
UA	32	B	2017/06/08	Temperature (Celsius)	degrees C	12
UA	32	B	2017/09/06	Temperature (Celsius)	degrees C	13.5
UA	32	B	2017/11/15	Temperature (Celsius)	degrees C	14.0
UA	32	B	2018/03/26	Temperature (Celsius)	degrees C	11.1
UA	32	B	2018/06/13	Temperature (Celsius)	degrees C	12.4
UA	32	B	2018/09/12	Temperature (Celsius)	degrees C	13.9
UA	32	B	2018/12/12	Temperature (Celsius)	degrees C	11.9
UA	32	B	2019/03/13	Temperature (Celsius)	degrees C	10.0
UA	32	B	2019/09/18	Temperature (Celsius)	degrees C	13.6
UA	32	B	2019/12/11	Temperature (Celsius)	degrees C	12.9
UA	32	B	2020/03/11	Temperature (Celsius)	degrees C	9.60
UA	32	B	2020/06/25	Temperature (Celsius)	degrees C	10.7
UA	32	B	2020/09/02	Temperature (Celsius)	degrees C	13.7
UA	32	B	2020/12/09	Temperature (Celsius)	degrees C	13.1
UA	32	B	2021/03/17	Temperature (Celsius)	degrees C	9.80
UA	32	B	2021/06/24	Temperature (Celsius)	degrees C	11.6
UA	32	B	2021/09/09	Temperature (Celsius)	degrees C	13.9
UA	32	B	2021/12/08	Temperature (Celsius)	degrees C	13.6
UA	32	B	2022/03/22	Temperature (Celsius)	degrees C	10.1
UA	32	B	2022/06/07	Temperature (Celsius)	degrees C	11.0
UA	32	B	2022/09/13	Temperature (Celsius)	degrees C	14.3
UA	32	B	2022/12/27	Temperature (Celsius)	degrees C	12.0

UA	32	B	2023/02/28	Temperature (Celsius)	degrees C	10.2
UA	32	B	2023/05/31	Temperature (Celsius)	degrees C	11.0
UA	32	B	2023/08/22	Temperature (Celsius)	degrees C	13.8
UA	32	B	2023/11/14	Temperature (Celsius)	degrees C	14.1
UA	32	B	2013/03/08	Total Dissolved Solids	mg/L	652
UA	32	B	2013/06/26	Total Dissolved Solids	mg/L	592
UA	32	B	2013/09/03	Total Dissolved Solids	mg/L	486
UA	32	B	2013/12/10	Total Dissolved Solids	mg/L	654
UA	32	B	2014/03/25	Total Dissolved Solids	mg/L	552
UA	32	B	2014/08/19	Total Dissolved Solids	mg/L	466
UA	32	B	2014/09/30	Total Dissolved Solids	mg/L	468
UA	32	B	2015/03/18	Total Dissolved Solids	mg/L	524
UA	32	B	2015/09/16	Total Dissolved Solids	mg/L	468
UA	32	B	2015/12/10	Total Dissolved Solids	mg/L	466
UA	32	B	2016/03/08	Total Dissolved Solids	mg/L	480
UA	32	B	2016/06/07	Total Dissolved Solids	mg/L	462
UA	32	B	2016/09/15	Total Dissolved Solids	mg/L	502
UA	32	B	2016/12/07	Total Dissolved Solids	mg/L	456
UA	32	B	2017/02/21	Total Dissolved Solids	mg/L	452
UA	32	B	2017/04/25	Total Dissolved Solids	mg/L	508
UA	32	B	2017/06/08	Total Dissolved Solids	mg/L	450
UA	32	B	2017/09/06	Total Dissolved Solids	mg/L	494
UA	32	B	2017/11/15	Total Dissolved Solids	mg/L	506
UA	32	B	2018/03/26	Total Dissolved Solids	mg/L	492
UA	32	B	2018/06/13	Total Dissolved Solids	mg/L	494
UA	32	B	2018/09/12	Total Dissolved Solids	mg/L	532
UA	32	B	2018/12/12	Total Dissolved Solids	mg/L	536
UA	32	B	2019/03/13	Total Dissolved Solids	mg/L	506
UA	32	B	2019/09/18	Total Dissolved Solids	mg/L	492
UA	32	B	2019/12/11	Total Dissolved Solids	mg/L	476
UA	32	B	2020/03/11	Total Dissolved Solids	mg/L	476
UA	32	B	2020/06/25	Total Dissolved Solids	mg/L	468
UA	32	B	2020/09/02	Total Dissolved Solids	mg/L	464
UA	32	B	2020/12/09	Total Dissolved Solids	mg/L	482
UA	32	B	2021/03/17	Total Dissolved Solids	mg/L	488
UA	32	B	2021/06/24	Total Dissolved Solids	mg/L	474
UA	32	B	2021/09/09	Total Dissolved Solids	mg/L	486
UA	32	B	2021/12/08	Total Dissolved Solids	mg/L	514
UA	32	B	2022/03/22	Total Dissolved Solids	mg/L	514
UA	32	B	2022/06/07	Total Dissolved Solids	mg/L	598
UA	32	B	2022/09/13	Total Dissolved Solids	mg/L	596
UA	32	B	2022/12/27	Total Dissolved Solids	mg/L	560
UA	32	B	2023/02/28	Total Dissolved Solids	mg/L	564
UA	32	B	2023/05/31	Total Dissolved Solids	mg/L	550
UA	32	B	2023/08/22	Total Dissolved Solids	mg/L	570
UA	32	B	2023/11/14	Total Dissolved Solids	mg/L	600
UA	34	B	2013/03/08	pH (field)	SU	7.2
UA	34	B	2013/09/04	pH (field)	SU	7.3
UA	34	B	2013/12/10	pH (field)	SU	7.2
UA	34	B	2014/03/25	pH (field)	SU	7.0
UA	34	B	2015/03/18	pH (field)	SU	7.1
UA	34	B	2015/12/09	pH (field)	SU	7.2
UA	34	B	2016/03/08	pH (field)	SU	7.0
UA	34	B	2016/06/07	pH (field)	SU	7.0
UA	34	B	2016/09/15	pH (field)	SU	7.1
UA	34	B	2016/12/07	pH (field)	SU	7.0
UA	34	B	2017/02/21	pH (field)	SU	7.1
UA	34	B	2017/04/25	pH (field)	SU	6.9
UA	34	B	2017/06/08	pH (field)	SU	7.0
UA	34	B	2017/11/15	pH (field)	SU	7.2
UA	34	B	2018/03/26	pH (field)	SU	7.2
UA	34	B	2018/06/13	pH (field)	SU	6.4

UA	34	B	2018/09/12	pH (field)	SU	7.0
UA	34	B	2018/12/12	pH (field)	SU	7.1
UA	34	B	2019/03/13	pH (field)	SU	7.2
UA	34	B	2019/09/18	pH (field)	SU	6.8
UA	34	B	2019/12/11	pH (field)	SU	7.0
UA	34	B	2020/03/11	pH (field)	SU	7.1
UA	34	B	2020/06/24	pH (field)	SU	7.1
UA	34	B	2020/09/02	pH (field)	SU	7.1
UA	34	B	2020/12/09	pH (field)	SU	7.1
UA	34	B	2021/03/19	pH (field)	SU	7.1
UA	34	B	2021/06/24	pH (field)	SU	6.7
UA	34	B	2021/09/09	pH (field)	SU	6.9
UA	34	B	2021/12/09	pH (field)	SU	7.0
UA	34	B	2022/03/22	pH (field)	SU	6.8
UA	34	B	2022/06/07	pH (field)	SU	6.9
UA	34	B	2022/12/29	pH (field)	SU	6.9
UA	34	B	2023/02/28	pH (field)	SU	6.9
UA	34	B	2023/05/31	pH (field)	SU	6.9
UA	34	B	2023/08/25	pH (field)	SU	7.1
UA	34	B	2023/11/14	pH (field)	SU	7.2
UA	34	B	2015/12/09	Oxidation Reduction Potential	mV	-67.0
UA	34	B	2016/03/08	Oxidation Reduction Potential	mV	-113
UA	34	B	2016/06/07	Oxidation Reduction Potential	mV	-125
UA	34	B	2016/09/15	Oxidation Reduction Potential	mV	-86.0
UA	34	B	2016/12/07	Oxidation Reduction Potential	mV	-77.0
UA	34	B	2017/02/21	Oxidation Reduction Potential	mV	-67.0
UA	34	B	2017/04/25	Oxidation Reduction Potential	mV	-90.0
UA	34	B	2017/06/08	Oxidation Reduction Potential	mV	-115
UA	34	B	2017/11/15	Oxidation Reduction Potential	mV	18.0
UA	34	B	2018/06/13	Oxidation Reduction Potential	mV	-8.00
UA	34	B	2018/09/12	Oxidation Reduction Potential	mV	-101
UA	34	B	2018/12/12	Oxidation Reduction Potential	mV	-113
UA	34	B	2019/03/13	Oxidation Reduction Potential	mV	-64.0
UA	34	B	2019/09/18	Oxidation Reduction Potential	mV	-79.0
UA	34	B	2019/12/11	Oxidation Reduction Potential	mV	-76.0
UA	34	B	2020/03/11	Oxidation Reduction Potential	mV	-60.0
UA	34	B	2020/06/24	Oxidation Reduction Potential	mV	-72.0
UA	34	B	2020/09/02	Oxidation Reduction Potential	mV	-80.0
UA	34	B	2020/12/09	Oxidation Reduction Potential	mV	-94.0
UA	34	B	2021/03/19	Oxidation Reduction Potential	mV	-108
UA	34	B	2021/06/24	Oxidation Reduction Potential	mV	-124
UA	34	B	2021/09/09	Oxidation Reduction Potential	mV	-30.0
UA	34	B	2021/12/09	Oxidation Reduction Potential	mV	-86.0
UA	34	B	2022/03/22	Oxidation Reduction Potential	mV	-86.0
UA	34	B	2022/06/07	Oxidation Reduction Potential	mV	51.0
UA	34	B	2022/12/29	Oxidation Reduction Potential	mV	-95.0
UA	34	B	2023/02/28	Oxidation Reduction Potential	mV	-84.5
UA	34	B	2023/05/31	Oxidation Reduction Potential	mV	-83.0
UA	34	B	2023/08/25	Oxidation Reduction Potential	mV	-111
UA	34	B	2023/11/14	Oxidation Reduction Potential	mV	-111
UA	34	B	2015/12/09	Eh	V	0.13
UA	34	B	2016/03/08	Eh	V	0.085
UA	34	B	2016/06/07	Eh	V	0.072
UA	34	B	2016/09/15	Eh	V	0.11
UA	34	B	2016/12/07	Eh	V	0.12
UA	34	B	2017/02/21	Eh	V	0.13
UA	34	B	2017/04/25	Eh	V	0.10
UA	34	B	2017/06/08	Eh	V	0.075
UA	34	B	2017/11/15	Eh	V	0.21
UA	34	B	2018/06/13	Eh	V	0.19
UA	34	B	2018/09/12	Eh	V	0.090
UA	34	B	2018/12/12	Eh	V	0.085

UA	34	B	2019/03/13	Eh	V	0.13
UA	34	B	2019/09/18	Eh	V	0.12
UA	34	B	2019/12/11	Eh	V	0.12
UA	34	B	2020/03/11	Eh	V	0.14
UA	34	B	2020/06/24	Eh	V	0.13
UA	34	B	2020/09/02	Eh	V	0.12
UA	34	B	2020/12/09	Eh	V	0.10
UA	34	B	2021/03/19	Eh	V	0.090
UA	34	B	2021/06/24	Eh	V	0.073
UA	34	B	2021/09/09	Eh	V	0.17
UA	34	B	2021/12/09	Eh	V	0.11
UA	34	B	2022/03/22	Eh	V	0.11
UA	34	B	2022/06/07	Eh	V	0.25
UA	34	B	2022/12/29	Eh	V	0.10
UA	34	B	2023/02/28	Eh	V	0.11
UA	34	B	2023/05/31	Eh	V	0.11
UA	34	B	2023/08/25	Eh	V	0.086
UA	34	B	2023/11/14	Eh	V	0.087
UA	34	B	2019/09/18	Alkalinity, bicarbonate	mg/L CaCO3	496
UA	34	B	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	504
UA	34	B	2021/03/19	Alkalinity, bicarbonate	mg/L CaCO3	514
UA	34	B	2021/09/09	Alkalinity, bicarbonate	mg/L CaCO3	516
UA	34	B	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	527
UA	34	B	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	575
UA	34	B	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	521
UA	34	B	2023/08/25	Alkalinity, bicarbonate	mg/L CaCO3	570
UA	34	B	2023/11/14	Alkalinity, bicarbonate	mg/L CaCO3	570
UA	34	B	2013/09/04	Arsenic, total	mg/L	<0.0007
UA	34	B	2015/12/09	Arsenic, total	mg/L	<0.0002
UA	34	B	2016/03/08	Arsenic, total	mg/L	<0.0002
UA	34	B	2016/06/07	Arsenic, total	mg/L	<0.0002
UA	34	B	2016/09/15	Arsenic, total	mg/L	<0.0002
UA	34	B	2016/12/07	Arsenic, total	mg/L	<0.0002
UA	34	B	2017/02/21	Arsenic, total	mg/L	<0.0002
UA	34	B	2017/04/25	Arsenic, total	mg/L	<0.0002
UA	34	B	2017/06/08	Arsenic, total	mg/L	<0.0002
UA	34	B	2018/06/13	Arsenic, total	mg/L	<0.0004
UA	34	B	2018/09/12	Arsenic, total	mg/L	<0.0004
UA	34	B	2018/12/12	Arsenic, total	mg/L	<0.0004
UA	34	B	2019/03/13	Arsenic, total	mg/L	0.00200
UA	34	B	2019/09/18	Arsenic, total	mg/L	<0.0004
UA	34	B	2019/12/11	Arsenic, total	mg/L	<0.0004
UA	34	B	2020/03/11	Arsenic, total	mg/L	<0.0004
UA	34	B	2020/06/24	Arsenic, total	mg/L	<0.0004
UA	34	B	2020/09/02	Arsenic, total	mg/L	<0.0004
UA	34	B	2020/12/09	Arsenic, total	mg/L	<0.0004
UA	34	B	2021/03/19	Arsenic, total	mg/L	<0.0004
UA	34	B	2021/06/24	Arsenic, total	mg/L	<0.0004
UA	34	B	2021/09/09	Arsenic, total	mg/L	<0.0004
UA	34	B	2021/12/09	Arsenic, total	mg/L	<0.0004
UA	34	B	2022/03/22	Arsenic, total	mg/L	<0.0004
UA	34	B	2022/06/07	Arsenic, total	mg/L	0.000500
UA	34	B	2022/12/29	Arsenic, total	mg/L	0.000600
UA	34	B	2023/02/28	Arsenic, total	mg/L	0.000700
UA	34	B	2023/05/31	Arsenic, total	mg/L	<0.0087
UA	34	B	2023/08/25	Arsenic, total	mg/L	<0.00023
UA	34	B	2023/11/14	Arsenic, total	mg/L	0.000690
UA	34	B	2013/09/04	Barium, total	mg/L	0.126
UA	34	B	2015/12/09	Barium, total	mg/L	0.123
UA	34	B	2016/03/08	Barium, total	mg/L	0.124
UA	34	B	2016/06/07	Barium, total	mg/L	0.0987
UA	34	B	2016/09/15	Barium, total	mg/L	0.107

UA	34	B	2016/12/07	Barium, total	mg/L	0.156
UA	34	B	2017/02/21	Barium, total	mg/L	0.116
UA	34	B	2017/04/25	Barium, total	mg/L	0.107
UA	34	B	2017/06/08	Barium, total	mg/L	0.126
UA	34	B	2018/06/13	Barium, total	mg/L	0.108
UA	34	B	2018/09/12	Barium, total	mg/L	0.120
UA	34	B	2018/12/12	Barium, total	mg/L	0.106
UA	34	B	2019/03/13	Barium, total	mg/L	0.120
UA	34	B	2019/09/18	Barium, total	mg/L	0.102
UA	34	B	2019/12/11	Barium, total	mg/L	0.103
UA	34	B	2020/03/11	Barium, total	mg/L	0.0970
UA	34	B	2020/06/24	Barium, total	mg/L	0.101
UA	34	B	2020/09/02	Barium, total	mg/L	0.105
UA	34	B	2020/12/09	Barium, total	mg/L	0.129
UA	34	B	2021/03/19	Barium, total	mg/L	0.114
UA	34	B	2021/06/24	Barium, total	mg/L	0.105
UA	34	B	2021/09/09	Barium, total	mg/L	0.0933
UA	34	B	2021/12/09	Barium, total	mg/L	0.0957
UA	34	B	2022/03/22	Barium, total	mg/L	0.102
UA	34	B	2022/06/07	Barium, total	mg/L	0.115
UA	34	B	2022/12/29	Barium, total	mg/L	0.129
UA	34	B	2023/02/28	Barium, total	mg/L	0.139
UA	34	B	2023/05/31	Barium, total	mg/L	0.0995
UA	34	B	2023/08/25	Barium, total	mg/L	0.110
UA	34	B	2023/11/14	Barium, total	mg/L	0.110
UA	34	B	2013/09/04	Boron, total	mg/L	0.104
UA	34	B	2015/12/09	Boron, total	mg/L	0.140
UA	34	B	2016/03/08	Boron, total	mg/L	0.146
UA	34	B	2016/06/07	Boron, total	mg/L	0.140
UA	34	B	2016/09/15	Boron, total	mg/L	0.162
UA	34	B	2016/12/07	Boron, total	mg/L	0.190
UA	34	B	2017/02/21	Boron, total	mg/L	0.133
UA	34	B	2017/04/25	Boron, total	mg/L	0.145
UA	34	B	2017/06/08	Boron, total	mg/L	0.130
UA	34	B	2017/11/15	Boron, total	mg/L	0.130
UA	34	B	2018/06/13	Boron, total	mg/L	0.143
UA	34	B	2018/09/12	Boron, total	mg/L	0.137
UA	34	B	2018/12/12	Boron, total	mg/L	0.132
UA	34	B	2019/03/13	Boron, total	mg/L	0.158
UA	34	B	2019/09/18	Boron, total	mg/L	0.153
UA	34	B	2019/12/11	Boron, total	mg/L	0.128
UA	34	B	2020/03/11	Boron, total	mg/L	0.127
UA	34	B	2020/06/24	Boron, total	mg/L	0.149
UA	34	B	2020/09/02	Boron, total	mg/L	0.136
UA	34	B	2020/12/09	Boron, total	mg/L	0.151
UA	34	B	2021/03/19	Boron, total	mg/L	0.142
UA	34	B	2021/06/24	Boron, total	mg/L	0.122
UA	34	B	2021/09/09	Boron, total	mg/L	0.145
UA	34	B	2021/12/09	Boron, total	mg/L	0.147
UA	34	B	2022/03/22	Boron, total	mg/L	0.158
UA	34	B	2022/06/07	Boron, total	mg/L	0.127
UA	34	B	2022/12/29	Boron, total	mg/L	0.153
UA	34	B	2023/02/28	Boron, total	mg/L	0.206
UA	34	B	2023/05/31	Boron, total	mg/L	0.125
UA	34	B	2023/08/25	Boron, total	mg/L	0.0750
UA	34	B	2023/11/14	Boron, total	mg/L	0.110
UA	34	B	2013/09/04	Cadmium, total	mg/L	<0.0003
UA	34	B	2015/12/09	Cadmium, total	mg/L	<0.0002
UA	34	B	2016/03/08	Cadmium, total	mg/L	<0.0002
UA	34	B	2016/06/07	Cadmium, total	mg/L	<0.0002
UA	34	B	2016/09/15	Cadmium, total	mg/L	<0.0002
UA	34	B	2016/12/07	Cadmium, total	mg/L	<0.0002

UA	34	B	2017/02/21	Cadmium, total	mg/L	<0.0002
UA	34	B	2017/04/25	Cadmium, total	mg/L	<0.0002
UA	34	B	2017/06/08	Cadmium, total	mg/L	<0.0002
UA	34	B	2018/06/13	Cadmium, total	mg/L	<0.0002
UA	34	B	2018/09/12	Cadmium, total	mg/L	<0.0002
UA	34	B	2018/12/12	Cadmium, total	mg/L	<0.0002
UA	34	B	2019/03/13	Cadmium, total	mg/L	<0.0002
UA	34	B	2019/09/18	Cadmium, total	mg/L	<0.0002
UA	34	B	2019/12/11	Cadmium, total	mg/L	<0.0002
UA	34	B	2020/03/11	Cadmium, total	mg/L	<0.0002
UA	34	B	2020/06/24	Cadmium, total	mg/L	<0.0002
UA	34	B	2020/09/02	Cadmium, total	mg/L	<0.0002
UA	34	B	2020/12/09	Cadmium, total	mg/L	<0.0002
UA	34	B	2021/03/19	Cadmium, total	mg/L	<0.0002
UA	34	B	2021/06/24	Cadmium, total	mg/L	<0.0002
UA	34	B	2021/09/09	Cadmium, total	mg/L	<0.0002
UA	34	B	2021/12/09	Cadmium, total	mg/L	<0.0002
UA	34	B	2022/03/22	Cadmium, total	mg/L	<0.0002
UA	34	B	2022/06/07	Cadmium, total	mg/L	<0.0002
UA	34	B	2022/12/29	Cadmium, total	mg/L	<0.0002
UA	34	B	2023/02/28	Cadmium, total	mg/L	<0.0002
UA	34	B	2023/05/31	Cadmium, total	mg/L	<0.0005
UA	34	B	2023/08/25	Cadmium, total	mg/L	<0.00017
UA	34	B	2023/11/14	Cadmium, total	mg/L	<0.00017
UA	34	B	2015/12/09	Calcium, total	mg/L	162
UA	34	B	2016/03/08	Calcium, total	mg/L	168
UA	34	B	2016/06/07	Calcium, total	mg/L	161
UA	34	B	2016/09/15	Calcium, total	mg/L	156
UA	34	B	2016/12/07	Calcium, total	mg/L	165
UA	34	B	2017/02/21	Calcium, total	mg/L	170
UA	34	B	2017/04/25	Calcium, total	mg/L	142
UA	34	B	2017/06/08	Calcium, total	mg/L	160
UA	34	B	2017/11/15	Calcium, total	mg/L	170
UA	34	B	2018/06/13	Calcium, total	mg/L	162
UA	34	B	2018/09/12	Calcium, total	mg/L	170
UA	34	B	2018/12/12	Calcium, total	mg/L	153
UA	34	B	2019/03/13	Calcium, total	mg/L	165
UA	34	B	2019/09/18	Calcium, total	mg/L	165
UA	34	B	2019/12/11	Calcium, total	mg/L	161
UA	34	B	2020/03/11	Calcium, total	mg/L	157
UA	34	B	2020/06/24	Calcium, total	mg/L	152
UA	34	B	2020/09/02	Calcium, total	mg/L	159
UA	34	B	2020/12/09	Calcium, total	mg/L	208
UA	34	B	2021/03/19	Calcium, total	mg/L	177
UA	34	B	2021/06/24	Calcium, total	mg/L	167
UA	34	B	2021/09/09	Calcium, total	mg/L	180
UA	34	B	2021/12/09	Calcium, total	mg/L	175
UA	34	B	2022/03/22	Calcium, total	mg/L	167
UA	34	B	2022/06/07	Calcium, total	mg/L	166
UA	34	B	2022/12/29	Calcium, total	mg/L	163
UA	34	B	2023/02/28	Calcium, total	mg/L	184
UA	34	B	2023/05/31	Calcium, total	mg/L	149
UA	34	B	2023/08/25	Calcium, total	mg/L	150
UA	34	B	2023/11/14	Calcium, total	mg/L	150
UA	34	B	2013/03/08	Chloride, total	mg/L	97.0
UA	34	B	2013/09/04	Chloride, total	mg/L	81.0
UA	34	B	2013/12/10	Chloride, total	mg/L	83.0
UA	34	B	2014/03/25	Chloride, total	mg/L	82.0
UA	34	B	2015/03/18	Chloride, total	mg/L	97.0
UA	34	B	2015/12/09	Chloride, total	mg/L	88.0
UA	34	B	2016/03/08	Chloride, total	mg/L	108
UA	34	B	2016/06/07	Chloride, total	mg/L	107

UA	34	B	2016/09/15	Chloride, total	mg/L	104
UA	34	B	2016/12/07	Chloride, total	mg/L	108
UA	34	B	2017/02/21	Chloride, total	mg/L	101
UA	34	B	2017/04/25	Chloride, total	mg/L	105
UA	34	B	2017/06/08	Chloride, total	mg/L	101
UA	34	B	2017/11/15	Chloride, total	mg/L	88.0
UA	34	B	2018/03/26	Chloride, total	mg/L	90.0
UA	34	B	2018/06/13	Chloride, total	mg/L	90.0
UA	34	B	2018/09/12	Chloride, total	mg/L	87.0
UA	34	B	2018/12/12	Chloride, total	mg/L	80.0
UA	34	B	2019/03/13	Chloride, total	mg/L	78.0
UA	34	B	2019/09/18	Chloride, total	mg/L	72.0
UA	34	B	2019/12/11	Chloride, total	mg/L	74.0
UA	34	B	2020/03/11	Chloride, total	mg/L	72.0
UA	34	B	2020/06/24	Chloride, total	mg/L	73.0
UA	34	B	2020/09/02	Chloride, total	mg/L	74.0
UA	34	B	2020/12/09	Chloride, total	mg/L	75.0
UA	34	B	2021/03/19	Chloride, total	mg/L	73.0
UA	34	B	2021/06/24	Chloride, total	mg/L	76.0
UA	34	B	2021/09/09	Chloride, total	mg/L	70.0
UA	34	B	2021/12/09	Chloride, total	mg/L	74.0
UA	34	B	2022/03/22	Chloride, total	mg/L	74.0
UA	34	B	2022/06/07	Chloride, total	mg/L	76.0
UA	34	B	2022/12/29	Chloride, total	mg/L	83.0
UA	34	B	2023/02/28	Chloride, total	mg/L	80.0
UA	34	B	2023/05/31	Chloride, total	mg/L	71.0
UA	34	B	2023/08/25	Chloride, total	mg/L	69.0
UA	34	B	2023/11/14	Chloride, total	mg/L	67.0
UA	34	B	2013/03/08	Iron, dissolved	mg/L	6.82
UA	34	B	2013/12/10	Iron, dissolved	mg/L	6.81
UA	34	B	2014/03/25	Iron, dissolved	mg/L	3.49
UA	34	B	2015/03/18	Iron, dissolved	mg/L	8.63
UA	34	B	2016/03/08	Iron, dissolved	mg/L	6.69
UA	34	B	2017/02/21	Iron, dissolved	mg/L	5.76
UA	34	B	2018/03/26	Iron, dissolved	mg/L	1.90
UA	34	B	2023/05/31	Iron, dissolved	mg/L	4.85
UA	34	B	2023/08/25	Iron, dissolved	mg/L	6.80
UA	34	B	2015/12/09	Lithium, total	mg/L	0.0120
UA	34	B	2016/03/08	Lithium, total	mg/L	0.0132
UA	34	B	2016/06/07	Lithium, total	mg/L	0.0118
UA	34	B	2016/09/15	Lithium, total	mg/L	0.0130
UA	34	B	2016/12/07	Lithium, total	mg/L	0.0115
UA	34	B	2017/02/21	Lithium, total	mg/L	0.0120
UA	34	B	2017/04/25	Lithium, total	mg/L	0.0135
UA	34	B	2017/06/08	Lithium, total	mg/L	0.0122
UA	34	B	2018/06/13	Lithium, total	mg/L	0.0133
UA	34	B	2018/09/12	Lithium, total	mg/L	0.0136
UA	34	B	2018/12/12	Lithium, total	mg/L	0.0136
UA	34	B	2019/03/13	Lithium, total	mg/L	0.0154
UA	34	B	2019/09/18	Lithium, total	mg/L	0.0138
UA	34	B	2019/12/11	Lithium, total	mg/L	0.0144
UA	34	B	2020/03/11	Lithium, total	mg/L	0.0134
UA	34	B	2020/06/24	Lithium, total	mg/L	0.0135
UA	34	B	2020/09/02	Lithium, total	mg/L	0.0127
UA	34	B	2020/12/09	Lithium, total	mg/L	0.0127
UA	34	B	2021/03/19	Lithium, total	mg/L	0.0138
UA	34	B	2021/06/24	Lithium, total	mg/L	0.0130
UA	34	B	2021/09/09	Lithium, total	mg/L	0.0132
UA	34	B	2021/12/09	Lithium, total	mg/L	0.0137
UA	34	B	2022/03/22	Lithium, total	mg/L	0.0146
UA	34	B	2022/06/07	Lithium, total	mg/L	0.0140
UA	34	B	2022/12/29	Lithium, total	mg/L	0.0149

UA	34	B	2023/02/28	Lithium, total	mg/L	0.0111
UA	34	B	2023/05/31	Lithium, total	mg/L	0.00320
UA	34	B	2023/08/25	Lithium, total	mg/L	0.0130
UA	34	B	2023/11/14	Lithium, total	mg/L	0.0160
UA	34	B	2019/09/18	Magnesium, total	mg/L	42.0
UA	34	B	2020/03/11	Magnesium, total	mg/L	41.7
UA	34	B	2020/06/24	Magnesium, total	mg/L	42.0
UA	34	B	2021/03/19	Magnesium, total	mg/L	43.2
UA	34	B	2021/09/09	Magnesium, total	mg/L	48.6
UA	34	B	2022/03/22	Magnesium, total	mg/L	43.0
UA	34	B	2023/02/28	Magnesium, total	mg/L	47.7
UA	34	B	2023/05/31	Magnesium, total	mg/L	41.8
UA	34	B	2023/08/25	Magnesium, total	mg/L	40.0
UA	34	B	2023/11/14	Magnesium, total	mg/L	42.0
UA	34	B	2013/03/08	Manganese, dissolved	mg/L	1.12
UA	34	B	2013/12/10	Manganese, dissolved	mg/L	1.24
UA	34	B	2014/03/25	Manganese, dissolved	mg/L	1.26
UA	34	B	2015/03/18	Manganese, dissolved	mg/L	1.24
UA	34	B	2016/03/08	Manganese, dissolved	mg/L	1.18
UA	34	B	2017/02/21	Manganese, dissolved	mg/L	1.17
UA	34	B	2018/03/26	Manganese, dissolved	mg/L	1.18
UA	34	B	2023/05/31	Manganese, dissolved	mg/L	1.12
UA	34	B	2023/08/25	Manganese, dissolved	mg/L	1.30
UA	34	B	2023/05/31	Phosphate, dissolved	mg/L	0.365
UA	34	B	2023/08/25	Phosphate, dissolved	mg/L	0.500
UA	34	B	2019/09/18	Potassium, total	mg/L	0.381
UA	34	B	2020/03/11	Potassium, total	mg/L	0.360
UA	34	B	2020/06/24	Potassium, total	mg/L	0.433
UA	34	B	2021/03/19	Potassium, total	mg/L	0.414
UA	34	B	2021/09/09	Potassium, total	mg/L	0.788
UA	34	B	2022/03/22	Potassium, total	mg/L	0.414
UA	34	B	2023/02/28	Potassium, total	mg/L	0.423
UA	34	B	2023/05/31	Potassium, total	mg/L	0.450
UA	34	B	2023/08/25	Potassium, total	mg/L	0.420
UA	34	B	2023/11/14	Potassium, total	mg/L	0.480
UA	34	B	2023/05/31	Silicon, dissolved	mg/L	11.4
UA	34	B	2023/08/25	Silicon, dissolved	mg/L	13.0
UA	34	B	2019/09/18	Sodium, total	mg/L	52.1
UA	34	B	2020/03/11	Sodium, total	mg/L	54.7
UA	34	B	2020/06/24	Sodium, total	mg/L	55.7
UA	34	B	2021/03/19	Sodium, total	mg/L	55.8
UA	34	B	2021/09/09	Sodium, total	mg/L	49.5
UA	34	B	2022/03/22	Sodium, total	mg/L	53.7
UA	34	B	2023/02/28	Sodium, total	mg/L	54.7
UA	34	B	2023/05/31	Sodium, total	mg/L	53.5
UA	34	B	2023/08/25	Sodium, total	mg/L	44.0
UA	34	B	2023/11/14	Sodium, total	mg/L	49.0
UA	34	B	2013/03/08	Sulfate, total	mg/L	111
UA	34	B	2013/09/04	Sulfate, total	mg/L	80.0
UA	34	B	2013/12/10	Sulfate, total	mg/L	83.0
UA	34	B	2014/03/25	Sulfate, total	mg/L	78.0
UA	34	B	2015/03/18	Sulfate, total	mg/L	85.0
UA	34	B	2015/12/09	Sulfate, total	mg/L	106
UA	34	B	2016/03/08	Sulfate, total	mg/L	99.0
UA	34	B	2016/06/07	Sulfate, total	mg/L	98.0
UA	34	B	2016/09/15	Sulfate, total	mg/L	117
UA	34	B	2016/12/07	Sulfate, total	mg/L	115
UA	34	B	2017/02/21	Sulfate, total	mg/L	107
UA	34	B	2017/04/25	Sulfate, total	mg/L	113
UA	34	B	2017/06/08	Sulfate, total	mg/L	112
UA	34	B	2017/11/15	Sulfate, total	mg/L	94.0
UA	34	B	2018/03/26	Sulfate, total	mg/L	104

UA	34	B	2018/06/13	Sulfate, total	mg/L	97.0
UA	34	B	2018/09/12	Sulfate, total	mg/L	94.0
UA	34	B	2018/12/12	Sulfate, total	mg/L	95.0
UA	34	B	2019/03/13	Sulfate, total	mg/L	81.0
UA	34	B	2019/09/18	Sulfate, total	mg/L	68.0
UA	34	B	2019/12/11	Sulfate, total	mg/L	74.0
UA	34	B	2020/03/11	Sulfate, total	mg/L	69.0
UA	34	B	2020/06/24	Sulfate, total	mg/L	80.0
UA	34	B	2020/09/02	Sulfate, total	mg/L	74.0
UA	34	B	2020/12/09	Sulfate, total	mg/L	72.0
UA	34	B	2021/03/19	Sulfate, total	mg/L	64.0
UA	34	B	2021/06/24	Sulfate, total	mg/L	61.0
UA	34	B	2021/09/09	Sulfate, total	mg/L	67.0
UA	34	B	2021/12/09	Sulfate, total	mg/L	60.0
UA	34	B	2022/03/22	Sulfate, total	mg/L	56.0
UA	34	B	2022/06/07	Sulfate, total	mg/L	57.0
UA	34	B	2022/12/29	Sulfate, total	mg/L	45.0
UA	34	B	2023/02/28	Sulfate, total	mg/L	48.0
UA	34	B	2023/05/31	Sulfate, total	mg/L	49.0
UA	34	B	2023/08/25	Sulfate, total	mg/L	46.0
UA	34	B	2023/11/14	Sulfate, total	mg/L	49.0
UA	34	B	2013/03/08	Temperature (Celsius)	degrees C	11.0
UA	34	B	2013/09/04	Temperature (Celsius)	degrees C	13.0
UA	34	B	2013/12/10	Temperature (Celsius)	degrees C	9.80
UA	34	B	2014/03/25	Temperature (Celsius)	degrees C	11.0
UA	34	B	2015/03/18	Temperature (Celsius)	degrees C	11.9
UA	34	B	2015/12/09	Temperature (Celsius)	degrees C	12.9
UA	34	B	2016/03/08	Temperature (Celsius)	degrees C	11.7
UA	34	B	2016/06/07	Temperature (Celsius)	degrees C	12.6
UA	34	B	2016/09/15	Temperature (Celsius)	degrees C	13.8
UA	34	B	2016/12/07	Temperature (Celsius)	degrees C	10.8
UA	34	B	2017/02/21	Temperature (Celsius)	degrees C	13.2
UA	34	B	2017/04/25	Temperature (Celsius)	degrees C	22.5
UA	34	B	2017/06/08	Temperature (Celsius)	degrees C	22.2
UA	34	B	2017/11/15	Temperature (Celsius)	degrees C	13
UA	34	B	2018/03/26	Temperature (Celsius)	degrees C	12.8
UA	34	B	2018/06/13	Temperature (Celsius)	degrees C	15.1
UA	34	B	2018/09/12	Temperature (Celsius)	degrees C	21.1
UA	34	B	2018/12/12	Temperature (Celsius)	degrees C	11.8
UA	34	B	2019/03/13	Temperature (Celsius)	degrees C	12.6
UA	34	B	2019/09/18	Temperature (Celsius)	degrees C	12.6
UA	34	B	2019/12/11	Temperature (Celsius)	degrees C	12.2
UA	34	B	2020/03/11	Temperature (Celsius)	degrees C	11.8
UA	34	B	2020/06/24	Temperature (Celsius)	degrees C	12.6
UA	34	B	2020/09/02	Temperature (Celsius)	degrees C	12.8
UA	34	B	2020/12/09	Temperature (Celsius)	degrees C	12.4
UA	34	B	2021/03/19	Temperature (Celsius)	degrees C	12.0
UA	34	B	2021/06/24	Temperature (Celsius)	degrees C	12.4
UA	34	B	2021/09/09	Temperature (Celsius)	degrees C	12.8
UA	34	B	2021/12/09	Temperature (Celsius)	degrees C	12.3
UA	34	B	2022/03/22	Temperature (Celsius)	degrees C	12.1
UA	34	B	2022/06/07	Temperature (Celsius)	degrees C	12.6
UA	34	B	2022/12/29	Temperature (Celsius)	degrees C	12.4
UA	34	B	2023/02/28	Temperature (Celsius)	degrees C	11.2
UA	34	B	2023/05/31	Temperature (Celsius)	degrees C	12.3
UA	34	B	2023/08/25	Temperature (Celsius)	degrees C	12.8
UA	34	B	2023/11/14	Temperature (Celsius)	degrees C	12.6
UA	34	B	2013/03/08	Total Dissolved Solids	mg/L	754
UA	34	B	2013/09/04	Total Dissolved Solids	mg/L	798
UA	34	B	2013/12/10	Total Dissolved Solids	mg/L	772
UA	34	B	2014/03/25	Total Dissolved Solids	mg/L	752
UA	34	B	2015/03/18	Total Dissolved Solids	mg/L	846

UA	34	B	2015/12/09	Total Dissolved Solids	mg/L	786
UA	34	B	2016/03/08	Total Dissolved Solids	mg/L	776
UA	34	B	2016/06/07	Total Dissolved Solids	mg/L	830
UA	34	B	2016/09/15	Total Dissolved Solids	mg/L	780
UA	34	B	2016/12/07	Total Dissolved Solids	mg/L	772
UA	34	B	2017/02/21	Total Dissolved Solids	mg/L	740
UA	34	B	2017/04/25	Total Dissolved Solids	mg/L	790
UA	34	B	2017/06/08	Total Dissolved Solids	mg/L	752
UA	34	B	2017/11/15	Total Dissolved Solids	mg/L	710
UA	34	B	2018/03/26	Total Dissolved Solids	mg/L	758
UA	34	B	2018/06/13	Total Dissolved Solids	mg/L	800
UA	34	B	2018/09/12	Total Dissolved Solids	mg/L	836
UA	34	B	2018/12/12	Total Dissolved Solids	mg/L	776
UA	34	B	2019/03/13	Total Dissolved Solids	mg/L	748
UA	34	B	2019/09/18	Total Dissolved Solids	mg/L	756
UA	34	B	2019/12/11	Total Dissolved Solids	mg/L	690
UA	34	B	2020/03/11	Total Dissolved Solids	mg/L	708
UA	34	B	2020/06/24	Total Dissolved Solids	mg/L	718
UA	34	B	2020/09/02	Total Dissolved Solids	mg/L	640
UA	34	B	2020/12/09	Total Dissolved Solids	mg/L	696
UA	34	B	2021/03/19	Total Dissolved Solids	mg/L	702
UA	34	B	2021/06/24	Total Dissolved Solids	mg/L	702
UA	34	B	2021/09/09	Total Dissolved Solids	mg/L	696
UA	34	B	2021/12/09	Total Dissolved Solids	mg/L	658
UA	34	B	2022/03/22	Total Dissolved Solids	mg/L	720
UA	34	B	2022/06/07	Total Dissolved Solids	mg/L	740
UA	34	B	2022/12/29	Total Dissolved Solids	mg/L	738
UA	34	B	2023/02/28	Total Dissolved Solids	mg/L	685
UA	34	B	2023/05/31	Total Dissolved Solids	mg/L	845
UA	34	B	2023/08/25	Total Dissolved Solids	mg/L	760
UA	34	B	2023/11/14	Total Dissolved Solids	mg/L	700
UA	21R	C	2020/03/11	pH (field)	SU	7.6
UA	21R	C	2020/06/24	pH (field)	SU	7.6
UA	21R	C	2020/09/02	pH (field)	SU	7.6
UA	21R	C	2020/12/10	pH (field)	SU	7.6
UA	21R	C	2021/03/17	pH (field)	SU	7.2
UA	21R	C	2021/06/23	pH (field)	SU	7.3
UA	21R	C	2021/09/09	pH (field)	SU	7.4
UA	21R	C	2021/12/09	pH (field)	SU	7.2
UA	21R	C	2022/03/22	pH (field)	SU	7.2
UA	21R	C	2022/06/07	pH (field)	SU	7.3
UA	21R	C	2022/09/13	pH (field)	SU	7.3
UA	21R	C	2022/12/27	pH (field)	SU	7.3
UA	21R	C	2023/02/28	pH (field)	SU	7.3
UA	21R	C	2023/05/31	pH (field)	SU	7.4
UA	21R	C	2023/08/22	pH (field)	SU	7.5
UA	21R	C	2023/11/14	pH (field)	SU	7.7
UA	21R	C	2020/03/11	Oxidation Reduction Potential	mV	-161
UA	21R	C	2020/06/24	Oxidation Reduction Potential	mV	-147
UA	21R	C	2020/09/02	Oxidation Reduction Potential	mV	-149
UA	21R	C	2020/12/10	Oxidation Reduction Potential	mV	-166
UA	21R	C	2021/03/17	Oxidation Reduction Potential	mV	-153
UA	21R	C	2021/06/23	Oxidation Reduction Potential	mV	-191
UA	21R	C	2021/09/09	Oxidation Reduction Potential	mV	-178
UA	21R	C	2021/12/09	Oxidation Reduction Potential	mV	-130
UA	21R	C	2022/03/22	Oxidation Reduction Potential	mV	-164
UA	21R	C	2022/06/07	Oxidation Reduction Potential	mV	52.0
UA	21R	C	2022/09/13	Oxidation Reduction Potential	mV	37.0
UA	21R	C	2022/12/27	Oxidation Reduction Potential	mV	-144
UA	21R	C	2023/02/28	Oxidation Reduction Potential	mV	-143
UA	21R	C	2023/05/31	Oxidation Reduction Potential	mV	-178
UA	21R	C	2023/08/22	Oxidation Reduction Potential	mV	-136

UA	21R	C	2023/11/14	Oxidation Reduction Potential	mV	-167
UA	21R	C	2020/03/11	Eh	V	0.037
UA	21R	C	2020/06/24	Eh	V	0.050
UA	21R	C	2020/09/02	Eh	V	0.047
UA	21R	C	2020/12/10	Eh	V	0.031
UA	21R	C	2021/03/17	Eh	V	0.045
UA	21R	C	2021/06/23	Eh	V	0.0056
UA	21R	C	2021/09/09	Eh	V	0.017
UA	21R	C	2021/12/09	Eh	V	0.067
UA	21R	C	2022/03/22	Eh	V	0.034
UA	21R	C	2022/06/07	Eh	V	0.25
UA	21R	C	2022/09/13	Eh	V	0.23
UA	21R	C	2022/12/27	Eh	V	0.054
UA	21R	C	2023/02/28	Eh	V	0.055
UA	21R	C	2023/05/31	Eh	V	0.019
UA	21R	C	2023/08/22	Eh	V	0.058
UA	21R	C	2023/11/14	Eh	V	0.029
UA	21R	C	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	360
UA	21R	C	2021/03/17	Alkalinity, bicarbonate	mg/L CaCO3	367
UA	21R	C	2021/09/09	Alkalinity, bicarbonate	mg/L CaCO3	370
UA	21R	C	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	372
UA	21R	C	2022/09/13	Alkalinity, bicarbonate	mg/L CaCO3	376
UA	21R	C	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	378
UA	21R	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	388
UA	21R	C	2023/08/22	Alkalinity, bicarbonate	mg/L CaCO3	370
UA	21R	C	2023/11/14	Alkalinity, bicarbonate	mg/L CaCO3	390
UA	21R	C	2020/03/11	Arsenic, total	mg/L	0.0215
UA	21R	C	2020/06/24	Arsenic, total	mg/L	0.0215
UA	21R	C	2020/09/02	Arsenic, total	mg/L	0.0246
UA	21R	C	2020/12/10	Arsenic, total	mg/L	0.0305
UA	21R	C	2021/03/17	Arsenic, total	mg/L	0.0255
UA	21R	C	2021/06/23	Arsenic, total	mg/L	0.0269
UA	21R	C	2021/09/09	Arsenic, total	mg/L	0.0259
UA	21R	C	2021/12/09	Arsenic, total	mg/L	0.0267
UA	21R	C	2022/03/22	Arsenic, total	mg/L	0.0279
UA	21R	C	2022/06/07	Arsenic, total	mg/L	0.0259
UA	21R	C	2022/09/13	Arsenic, total	mg/L	0.0332
UA	21R	C	2022/12/27	Arsenic, total	mg/L	0.0275
UA	21R	C	2023/02/28	Arsenic, total	mg/L	0.0345
UA	21R	C	2023/05/31	Arsenic, total	mg/L	0.0274
UA	21R	C	2023/08/22	Arsenic, total	mg/L	0.0230
UA	21R	C	2023/11/14	Arsenic, total	mg/L	0.0210
UA	21R	C	2020/03/11	Barium, total	mg/L	0.274
UA	21R	C	2020/06/24	Barium, total	mg/L	0.295
UA	21R	C	2020/09/02	Barium, total	mg/L	0.311
UA	21R	C	2020/12/10	Barium, total	mg/L	0.360
UA	21R	C	2021/03/17	Barium, total	mg/L	0.329
UA	21R	C	2021/06/23	Barium, total	mg/L	0.316
UA	21R	C	2021/09/09	Barium, total	mg/L	0.304
UA	21R	C	2021/12/09	Barium, total	mg/L	0.316
UA	21R	C	2022/03/22	Barium, total	mg/L	0.326
UA	21R	C	2022/06/07	Barium, total	mg/L	0.287
UA	21R	C	2022/09/13	Barium, total	mg/L	0.378
UA	21R	C	2022/12/27	Barium, total	mg/L	0.331
UA	21R	C	2023/02/28	Barium, total	mg/L	0.398
UA	21R	C	2023/05/31	Barium, total	mg/L	0.296
UA	21R	C	2023/08/22	Barium, total	mg/L	0.300
UA	21R	C	2023/11/14	Barium, total	mg/L	0.310
UA	21R	C	2020/03/11	Boron, total	mg/L	3.72
UA	21R	C	2020/06/24	Boron, total	mg/L	3.61
UA	21R	C	2020/09/02	Boron, total	mg/L	3.23
UA	21R	C	2020/12/10	Boron, total	mg/L	3.31

UA	21R	C	2021/03/17	Boron, total	mg/L	3.11
UA	21R	C	2021/06/23	Boron, total	mg/L	2.92
UA	21R	C	2021/09/09	Boron, total	mg/L	3.23
UA	21R	C	2021/12/09	Boron, total	mg/L	2.91
UA	21R	C	2022/03/22	Boron, total	mg/L	3.33
UA	21R	C	2022/06/07	Boron, total	mg/L	2.57
UA	21R	C	2022/09/13	Boron, total	mg/L	2.28
UA	21R	C	2022/12/27	Boron, total	mg/L	2.99
UA	21R	C	2023/02/28	Boron, total	mg/L	3.28
UA	21R	C	2023/05/31	Boron, total	mg/L	2.32
UA	21R	C	2023/08/22	Boron, total	mg/L	1.70
UA	21R	C	2023/11/14	Boron, total	mg/L	2.10
UA	21R	C	2020/03/11	Cadmium, total	mg/L	<0.0002
UA	21R	C	2020/06/24	Cadmium, total	mg/L	<0.0002
UA	21R	C	2020/09/02	Cadmium, total	mg/L	<0.0002
UA	21R	C	2020/12/10	Cadmium, total	mg/L	<0.0002
UA	21R	C	2021/03/17	Cadmium, total	mg/L	<0.0002
UA	21R	C	2021/06/23	Cadmium, total	mg/L	<0.0002
UA	21R	C	2021/09/09	Cadmium, total	mg/L	<0.0002
UA	21R	C	2021/12/09	Cadmium, total	mg/L	<0.0002
UA	21R	C	2022/03/22	Cadmium, total	mg/L	<0.0002
UA	21R	C	2022/06/07	Cadmium, total	mg/L	<0.0002
UA	21R	C	2022/09/13	Cadmium, total	mg/L	<0.0002
UA	21R	C	2022/12/27	Cadmium, total	mg/L	<0.0002
UA	21R	C	2023/02/28	Cadmium, total	mg/L	0.000200
UA	21R	C	2023/05/31	Cadmium, total	mg/L	<0.0005
UA	21R	C	2023/08/22	Cadmium, total	mg/L	<0.00017
UA	21R	C	2023/11/14	Cadmium, total	mg/L	0.000240
UA	21R	C	2020/03/11	Calcium, total	mg/L	137
UA	21R	C	2020/06/24	Calcium, total	mg/L	125
UA	21R	C	2020/09/02	Calcium, total	mg/L	123
UA	21R	C	2020/12/10	Calcium, total	mg/L	162
UA	21R	C	2021/03/17	Calcium, total	mg/L	139
UA	21R	C	2021/06/23	Calcium, total	mg/L	144
UA	21R	C	2021/09/09	Calcium, total	mg/L	145
UA	21R	C	2021/12/09	Calcium, total	mg/L	154
UA	21R	C	2022/03/22	Calcium, total	mg/L	146
UA	21R	C	2022/06/07	Calcium, total	mg/L	139
UA	21R	C	2022/09/13	Calcium, total	mg/L	135
UA	21R	C	2022/12/27	Calcium, total	mg/L	135
UA	21R	C	2023/02/28	Calcium, total	mg/L	147
UA	21R	C	2023/05/31	Calcium, total	mg/L	121
UA	21R	C	2023/08/22	Calcium, total	mg/L	120
UA	21R	C	2023/11/14	Calcium, total	mg/L	120
UA	21R	C	2020/03/11	Chloride, total	mg/L	70.0
UA	21R	C	2020/06/24	Chloride, total	mg/L	70.0
UA	21R	C	2020/09/02	Chloride, total	mg/L	75.0
UA	21R	C	2020/12/10	Chloride, total	mg/L	90.0
UA	21R	C	2021/03/17	Chloride, total	mg/L	88.0
UA	21R	C	2021/06/23	Chloride, total	mg/L	96.0
UA	21R	C	2021/09/09	Chloride, total	mg/L	97.0
UA	21R	C	2021/12/09	Chloride, total	mg/L	107
UA	21R	C	2022/03/22	Chloride, total	mg/L	99.0
UA	21R	C	2022/06/07	Chloride, total	mg/L	97.0
UA	21R	C	2022/09/13	Chloride, total	mg/L	104
UA	21R	C	2022/12/27	Chloride, total	mg/L	107
UA	21R	C	2023/02/28	Chloride, total	mg/L	108
UA	21R	C	2023/05/31	Chloride, total	mg/L	103
UA	21R	C	2023/08/22	Chloride, total	mg/L	95.0
UA	21R	C	2023/11/14	Chloride, total	mg/L	89.0
UA	21R	C	2023/08/22	Ferrous Iron, dissolved	mg/L	0.916
UA	21R	C	2023/05/31	Iron, dissolved	mg/L	5.64

UA	21R	C	2023/08/22	Iron, dissolved	mg/L	5.40
UA	21R	C	2020/03/11	Lithium, total	mg/L	0.0236
UA	21R	C	2020/06/24	Lithium, total	mg/L	0.0193
UA	21R	C	2020/09/02	Lithium, total	mg/L	0.0185
UA	21R	C	2020/12/10	Lithium, total	mg/L	0.0203
UA	21R	C	2021/03/17	Lithium, total	mg/L	0.0209
UA	21R	C	2021/06/23	Lithium, total	mg/L	0.0213
UA	21R	C	2021/09/09	Lithium, total	mg/L	0.0229
UA	21R	C	2021/12/09	Lithium, total	mg/L	0.0242
UA	21R	C	2022/03/22	Lithium, total	mg/L	0.0280
UA	21R	C	2022/06/07	Lithium, total	mg/L	0.0209
UA	21R	C	2022/09/13	Lithium, total	mg/L	0.0178
UA	21R	C	2022/12/27	Lithium, total	mg/L	0.0252
UA	21R	C	2023/02/28	Lithium, total	mg/L	0.0199
UA	21R	C	2023/05/31	Lithium, total	mg/L	0.0167
UA	21R	C	2023/08/22	Lithium, total	mg/L	0.0260
UA	21R	C	2023/11/14	Lithium, total	mg/L	0.0280
UA	21R	C	2020/03/11	Magnesium, total	mg/L	44.2
UA	21R	C	2020/06/24	Magnesium, total	mg/L	42.7
UA	21R	C	2021/03/17	Magnesium, total	mg/L	45.6
UA	21R	C	2021/09/09	Magnesium, total	mg/L	47.4
UA	21R	C	2022/03/22	Magnesium, total	mg/L	46.6
UA	21R	C	2022/09/13	Magnesium, total	mg/L	42.0
UA	21R	C	2023/02/28	Magnesium, total	mg/L	44.7
UA	21R	C	2023/05/31	Magnesium, total	mg/L	41.7
UA	21R	C	2023/08/22	Magnesium, total	mg/L	39.0
UA	21R	C	2023/11/14	Magnesium, total	mg/L	39.0
UA	21R	C	2023/05/31	Manganese, dissolved	mg/L	0.111
UA	21R	C	2023/08/22	Manganese, dissolved	mg/L	0.110
UA	21R	C	2023/05/31	Phosphate, dissolved	mg/L	0.666
UA	21R	C	2023/08/22	Phosphate, dissolved	mg/L	<0.073
UA	21R	C	2020/03/11	Potassium, total	mg/L	4.02
UA	21R	C	2020/06/24	Potassium, total	mg/L	2.78
UA	21R	C	2021/03/17	Potassium, total	mg/L	3.08
UA	21R	C	2021/09/09	Potassium, total	mg/L	3.16
UA	21R	C	2022/03/22	Potassium, total	mg/L	3.10
UA	21R	C	2022/09/13	Potassium, total	mg/L	2.81
UA	21R	C	2023/02/28	Potassium, total	mg/L	2.91
UA	21R	C	2023/05/31	Potassium, total	mg/L	3.01
UA	21R	C	2023/08/22	Potassium, total	mg/L	2.80
UA	21R	C	2023/11/14	Potassium, total	mg/L	3.00
UA	21R	C	2023/05/31	Silicon, dissolved	mg/L	8.17
UA	21R	C	2023/08/22	Silicon, dissolved	mg/L	10.0
UA	21R	C	2020/03/11	Sodium, total	mg/L	32.6
UA	21R	C	2020/06/24	Sodium, total	mg/L	32.8
UA	21R	C	2021/03/17	Sodium, total	mg/L	40.2
UA	21R	C	2021/09/09	Sodium, total	mg/L	37.8
UA	21R	C	2022/03/22	Sodium, total	mg/L	47.5
UA	21R	C	2022/09/13	Sodium, total	mg/L	45.1
UA	21R	C	2023/02/28	Sodium, total	mg/L	52.5
UA	21R	C	2023/05/31	Sodium, total	mg/L	49.4
UA	21R	C	2023/08/22	Sodium, total	mg/L	45.0
UA	21R	C	2023/11/14	Sodium, total	mg/L	47.0
UA	21R	C	2020/03/11	Sulfate, total	mg/L	102
UA	21R	C	2020/06/24	Sulfate, total	mg/L	96.0
UA	21R	C	2020/09/02	Sulfate, total	mg/L	88.0
UA	21R	C	2020/12/10	Sulfate, total	mg/L	90.0
UA	21R	C	2021/03/17	Sulfate, total	mg/L	89.0
UA	21R	C	2021/06/23	Sulfate, total	mg/L	92.0
UA	21R	C	2021/09/09	Sulfate, total	mg/L	93.0
UA	21R	C	2021/12/09	Sulfate, total	mg/L	83.0
UA	21R	C	2022/03/22	Sulfate, total	mg/L	91.0

UA	21R	C	2022/06/07	Sulfate, total	mg/L	105
UA	21R	C	2022/09/13	Sulfate, total	mg/L	87.0
UA	21R	C	2022/12/27	Sulfate, total	mg/L	95.0
UA	21R	C	2023/02/28	Sulfate, total	mg/L	105
UA	21R	C	2023/05/31	Sulfate, total	mg/L	91.0
UA	21R	C	2023/08/22	Sulfate, total	mg/L	94.0
UA	21R	C	2023/11/14	Sulfate, total	mg/L	81.0
UA	21R	C	2020/03/11	Temperature (Celsius)	degrees C	11.7
UA	21R	C	2020/06/24	Temperature (Celsius)	degrees C	13.3
UA	21R	C	2020/09/02	Temperature (Celsius)	degrees C	14.2
UA	21R	C	2020/12/10	Temperature (Celsius)	degrees C	12.3
UA	21R	C	2021/03/17	Temperature (Celsius)	degrees C	10.8
UA	21R	C	2021/06/23	Temperature (Celsius)	degrees C	13.5
UA	21R	C	2021/09/09	Temperature (Celsius)	degrees C	15.8
UA	21R	C	2021/12/09	Temperature (Celsius)	degrees C	12.4
UA	21R	C	2022/03/22	Temperature (Celsius)	degrees C	11.8
UA	21R	C	2022/06/07	Temperature (Celsius)	degrees C	13.5
UA	21R	C	2022/09/13	Temperature (Celsius)	degrees C	14.3
UA	21R	C	2022/12/27	Temperature (Celsius)	degrees C	12.1
UA	21R	C	2023/02/28	Temperature (Celsius)	degrees C	10.9
UA	21R	C	2023/05/31	Temperature (Celsius)	degrees C	13.2
UA	21R	C	2023/08/22	Temperature (Celsius)	degrees C	16.6
UA	21R	C	2023/11/14	Temperature (Celsius)	degrees C	13.4
UA	21R	C	2020/03/11	Total Dissolved Solids	mg/L	590
UA	21R	C	2020/06/24	Total Dissolved Solids	mg/L	918
UA	21R	C	2020/09/02	Total Dissolved Solids	mg/L	540
UA	21R	C	2020/12/10	Total Dissolved Solids	mg/L	598
UA	21R	C	2021/03/17	Total Dissolved Solids	mg/L	636
UA	21R	C	2021/06/23	Total Dissolved Solids	mg/L	686
UA	21R	C	2021/09/09	Total Dissolved Solids	mg/L	684
UA	21R	C	2021/12/09	Total Dissolved Solids	mg/L	590
UA	21R	C	2022/03/22	Total Dissolved Solids	mg/L	622
UA	21R	C	2022/06/07	Total Dissolved Solids	mg/L	758
UA	21R	C	2022/09/13	Total Dissolved Solids	mg/L	682
UA	21R	C	2022/12/27	Total Dissolved Solids	mg/L	642
UA	21R	C	2023/02/28	Total Dissolved Solids	mg/L	678
UA	21R	C	2023/05/31	Total Dissolved Solids	mg/L	695
UA	21R	C	2023/08/22	Total Dissolved Solids	mg/L	730
UA	21R	C	2023/11/14	Total Dissolved Solids	mg/L	700
UA	22	C	2013/03/08	pH (field)	SU	7.3
UA	22	C	2013/06/07	pH (field)	SU	7.8
UA	22	C	2013/09/03	pH (field)	SU	7.9
UA	22	C	2013/12/10	pH (field)	SU	7.8
UA	22	C	2014/03/25	pH (field)	SU	7.3
UA	22	C	2014/08/19	pH (field)	SU	8.1
UA	22	C	2014/09/30	pH (field)	SU	8.1
UA	22	C	2015/03/18	pH (field)	SU	7.9
UA	22	C	2015/09/16	pH (field)	SU	7.8
UA	22	C	2015/12/10	pH (field)	SU	8.2
UA	22	C	2016/03/09	pH (field)	SU	7.8
UA	22	C	2016/06/07	pH (field)	SU	7.8
UA	22	C	2016/09/15	pH (field)	SU	7.8
UA	22	C	2016/12/07	pH (field)	SU	7.7
UA	22	C	2017/02/21	pH (field)	SU	7.4
UA	22	C	2017/04/25	pH (field)	SU	7.5
UA	22	C	2017/06/08	pH (field)	SU	7.7
UA	22	C	2017/09/06	pH (field)	SU	7.7
UA	22	C	2017/11/16	pH (field)	SU	7.4
UA	22	C	2018/03/26	pH (field)	SU	7.8
UA	22	C	2018/06/13	pH (field)	SU	7.2
UA	22	C	2018/09/12	pH (field)	SU	7.6
UA	22	C	2018/12/12	pH (field)	SU	7.6

UA	22	C	2019/03/13	pH (field)	SU	7.7
UA	22	C	2019/06/19	pH (field)	SU	7.6
UA	22	C	2019/09/17	pH (field)	SU	7.5
UA	22	C	2019/12/11	pH (field)	SU	7.6
UA	22	C	2020/03/11	pH (field)	SU	7.7
UA	22	C	2020/06/03	pH (field)	SU	7.7
UA	22	C	2020/06/25	pH (field)	SU	7.8
UA	22	C	2020/09/02	pH (field)	SU	7.6
UA	22	C	2020/12/09	pH (field)	SU	7.7
UA	22	C	2021/03/19	pH (field)	SU	7.7
UA	22	C	2021/06/23	pH (field)	SU	7.4
UA	22	C	2021/09/08	pH (field)	SU	7.2
UA	22	C	2021/12/08	pH (field)	SU	7.6
UA	22	C	2022/03/22	pH (field)	SU	7.6
UA	22	C	2022/06/07	pH (field)	SU	7.6
UA	22	C	2022/09/13	pH (field)	SU	7.5
UA	22	C	2022/12/27	pH (field)	SU	7.5
UA	22	C	2023/02/28	pH (field)	SU	7.6
UA	22	C	2023/05/31	pH (field)	SU	7.6
UA	22	C	2023/08/25	pH (field)	SU	7.7
UA	22	C	2023/11/15	pH (field)	SU	7.7
UA	22	C	2015/12/10	Oxidation Reduction Potential	mV	-18.0
UA	22	C	2016/03/09	Oxidation Reduction Potential	mV	-6.00
UA	22	C	2016/06/07	Oxidation Reduction Potential	mV	72.0
UA	22	C	2016/09/15	Oxidation Reduction Potential	mV	-1.00
UA	22	C	2016/12/07	Oxidation Reduction Potential	mV	126
UA	22	C	2017/02/21	Oxidation Reduction Potential	mV	114
UA	22	C	2017/04/25	Oxidation Reduction Potential	mV	-5.00
UA	22	C	2017/06/08	Oxidation Reduction Potential	mV	42.0
UA	22	C	2017/11/16	Oxidation Reduction Potential	mV	185
UA	22	C	2018/06/13	Oxidation Reduction Potential	mV	73.0
UA	22	C	2018/09/12	Oxidation Reduction Potential	mV	167
UA	22	C	2018/12/12	Oxidation Reduction Potential	mV	119
UA	22	C	2019/03/13	Oxidation Reduction Potential	mV	26.0
UA	22	C	2019/06/19	Oxidation Reduction Potential	mV	65.0
UA	22	C	2019/09/17	Oxidation Reduction Potential	mV	117
UA	22	C	2019/12/11	Oxidation Reduction Potential	mV	-47.0
UA	22	C	2020/03/11	Oxidation Reduction Potential	mV	121
UA	22	C	2020/06/03	Oxidation Reduction Potential	mV	76.0
UA	22	C	2020/06/25	Oxidation Reduction Potential	mV	69.2
UA	22	C	2020/09/02	Oxidation Reduction Potential	mV	118
UA	22	C	2020/12/09	Oxidation Reduction Potential	mV	-84.0
UA	22	C	2021/03/19	Oxidation Reduction Potential	mV	168
UA	22	C	2021/06/23	Oxidation Reduction Potential	mV	-51.0
UA	22	C	2021/09/08	Oxidation Reduction Potential	mV	64.0
UA	22	C	2021/12/08	Oxidation Reduction Potential	mV	55.0
UA	22	C	2022/03/22	Oxidation Reduction Potential	mV	-67.0
UA	22	C	2022/06/07	Oxidation Reduction Potential	mV	31.0
UA	22	C	2022/09/13	Oxidation Reduction Potential	mV	47.0
UA	22	C	2022/12/27	Oxidation Reduction Potential	mV	-54.0
UA	22	C	2023/02/28	Oxidation Reduction Potential	mV	51.9
UA	22	C	2023/05/31	Oxidation Reduction Potential	mV	49.0
UA	22	C	2023/08/25	Oxidation Reduction Potential	mV	77.8
UA	22	C	2023/11/15	Oxidation Reduction Potential	mV	-48.4
UA	22	C	2015/12/10	Eh	V	0.18
UA	22	C	2016/03/09	Eh	V	0.19
UA	22	C	2016/06/07	Eh	V	0.27
UA	22	C	2016/09/15	Eh	V	0.20
UA	22	C	2016/12/07	Eh	V	0.32
UA	22	C	2017/02/21	Eh	V	0.31
UA	22	C	2017/04/25	Eh	V	0.19
UA	22	C	2017/06/08	Eh	V	0.24

UA	22	C	2017/11/16	Eh	V	0.38
UA	22	C	2018/06/13	Eh	V	0.27
UA	22	C	2018/09/12	Eh	V	0.36
UA	22	C	2018/12/12	Eh	V	0.32
UA	22	C	2019/03/13	Eh	V	0.22
UA	22	C	2019/06/19	Eh	V	0.26
UA	22	C	2019/09/17	Eh	V	0.31
UA	22	C	2019/12/11	Eh	V	0.15
UA	22	C	2020/03/11	Eh	V	0.32
UA	22	C	2020/06/03	Eh	V	0.27
UA	22	C	2020/06/25	Eh	V	0.26
UA	22	C	2020/09/02	Eh	V	0.31
UA	22	C	2020/12/09	Eh	V	0.11
UA	22	C	2021/03/19	Eh	V	0.36
UA	22	C	2021/06/23	Eh	V	0.14
UA	22	C	2021/09/08	Eh	V	0.26
UA	22	C	2021/12/08	Eh	V	0.25
UA	22	C	2022/03/22	Eh	V	0.13
UA	22	C	2022/06/07	Eh	V	0.23
UA	22	C	2022/09/13	Eh	V	0.24
UA	22	C	2022/12/27	Eh	V	0.14
UA	22	C	2023/02/28	Eh	V	0.25
UA	22	C	2023/05/31	Eh	V	0.24
UA	22	C	2023/08/25	Eh	V	0.27
UA	22	C	2023/11/15	Eh	V	0.15
UA	22	C	2019/09/17	Alkalinity, bicarbonate	mg/L CaCO3	242
UA	22	C	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	230
UA	22	C	2021/02/24	Alkalinity, bicarbonate	mg/L CaCO3	230
UA	22	C	2021/03/04	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	22	C	2021/03/09	Alkalinity, bicarbonate	mg/L CaCO3	327
UA	22	C	2021/03/17	Alkalinity, bicarbonate	mg/L CaCO3	332
UA	22	C	2021/03/19	Alkalinity, bicarbonate	mg/L CaCO3	216
UA	22	C	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	346
UA	22	C	2021/09/08	Alkalinity, bicarbonate	mg/L CaCO3	249
UA	22	C	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	236
UA	22	C	2022/09/13	Alkalinity, bicarbonate	mg/L CaCO3	248
UA	22	C	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	237
UA	22	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	243
UA	22	C	2023/08/25	Alkalinity, bicarbonate	mg/L CaCO3	240
UA	22	C	2023/11/15	Alkalinity, bicarbonate	mg/L CaCO3	260
UA	22	C	2013/06/07	Arsenic, total	mg/L	<0.0007
UA	22	C	2013/09/03	Arsenic, total	mg/L	<0.0007
UA	22	C	2015/12/10	Arsenic, total	mg/L	<0.0002
UA	22	C	2016/03/09	Arsenic, total	mg/L	<0.0002
UA	22	C	2016/06/07	Arsenic, total	mg/L	<0.0002
UA	22	C	2016/09/15	Arsenic, total	mg/L	<0.0002
UA	22	C	2016/12/07	Arsenic, total	mg/L	<0.0002
UA	22	C	2017/02/21	Arsenic, total	mg/L	<0.0002
UA	22	C	2017/04/25	Arsenic, total	mg/L	<0.0002
UA	22	C	2017/06/08	Arsenic, total	mg/L	<0.0002
UA	22	C	2018/06/13	Arsenic, total	mg/L	<0.0004
UA	22	C	2018/09/12	Arsenic, total	mg/L	<0.0004
UA	22	C	2018/12/12	Arsenic, total	mg/L	<0.0004
UA	22	C	2019/03/13	Arsenic, total	mg/L	0.00140
UA	22	C	2019/06/19	Arsenic, total	mg/L	<0.0004
UA	22	C	2019/09/17	Arsenic, total	mg/L	<0.0004
UA	22	C	2019/12/11	Arsenic, total	mg/L	<0.0004
UA	22	C	2020/03/11	Arsenic, total	mg/L	<0.0004
UA	22	C	2020/06/03	Arsenic, total	mg/L	0.00110
UA	22	C	2020/09/02	Arsenic, total	mg/L	<0.0004
UA	22	C	2020/12/09	Arsenic, total	mg/L	0.00130
UA	22	C	2021/02/24	Arsenic, total	mg/L	<0.0000004

UA	22	C	2021/03/04	Arsenic, total	mg/L	0.00120
UA	22	C	2021/03/09	Arsenic, total	mg/L	0.00130
UA	22	C	2021/03/17	Arsenic, total	mg/L	0.00150
UA	22	C	2021/03/19	Arsenic, total	mg/L	<0.0004
UA	22	C	2021/03/30	Arsenic, total	mg/L	<0.0004
UA	22	C	2021/06/23	Arsenic, total	mg/L	<0.0004
UA	22	C	2021/09/08	Arsenic, total	mg/L	0.00110
UA	22	C	2021/12/08	Arsenic, total	mg/L	0.00100
UA	22	C	2022/03/22	Arsenic, total	mg/L	<0.0004
UA	22	C	2022/06/07	Arsenic, total	mg/L	0.000900
UA	22	C	2022/09/13	Arsenic, total	mg/L	0.00100
UA	22	C	2022/12/27	Arsenic, total	mg/L	0.000900
UA	22	C	2023/02/28	Arsenic, total	mg/L	0.00140
UA	22	C	2023/05/31	Arsenic, total	mg/L	<0.0087
UA	22	C	2023/08/25	Arsenic, total	mg/L	<0.00023
UA	22	C	2023/11/15	Arsenic, total	mg/L	0.000870
UA	22	C	2013/06/07	Barium, total	mg/L	0.0615
UA	22	C	2013/09/03	Barium, total	mg/L	0.0657
UA	22	C	2015/12/10	Barium, total	mg/L	0.0604
UA	22	C	2016/03/09	Barium, total	mg/L	0.0634
UA	22	C	2016/06/07	Barium, total	mg/L	0.0657
UA	22	C	2016/09/15	Barium, total	mg/L	0.0620
UA	22	C	2016/12/07	Barium, total	mg/L	0.0760
UA	22	C	2017/02/21	Barium, total	mg/L	0.0628
UA	22	C	2017/04/25	Barium, total	mg/L	0.0605
UA	22	C	2017/06/08	Barium, total	mg/L	0.0673
UA	22	C	2018/06/13	Barium, total	mg/L	0.0688
UA	22	C	2018/09/12	Barium, total	mg/L	0.0816
UA	22	C	2018/12/12	Barium, total	mg/L	0.0902
UA	22	C	2019/03/13	Barium, total	mg/L	0.0669
UA	22	C	2019/06/19	Barium, total	mg/L	0.0744
UA	22	C	2019/09/17	Barium, total	mg/L	0.0687
UA	22	C	2019/12/11	Barium, total	mg/L	0.0736
UA	22	C	2020/03/11	Barium, total	mg/L	0.0731
UA	22	C	2020/06/03	Barium, total	mg/L	0.0731
UA	22	C	2020/09/02	Barium, total	mg/L	0.0722
UA	22	C	2020/12/09	Barium, total	mg/L	0.0931
UA	22	C	2021/02/24	Barium, total	mg/L	0.0655
UA	22	C	2021/03/19	Barium, total	mg/L	0.0669
UA	22	C	2021/06/23	Barium, total	mg/L	0.0699
UA	22	C	2021/09/08	Barium, total	mg/L	0.0622
UA	22	C	2021/12/08	Barium, total	mg/L	0.0635
UA	22	C	2022/03/22	Barium, total	mg/L	0.0616
UA	22	C	2022/06/07	Barium, total	mg/L	0.0678
UA	22	C	2022/09/13	Barium, total	mg/L	0.0652
UA	22	C	2022/12/27	Barium, total	mg/L	0.0676
UA	22	C	2023/02/28	Barium, total	mg/L	0.0900
UA	22	C	2023/05/31	Barium, total	mg/L	0.0585
UA	22	C	2023/08/25	Barium, total	mg/L	0.0130
UA	22	C	2023/11/15	Barium, total	mg/L	0.0580
UA	22	C	2013/06/07	Boron, total	mg/L	7.66
UA	22	C	2013/09/03	Boron, total	mg/L	7.51
UA	22	C	2015/12/10	Boron, total	mg/L	6.01
UA	22	C	2016/03/09	Boron, total	mg/L	5.85
UA	22	C	2016/06/07	Boron, total	mg/L	6.28
UA	22	C	2016/09/15	Boron, total	mg/L	5.75
UA	22	C	2016/12/07	Boron, total	mg/L	6.72
UA	22	C	2017/02/21	Boron, total	mg/L	5.47
UA	22	C	2017/04/25	Boron, total	mg/L	5.29
UA	22	C	2017/06/08	Boron, total	mg/L	4.99
UA	22	C	2017/11/16	Boron, total	mg/L	5.35
UA	22	C	2018/06/13	Boron, total	mg/L	5.57

UA	22	C	2018/09/12	Boron, total	mg/L	4.66
UA	22	C	2018/12/12	Boron, total	mg/L	4.92
UA	22	C	2019/03/13	Boron, total	mg/L	5.75
UA	22	C	2019/06/19	Boron, total	mg/L	5.62
UA	22	C	2019/09/17	Boron, total	mg/L	5.37
UA	22	C	2019/12/11	Boron, total	mg/L	5.70
UA	22	C	2020/03/11	Boron, total	mg/L	5.20
UA	22	C	2020/06/03	Boron, total	mg/L	5.07
UA	22	C	2020/09/02	Boron, total	mg/L	4.72
UA	22	C	2020/12/09	Boron, total	mg/L	4.77
UA	22	C	2021/02/24	Boron, total	mg/L	4.92
UA	22	C	2021/03/04	Boron, total	mg/L	5.10
UA	22	C	2021/03/09	Boron, total	mg/L	1.90
UA	22	C	2021/03/17	Boron, total	mg/L	2.00
UA	22	C	2021/03/19	Boron, total	mg/L	4.89
UA	22	C	2021/03/30	Boron, total	mg/L	1.17
UA	22	C	2021/06/23	Boron, total	mg/L	4.91
UA	22	C	2021/09/08	Boron, total	mg/L	4.39
UA	22	C	2021/12/08	Boron, total	mg/L	3.81
UA	22	C	2022/03/22	Boron, total	mg/L	4.84
UA	22	C	2022/06/07	Boron, total	mg/L	3.95
UA	22	C	2022/09/13	Boron, total	mg/L	3.42
UA	22	C	2022/12/27	Boron, total	mg/L	4.44
UA	22	C	2023/02/28	Boron, total	mg/L	4.51
UA	22	C	2023/05/31	Boron, total	mg/L	3.44
UA	22	C	2023/08/25	Boron, total	mg/L	0.130
UA	22	C	2023/11/15	Boron, total	mg/L	3.20
UA	22	C	2013/06/07	Cadmium, total	mg/L	<0.0003
UA	22	C	2013/09/03	Cadmium, total	mg/L	<0.0003
UA	22	C	2015/12/10	Cadmium, total	mg/L	0.00140
UA	22	C	2016/03/09	Cadmium, total	mg/L	0.00170
UA	22	C	2016/06/07	Cadmium, total	mg/L	0.00230
UA	22	C	2016/09/15	Cadmium, total	mg/L	0.00310
UA	22	C	2016/12/07	Cadmium, total	mg/L	0.00440
UA	22	C	2017/02/21	Cadmium, total	mg/L	0.00390
UA	22	C	2017/04/25	Cadmium, total	mg/L	0.00360
UA	22	C	2017/06/08	Cadmium, total	mg/L	0.00320
UA	22	C	2018/06/13	Cadmium, total	mg/L	0.00430
UA	22	C	2018/09/12	Cadmium, total	mg/L	0.00570
UA	22	C	2018/12/12	Cadmium, total	mg/L	0.00760
UA	22	C	2019/03/13	Cadmium, total	mg/L	0.00570
UA	22	C	2019/06/19	Cadmium, total	mg/L	0.00480
UA	22	C	2019/09/17	Cadmium, total	mg/L	0.00480
UA	22	C	2019/12/11	Cadmium, total	mg/L	0.00550
UA	22	C	2020/03/11	Cadmium, total	mg/L	0.00500
UA	22	C	2020/06/03	Cadmium, total	mg/L	0.00530
UA	22	C	2020/09/02	Cadmium, total	mg/L	0.00530
UA	22	C	2020/12/09	Cadmium, total	mg/L	0.00900
UA	22	C	2021/02/24	Cadmium, total	mg/L	0.00600
UA	22	C	2021/03/19	Cadmium, total	mg/L	0.00590
UA	22	C	2021/06/23	Cadmium, total	mg/L	0.00600
UA	22	C	2021/09/08	Cadmium, total	mg/L	0.00540
UA	22	C	2021/12/08	Cadmium, total	mg/L	0.00540
UA	22	C	2022/03/22	Cadmium, total	mg/L	0.00570
UA	22	C	2022/06/07	Cadmium, total	mg/L	0.00570
UA	22	C	2022/09/13	Cadmium, total	mg/L	0.00570
UA	22	C	2022/12/27	Cadmium, total	mg/L	0.00590
UA	22	C	2023/02/28	Cadmium, total	mg/L	0.00960
UA	22	C	2023/05/31	Cadmium, total	mg/L	0.00520
UA	22	C	2023/08/25	Cadmium, total	mg/L	<0.00017
UA	22	C	2023/11/15	Cadmium, total	mg/L	0.00510
UA	22	C	2015/12/10	Calcium, total	mg/L	117

UA	22	C	2016/03/09	Calcium, total	mg/L	124
UA	22	C	2016/06/07	Calcium, total	mg/L	137
UA	22	C	2016/09/15	Calcium, total	mg/L	118
UA	22	C	2016/12/07	Calcium, total	mg/L	123
UA	22	C	2017/02/21	Calcium, total	mg/L	117
UA	22	C	2017/04/25	Calcium, total	mg/L	101
UA	22	C	2017/06/08	Calcium, total	mg/L	121
UA	22	C	2017/11/16	Calcium, total	mg/L	121
UA	22	C	2018/06/13	Calcium, total	mg/L	123
UA	22	C	2018/09/12	Calcium, total	mg/L	137
UA	22	C	2018/12/12	Calcium, total	mg/L	150
UA	22	C	2019/03/13	Calcium, total	mg/L	116
UA	22	C	2019/06/19	Calcium, total	mg/L	126
UA	22	C	2019/09/17	Calcium, total	mg/L	125
UA	22	C	2019/12/11	Calcium, total	mg/L	124
UA	22	C	2020/03/11	Calcium, total	mg/L	124
UA	22	C	2020/06/03	Calcium, total	mg/L	125
UA	22	C	2020/09/02	Calcium, total	mg/L	120
UA	22	C	2020/12/09	Calcium, total	mg/L	159
UA	22	C	2021/02/24	Calcium, total	mg/L	108
UA	22	C	2021/03/04	Calcium, total	mg/L	108
UA	22	C	2021/03/09	Calcium, total	mg/L	120
UA	22	C	2021/03/17	Calcium, total	mg/L	133
UA	22	C	2021/03/19	Calcium, total	mg/L	113
UA	22	C	2021/03/30	Calcium, total	mg/L	72.2
UA	22	C	2021/06/23	Calcium, total	mg/L	112
UA	22	C	2021/09/08	Calcium, total	mg/L	107
UA	22	C	2021/12/08	Calcium, total	mg/L	97.4
UA	22	C	2022/03/22	Calcium, total	mg/L	108
UA	22	C	2022/06/07	Calcium, total	mg/L	104
UA	22	C	2022/09/13	Calcium, total	mg/L	97.0
UA	22	C	2022/12/27	Calcium, total	mg/L	98.7
UA	22	C	2023/02/28	Calcium, total	mg/L	102
UA	22	C	2023/05/31	Calcium, total	mg/L	87.1
UA	22	C	2023/08/25	Calcium, total	mg/L	23.0
UA	22	C	2023/11/15	Calcium, total	mg/L	87.0
UA	22	C	2013/03/08	Chloride, total	mg/L	31.0
UA	22	C	2013/06/07	Chloride, total	mg/L	38.0
UA	22	C	2013/09/03	Chloride, total	mg/L	34.0
UA	22	C	2013/12/10	Chloride, total	mg/L	38.0
UA	22	C	2014/03/25	Chloride, total	mg/L	36.0
UA	22	C	2014/09/30	Chloride, total	mg/L	40.0
UA	22	C	2015/03/18	Chloride, total	mg/L	56.0
UA	22	C	2015/09/16	Chloride, total	mg/L	56.0
UA	22	C	2015/12/10	Chloride, total	mg/L	65.0
UA	22	C	2016/03/09	Chloride, total	mg/L	76.0
UA	22	C	2016/06/07	Chloride, total	mg/L	76.0
UA	22	C	2016/09/15	Chloride, total	mg/L	78.0
UA	22	C	2016/12/07	Chloride, total	mg/L	85.0
UA	22	C	2017/02/21	Chloride, total	mg/L	77.0
UA	22	C	2017/04/25	Chloride, total	mg/L	81.0
UA	22	C	2017/06/08	Chloride, total	mg/L	77.0
UA	22	C	2017/09/06	Chloride, total	mg/L	83.0
UA	22	C	2017/11/16	Chloride, total	mg/L	83.0
UA	22	C	2018/03/26	Chloride, total	mg/L	88.0
UA	22	C	2018/06/13	Chloride, total	mg/L	88.0
UA	22	C	2018/09/12	Chloride, total	mg/L	90.0
UA	22	C	2018/12/12	Chloride, total	mg/L	89.0
UA	22	C	2019/03/13	Chloride, total	mg/L	86.0
UA	22	C	2019/06/19	Chloride, total	mg/L	79.0
UA	22	C	2019/09/17	Chloride, total	mg/L	84.0
UA	22	C	2019/12/11	Chloride, total	mg/L	87.0

UA	22	C	2020/03/11	Chloride, total	mg/L	84.0
UA	22	C	2020/06/03	Chloride, total	mg/L	86.0
UA	22	C	2020/09/02	Chloride, total	mg/L	83.0
UA	22	C	2020/12/09	Chloride, total	mg/L	85.0
UA	22	C	2021/02/24	Chloride, total	mg/L	79.0
UA	22	C	2021/03/04	Chloride, total	mg/L	88.0
UA	22	C	2021/03/09	Chloride, total	mg/L	97.0
UA	22	C	2021/03/17	Chloride, total	mg/L	92.0
UA	22	C	2021/03/19	Chloride, total	mg/L	79.0
UA	22	C	2021/03/30	Chloride, total	mg/L	97.0
UA	22	C	2021/06/23	Chloride, total	mg/L	93.0
UA	22	C	2021/09/08	Chloride, total	mg/L	93.0
UA	22	C	2021/12/08	Chloride, total	mg/L	23.0
UA	22	C	2022/03/22	Chloride, total	mg/L	90.0
UA	22	C	2022/06/07	Chloride, total	mg/L	92.0
UA	22	C	2022/09/13	Chloride, total	mg/L	97.0
UA	22	C	2022/12/27	Chloride, total	mg/L	104
UA	22	C	2023/02/28	Chloride, total	mg/L	100
UA	22	C	2023/05/31	Chloride, total	mg/L	97.0
UA	22	C	2023/08/25	Chloride, total	mg/L	89.0
UA	22	C	2023/11/15	Chloride, total	mg/L	92.0
UA	22	C	2013/12/10	Iron, dissolved	mg/L	<0.007
UA	22	C	2014/03/25	Iron, dissolved	mg/L	<0.007
UA	22	C	2014/08/19	Iron, dissolved	mg/L	<0.007
UA	22	C	2014/09/30	Iron, dissolved	mg/L	<0.007
UA	22	C	2015/03/18	Iron, dissolved	mg/L	<0.007
UA	22	C	2015/09/16	Iron, dissolved	mg/L	<0.007
UA	22	C	2016/03/09	Iron, dissolved	mg/L	<0.007
UA	22	C	2016/09/15	Iron, dissolved	mg/L	<0.007
UA	22	C	2017/02/21	Iron, dissolved	mg/L	<0.007
UA	22	C	2017/09/06	Iron, dissolved	mg/L	<0.007
UA	22	C	2018/03/26	Iron, dissolved	mg/L	<0.007
UA	22	C	2021/02/24	Iron, dissolved	mg/L	<0.0000115
UA	22	C	2021/03/04	Iron, dissolved	mg/L	<0.0115
UA	22	C	2021/03/09	Iron, dissolved	mg/L	2.20
UA	22	C	2021/03/17	Iron, dissolved	mg/L	2.23
UA	22	C	2021/03/30	Iron, dissolved	mg/L	2.10
UA	22	C	2023/05/31	Iron, dissolved	mg/L	<0.02
UA	22	C	2023/08/25	Iron, dissolved	mg/L	<0.047
UA	22	C	2015/12/10	Lithium, total	mg/L	0.0588
UA	22	C	2016/03/09	Lithium, total	mg/L	0.0594
UA	22	C	2016/06/07	Lithium, total	mg/L	0.0641
UA	22	C	2016/09/15	Lithium, total	mg/L	0.0595
UA	22	C	2016/12/07	Lithium, total	mg/L	0.0552
UA	22	C	2017/02/21	Lithium, total	mg/L	0.0554
UA	22	C	2017/04/25	Lithium, total	mg/L	0.0527
UA	22	C	2017/06/08	Lithium, total	mg/L	0.0543
UA	22	C	2018/06/13	Lithium, total	mg/L	0.0616
UA	22	C	2018/09/12	Lithium, total	mg/L	0.0764
UA	22	C	2018/12/12	Lithium, total	mg/L	0.0550
UA	22	C	2019/03/13	Lithium, total	mg/L	0.0650
UA	22	C	2019/06/19	Lithium, total	mg/L	0.0654
UA	22	C	2019/09/17	Lithium, total	mg/L	0.0610
UA	22	C	2019/12/11	Lithium, total	mg/L	0.0632
UA	22	C	2020/03/11	Lithium, total	mg/L	0.0616
UA	22	C	2020/06/03	Lithium, total	mg/L	0.0580
UA	22	C	2020/09/02	Lithium, total	mg/L	0.0545
UA	22	C	2020/12/09	Lithium, total	mg/L	0.0543
UA	22	C	2021/02/24	Lithium, total	mg/L	0.0529
UA	22	C	2021/03/04	Lithium, total	mg/L	0.0621
UA	22	C	2021/03/09	Lithium, total	mg/L	0.0140
UA	22	C	2021/03/17	Lithium, total	mg/L	0.0160

UA	22	C	2021/03/19	Lithium, total	mg/L	0.0562
UA	22	C	2021/03/30	Lithium, total	mg/L	0.00900
UA	22	C	2021/06/23	Lithium, total	mg/L	0.0583
UA	22	C	2021/09/08	Lithium, total	mg/L	0.0542
UA	22	C	2021/12/08	Lithium, total	mg/L	0.0477
UA	22	C	2022/03/22	Lithium, total	mg/L	0.0620
UA	22	C	2022/06/07	Lithium, total	mg/L	0.0507
UA	22	C	2022/09/13	Lithium, total	mg/L	0.0439
UA	22	C	2022/12/27	Lithium, total	mg/L	0.0584
UA	22	C	2023/02/28	Lithium, total	mg/L	0.0419
UA	22	C	2023/05/31	Lithium, total	mg/L	0.0500
UA	22	C	2023/08/25	Lithium, total	mg/L	0.0490
UA	22	C	2023/11/15	Lithium, total	mg/L	0.0510
UA	22	C	2019/09/17	Magnesium, total	mg/L	33.6
UA	22	C	2020/03/11	Magnesium, total	mg/L	35.1
UA	22	C	2020/06/03	Magnesium, total	mg/L	33.8
UA	22	C	2021/02/24	Magnesium, total	mg/L	32.4
UA	22	C	2021/03/04	Magnesium, total	mg/L	30.4
UA	22	C	2021/03/09	Magnesium, total	mg/L	51.0
UA	22	C	2021/03/17	Magnesium, total	mg/L	44.9
UA	22	C	2021/03/19	Magnesium, total	mg/L	34.0
UA	22	C	2021/03/30	Magnesium, total	mg/L	25.4
UA	22	C	2021/09/08	Magnesium, total	mg/L	30.8
UA	22	C	2022/03/22	Magnesium, total	mg/L	33.4
UA	22	C	2022/09/13	Magnesium, total	mg/L	31.0
UA	22	C	2023/02/28	Magnesium, total	mg/L	34.0
UA	22	C	2023/05/31	Magnesium, total	mg/L	32.0
UA	22	C	2023/08/25	Magnesium, total	mg/L	7.10
UA	22	C	2023/11/15	Magnesium, total	mg/L	32.0
UA	22	C	2013/03/08	Manganese, dissolved	mg/L	0.0500
UA	22	C	2013/12/10	Manganese, dissolved	mg/L	0.0779
UA	22	C	2014/03/25	Manganese, dissolved	mg/L	0.0405
UA	22	C	2014/08/19	Manganese, dissolved	mg/L	0.0354
UA	22	C	2014/09/30	Manganese, dissolved	mg/L	0.0663
UA	22	C	2015/03/18	Manganese, dissolved	mg/L	0.0533
UA	22	C	2015/09/16	Manganese, dissolved	mg/L	0.0835
UA	22	C	2016/03/09	Manganese, dissolved	mg/L	0.104
UA	22	C	2016/09/15	Manganese, dissolved	mg/L	0.125
UA	22	C	2017/02/21	Manganese, dissolved	mg/L	0.123
UA	22	C	2017/09/06	Manganese, dissolved	mg/L	0.120
UA	22	C	2018/03/26	Manganese, dissolved	mg/L	0.120
UA	22	C	2021/02/24	Manganese, dissolved	mg/L	0.0874
UA	22	C	2021/03/04	Manganese, dissolved	mg/L	0.101
UA	22	C	2021/03/09	Manganese, dissolved	mg/L	0.0730
UA	22	C	2021/03/17	Manganese, dissolved	mg/L	0.0726
UA	22	C	2021/03/30	Manganese, dissolved	mg/L	0.0698
UA	22	C	2023/05/31	Manganese, dissolved	mg/L	0.0340
UA	22	C	2023/08/25	Manganese, dissolved	mg/L	0.0360
UA	22	C	2023/05/31	Phosphate, dissolved	mg/L	<0.005
UA	22	C	2023/08/25	Phosphate, dissolved	mg/L	0.300
UA	22	C	2019/09/17	Potassium, total	mg/L	12.4
UA	22	C	2020/03/11	Potassium, total	mg/L	14.0
UA	22	C	2020/06/03	Potassium, total	mg/L	12.8
UA	22	C	2021/02/24	Potassium, total	mg/L	12.4
UA	22	C	2021/03/04	Potassium, total	mg/L	12.7
UA	22	C	2021/03/09	Potassium, total	mg/L	3.30
UA	22	C	2021/03/17	Potassium, total	mg/L	3.50
UA	22	C	2021/03/19	Potassium, total	mg/L	13.1
UA	22	C	2021/03/30	Potassium, total	mg/L	1.84
UA	22	C	2021/09/08	Potassium, total	mg/L	12.2
UA	22	C	2022/03/22	Potassium, total	mg/L	12.3
UA	22	C	2022/09/13	Potassium, total	mg/L	11.4

UA	22	C	2023/02/28	Potassium, total	mg/L	11.5
UA	22	C	2023/05/31	Potassium, total	mg/L	11.4
UA	22	C	2023/08/25	Potassium, total	mg/L	2.50
UA	22	C	2023/11/15	Potassium, total	mg/L	10.0
UA	22	C	2023/05/31	Silicon, dissolved	mg/L	17.2
UA	22	C	2023/08/25	Silicon, dissolved	mg/L	21.0
UA	22	C	2019/09/17	Sodium, total	mg/L	55.8
UA	22	C	2020/03/11	Sodium, total	mg/L	56.1
UA	22	C	2020/06/03	Sodium, total	mg/L	57.0
UA	22	C	2021/02/24	Sodium, total	mg/L	55.6
UA	22	C	2021/03/04	Sodium, total	mg/L	61.1
UA	22	C	2021/03/09	Sodium, total	mg/L	41.0
UA	22	C	2021/03/17	Sodium, total	mg/L	43.9
UA	22	C	2021/03/19	Sodium, total	mg/L	57.5
UA	22	C	2021/03/30	Sodium, total	mg/L	24.5
UA	22	C	2021/09/08	Sodium, total	mg/L	56.3
UA	22	C	2022/03/22	Sodium, total	mg/L	59.3
UA	22	C	2022/09/13	Sodium, total	mg/L	52.6
UA	22	C	2023/02/28	Sodium, total	mg/L	57.4
UA	22	C	2023/05/31	Sodium, total	mg/L	55.8
UA	22	C	2023/08/25	Sodium, total	mg/L	12.0
UA	22	C	2023/11/15	Sodium, total	mg/L	55.0
UA	22	C	2013/03/08	Sulfate, total	mg/L	339
UA	22	C	2013/06/07	Sulfate, total	mg/L	346
UA	22	C	2013/09/03	Sulfate, total	mg/L	341
UA	22	C	2013/12/10	Sulfate, total	mg/L	280
UA	22	C	2014/03/25	Sulfate, total	mg/L	264
UA	22	C	2014/09/30	Sulfate, total	mg/L	242
UA	22	C	2015/03/18	Sulfate, total	mg/L	236
UA	22	C	2015/09/16	Sulfate, total	mg/L	224
UA	22	C	2015/12/10	Sulfate, total	mg/L	221
UA	22	C	2016/03/09	Sulfate, total	mg/L	261
UA	22	C	2016/06/07	Sulfate, total	mg/L	255
UA	22	C	2016/09/15	Sulfate, total	mg/L	208
UA	22	C	2016/12/07	Sulfate, total	mg/L	204
UA	22	C	2017/02/21	Sulfate, total	mg/L	197
UA	22	C	2017/04/25	Sulfate, total	mg/L	213
UA	22	C	2017/06/08	Sulfate, total	mg/L	229
UA	22	C	2017/09/06	Sulfate, total	mg/L	228
UA	22	C	2017/11/16	Sulfate, total	mg/L	187
UA	22	C	2018/03/26	Sulfate, total	mg/L	224
UA	22	C	2018/06/13	Sulfate, total	mg/L	219
UA	22	C	2018/09/12	Sulfate, total	mg/L	207
UA	22	C	2018/12/12	Sulfate, total	mg/L	181
UA	22	C	2019/03/13	Sulfate, total	mg/L	179
UA	22	C	2019/06/19	Sulfate, total	mg/L	249
UA	22	C	2019/09/17	Sulfate, total	mg/L	204
UA	22	C	2019/12/11	Sulfate, total	mg/L	187
UA	22	C	2020/03/11	Sulfate, total	mg/L	220
UA	22	C	2020/06/03	Sulfate, total	mg/L	214
UA	22	C	2020/09/02	Sulfate, total	mg/L	206
UA	22	C	2020/12/09	Sulfate, total	mg/L	201
UA	22	C	2021/02/24	Sulfate, total	mg/L	182
UA	22	C	2021/03/04	Sulfate, total	mg/L	205
UA	22	C	2021/03/09	Sulfate, total	mg/L	112
UA	22	C	2021/03/17	Sulfate, total	mg/L	101
UA	22	C	2021/03/19	Sulfate, total	mg/L	179
UA	22	C	2021/03/30	Sulfate, total	mg/L	107
UA	22	C	2021/06/23	Sulfate, total	mg/L	168
UA	22	C	2021/09/08	Sulfate, total	mg/L	160
UA	22	C	2021/12/08	Sulfate, total	mg/L	146
UA	22	C	2022/03/22	Sulfate, total	mg/L	145

UA	22	C	2022/06/07	Sulfate, total	mg/L	134
UA	22	C	2022/09/13	Sulfate, total	mg/L	142
UA	22	C	2022/12/27	Sulfate, total	mg/L	141
UA	22	C	2023/02/28	Sulfate, total	mg/L	145
UA	22	C	2023/05/31	Sulfate, total	mg/L	123
UA	22	C	2023/08/25	Sulfate, total	mg/L	120
UA	22	C	2023/11/15	Sulfate, total	mg/L	120
UA	22	C	2013/03/08	Temperature (Celsius)	degrees C	11.7
UA	22	C	2013/06/07	Temperature (Celsius)	degrees C	13.6
UA	22	C	2013/09/03	Temperature (Celsius)	degrees C	13.6
UA	22	C	2013/12/10	Temperature (Celsius)	degrees C	10.1
UA	22	C	2014/03/25	Temperature (Celsius)	degrees C	10.5
UA	22	C	2014/08/19	Temperature (Celsius)	degrees C	13.8
UA	22	C	2014/09/30	Temperature (Celsius)	degrees C	13.1
UA	22	C	2015/03/18	Temperature (Celsius)	degrees C	12.0
UA	22	C	2015/09/16	Temperature (Celsius)	degrees C	13.4
UA	22	C	2015/12/10	Temperature (Celsius)	degrees C	13.2
UA	22	C	2016/03/09	Temperature (Celsius)	degrees C	12.0
UA	22	C	2016/06/07	Temperature (Celsius)	degrees C	12.5
UA	22	C	2016/09/15	Temperature (Celsius)	degrees C	14.0
UA	22	C	2016/12/07	Temperature (Celsius)	degrees C	10.3
UA	22	C	2017/02/21	Temperature (Celsius)	degrees C	14.0
UA	22	C	2017/04/25	Temperature (Celsius)	degrees C	21.0
UA	22	C	2017/06/08	Temperature (Celsius)	degrees C	14.3
UA	22	C	2017/09/06	Temperature (Celsius)	degrees C	13.6
UA	22	C	2017/11/16	Temperature (Celsius)	degrees C	13.3
UA	22	C	2018/03/26	Temperature (Celsius)	degrees C	14.6
UA	22	C	2018/06/13	Temperature (Celsius)	degrees C	15.4
UA	22	C	2018/09/12	Temperature (Celsius)	degrees C	15.8
UA	22	C	2018/12/12	Temperature (Celsius)	degrees C	13.6
UA	22	C	2019/03/13	Temperature (Celsius)	degrees C	13.8
UA	22	C	2019/06/19	Temperature (Celsius)	degrees C	14.4
UA	22	C	2019/09/17	Temperature (Celsius)	degrees C	14.8
UA	22	C	2019/12/11	Temperature (Celsius)	degrees C	14.2
UA	22	C	2020/03/11	Temperature (Celsius)	degrees C	14.5
UA	22	C	2020/06/03	Temperature (Celsius)	degrees C	15.1
UA	22	C	2020/06/25	Temperature (Celsius)	degrees C	15.1
UA	22	C	2020/09/02	Temperature (Celsius)	degrees C	16.0
UA	22	C	2020/12/09	Temperature (Celsius)	degrees C	14.8
UA	22	C	2021/03/19	Temperature (Celsius)	degrees C	15.0
UA	22	C	2021/06/23	Temperature (Celsius)	degrees C	15.8
UA	22	C	2021/09/08	Temperature (Celsius)	degrees C	16.5
UA	22	C	2021/12/08	Temperature (Celsius)	degrees C	15.1
UA	22	C	2022/03/22	Temperature (Celsius)	degrees C	14.6
UA	22	C	2022/06/07	Temperature (Celsius)	degrees C	15.8
UA	22	C	2022/09/13	Temperature (Celsius)	degrees C	15.8
UA	22	C	2022/12/27	Temperature (Celsius)	degrees C	14.3
UA	22	C	2023/02/28	Temperature (Celsius)	degrees C	14.8
UA	22	C	2023/05/31	Temperature (Celsius)	degrees C	15.7
UA	22	C	2023/08/25	Temperature (Celsius)	degrees C	16.1
UA	22	C	2023/11/15	Temperature (Celsius)	degrees C	15.7
UA	22	C	2013/03/08	Total Dissolved Solids	mg/L	646
UA	22	C	2013/06/07	Total Dissolved Solids	mg/L	702
UA	22	C	2013/09/03	Total Dissolved Solids	mg/L	784
UA	22	C	2013/12/10	Total Dissolved Solids	mg/L	694
UA	22	C	2014/03/25	Total Dissolved Solids	mg/L	596
UA	22	C	2014/08/19	Total Dissolved Solids	mg/L	654
UA	22	C	2014/09/30	Total Dissolved Solids	mg/L	688
UA	22	C	2015/03/18	Total Dissolved Solids	mg/L	650
UA	22	C	2015/09/16	Total Dissolved Solids	mg/L	664
UA	22	C	2015/12/10	Total Dissolved Solids	mg/L	660
UA	22	C	2016/03/09	Total Dissolved Solids	mg/L	684

UA	22	C	2016/06/07	Total Dissolved Solids	mg/L	718
UA	22	C	2016/09/15	Total Dissolved Solids	mg/L	706
UA	22	C	2016/12/07	Total Dissolved Solids	mg/L	670
UA	22	C	2017/02/21	Total Dissolved Solids	mg/L	678
UA	22	C	2017/04/25	Total Dissolved Solids	mg/L	730
UA	22	C	2017/06/08	Total Dissolved Solids	mg/L	760
UA	22	C	2017/09/06	Total Dissolved Solids	mg/L	698
UA	22	C	2017/11/16	Total Dissolved Solids	mg/L	694
UA	22	C	2018/03/26	Total Dissolved Solids	mg/L	684
UA	22	C	2018/06/13	Total Dissolved Solids	mg/L	740
UA	22	C	2018/09/12	Total Dissolved Solids	mg/L	800
UA	22	C	2018/12/12	Total Dissolved Solids	mg/L	734
UA	22	C	2019/03/13	Total Dissolved Solids	mg/L	710
UA	22	C	2019/06/19	Total Dissolved Solids	mg/L	774
UA	22	C	2019/09/17	Total Dissolved Solids	mg/L	732
UA	22	C	2019/12/11	Total Dissolved Solids	mg/L	676
UA	22	C	2020/03/11	Total Dissolved Solids	mg/L	722
UA	22	C	2020/06/03	Total Dissolved Solids	mg/L	688
UA	22	C	2020/09/02	Total Dissolved Solids	mg/L	676
UA	22	C	2020/12/09	Total Dissolved Solids	mg/L	684
UA	22	C	2021/02/24	Total Dissolved Solids	mg/L	674
UA	22	C	2021/03/04	Total Dissolved Solids	mg/L	688
UA	22	C	2021/03/09	Total Dissolved Solids	mg/L	646
UA	22	C	2021/03/17	Total Dissolved Solids	mg/L	712
UA	22	C	2021/03/19	Total Dissolved Solids	mg/L	644
UA	22	C	2021/03/30	Total Dissolved Solids	mg/L	618
UA	22	C	2021/06/23	Total Dissolved Solids	mg/L	640
UA	22	C	2021/09/08	Total Dissolved Solids	mg/L	626
UA	22	C	2021/12/08	Total Dissolved Solids	mg/L	588
UA	22	C	2022/03/22	Total Dissolved Solids	mg/L	608
UA	22	C	2022/06/07	Total Dissolved Solids	mg/L	664
UA	22	C	2022/09/13	Total Dissolved Solids	mg/L	662
UA	22	C	2022/12/27	Total Dissolved Solids	mg/L	594
UA	22	C	2023/02/28	Total Dissolved Solids	mg/L	598
UA	22	C	2023/05/31	Total Dissolved Solids	mg/L	586
UA	22	C	2023/08/25	Total Dissolved Solids	mg/L	640
UA	22	C	2023/11/15	Total Dissolved Solids	mg/L	590
UA	22D	C	2019/09/17	pH (field)	SU	7.2
UA	22D	C	2019/12/11	pH (field)	SU	7.3
UA	22D	C	2020/03/11	pH (field)	SU	7.3
UA	22D	C	2020/06/03	pH (field)	SU	7.4
UA	22D	C	2020/06/25	pH (field)	SU	7.5
UA	22D	C	2020/09/02	pH (field)	SU	7.4
UA	22D	C	2020/12/09	pH (field)	SU	7.4
UA	22D	C	2021/03/19	pH (field)	SU	7.3
UA	22D	C	2021/06/23	pH (field)	SU	7.0
UA	22D	C	2021/09/08	pH (field)	SU	7.2
UA	22D	C	2021/12/08	pH (field)	SU	7.2
UA	22D	C	2022/03/22	pH (field)	SU	7.3
UA	22D	C	2022/06/07	pH (field)	SU	7.3
UA	22D	C	2022/09/13	pH (field)	SU	7.2
UA	22D	C	2022/12/27	pH (field)	SU	7.2
UA	22D	C	2023/02/28	pH (field)	SU	7.2
UA	22D	C	2023/05/31	pH (field)	SU	7.2
UA	22D	C	2023/08/22	pH (field)	SU	7.3
UA	22D	C	2023/11/15	pH (field)	SU	7.4
UA	22D	C	2019/09/17	Oxidation Reduction Potential	mV	-124
UA	22D	C	2019/12/11	Oxidation Reduction Potential	mV	-100
UA	22D	C	2020/03/11	Oxidation Reduction Potential	mV	-106
UA	22D	C	2020/06/03	Oxidation Reduction Potential	mV	-122
UA	22D	C	2020/06/25	Oxidation Reduction Potential	mV	-111
UA	22D	C	2020/09/02	Oxidation Reduction Potential	mV	-135

UA	22D	C	2020/12/09	Oxidation Reduction Potential	mV	-139
UA	22D	C	2021/03/19	Oxidation Reduction Potential	mV	-109
UA	22D	C	2021/06/23	Oxidation Reduction Potential	mV	-145
UA	22D	C	2021/09/08	Oxidation Reduction Potential	mV	68.0
UA	22D	C	2021/12/08	Oxidation Reduction Potential	mV	-122
UA	22D	C	2022/03/22	Oxidation Reduction Potential	mV	-155
UA	22D	C	2022/06/07	Oxidation Reduction Potential	mV	42.0
UA	22D	C	2022/09/13	Oxidation Reduction Potential	mV	21.0
UA	22D	C	2022/12/27	Oxidation Reduction Potential	mV	-133
UA	22D	C	2023/02/28	Oxidation Reduction Potential	mV	-107
UA	22D	C	2023/05/31	Oxidation Reduction Potential	mV	-121
UA	22D	C	2023/08/22	Oxidation Reduction Potential	mV	-82.1
UA	22D	C	2023/11/15	Oxidation Reduction Potential	mV	-112
UA	22D	C	2019/09/17	Eh	V	0.072
UA	22D	C	2019/12/11	Eh	V	0.096
UA	22D	C	2020/03/11	Eh	V	0.091
UA	22D	C	2020/06/03	Eh	V	0.073
UA	22D	C	2020/06/25	Eh	V	0.084
UA	22D	C	2020/09/02	Eh	V	0.060
UA	22D	C	2020/12/09	Eh	V	0.057
UA	22D	C	2021/03/19	Eh	V	0.087
UA	22D	C	2021/06/23	Eh	V	0.050
UA	22D	C	2021/09/08	Eh	V	0.26
UA	22D	C	2021/12/08	Eh	V	0.074
UA	22D	C	2022/03/22	Eh	V	0.041
UA	22D	C	2022/06/07	Eh	V	0.24
UA	22D	C	2022/09/13	Eh	V	0.22
UA	22D	C	2022/12/27	Eh	V	0.063
UA	22D	C	2023/02/28	Eh	V	0.088
UA	22D	C	2023/05/31	Eh	V	0.074
UA	22D	C	2023/08/22	Eh	V	0.11
UA	22D	C	2023/11/15	Eh	V	0.083
UA	22D	C	2019/09/17	Alkalinity, bicarbonate	mg/L CaCO3	324
UA	22D	C	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	334
UA	22D	C	2021/03/19	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	22D	C	2021/09/08	Alkalinity, bicarbonate	mg/L CaCO3	316
UA	22D	C	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	333
UA	22D	C	2022/09/13	Alkalinity, bicarbonate	mg/L CaCO3	346
UA	22D	C	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	341
UA	22D	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	345
UA	22D	C	2023/08/22	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	22D	C	2023/11/15	Alkalinity, bicarbonate	mg/L CaCO3	350
UA	22D	C	2019/09/17	Arsenic, total	mg/L	0.00140
UA	22D	C	2019/12/11	Arsenic, total	mg/L	0.00130
UA	22D	C	2020/03/11	Arsenic, total	mg/L	0.00120
UA	22D	C	2020/06/03	Arsenic, total	mg/L	0.00150
UA	22D	C	2020/09/02	Arsenic, total	mg/L	0.00120
UA	22D	C	2020/12/09	Arsenic, total	mg/L	0.00180
UA	22D	C	2021/03/19	Arsenic, total	mg/L	0.00120
UA	22D	C	2021/06/23	Arsenic, total	mg/L	0.00140
UA	22D	C	2021/09/08	Arsenic, total	mg/L	0.00120
UA	22D	C	2021/12/08	Arsenic, total	mg/L	0.00170
UA	22D	C	2022/03/22	Arsenic, total	mg/L	0.00130
UA	22D	C	2022/09/13	Arsenic, total	mg/L	0.00110
UA	22D	C	2023/02/28	Arsenic, total	mg/L	0.00160
UA	22D	C	2023/05/31	Arsenic, total	mg/L	<0.0087
UA	22D	C	2023/08/22	Arsenic, total	mg/L	0.00130
UA	22D	C	2023/11/15	Arsenic, total	mg/L	0.00120
UA	22D	C	2019/09/17	Barium, total	mg/L	0.0565
UA	22D	C	2019/12/11	Barium, total	mg/L	0.0587
UA	22D	C	2020/03/11	Barium, total	mg/L	0.0601
UA	22D	C	2020/06/03	Barium, total	mg/L	0.0619

UA	22D	C	2020/09/02	Barium, total	mg/L	0.0629
UA	22D	C	2020/12/09	Barium, total	mg/L	0.0881
UA	22D	C	2021/03/19	Barium, total	mg/L	0.0656
UA	22D	C	2021/06/23	Barium, total	mg/L	0.0662
UA	22D	C	2021/09/08	Barium, total	mg/L	0.0627
UA	22D	C	2021/12/08	Barium, total	mg/L	0.0609
UA	22D	C	2022/03/22	Barium, total	mg/L	0.0676
UA	22D	C	2022/09/13	Barium, total	mg/L	0.0739
UA	22D	C	2023/02/28	Barium, total	mg/L	0.0783
UA	22D	C	2023/05/31	Barium, total	mg/L	0.0669
UA	22D	C	2023/08/22	Barium, total	mg/L	0.0660
UA	22D	C	2023/11/15	Barium, total	mg/L	0.0670
UA	22D	C	2019/09/17	Boron, total	mg/L	2.68
UA	22D	C	2019/12/11	Boron, total	mg/L	2.41
UA	22D	C	2020/03/11	Boron, total	mg/L	2.14
UA	22D	C	2020/06/03	Boron, total	mg/L	2.24
UA	22D	C	2020/09/02	Boron, total	mg/L	1.94
UA	22D	C	2020/12/09	Boron, total	mg/L	1.86
UA	22D	C	2021/03/19	Boron, total	mg/L	1.92
UA	22D	C	2021/06/23	Boron, total	mg/L	1.90
UA	22D	C	2021/09/08	Boron, total	mg/L	2.05
UA	22D	C	2021/12/08	Boron, total	mg/L	2.02
UA	22D	C	2022/03/22	Boron, total	mg/L	2.10
UA	22D	C	2022/09/13	Boron, total	mg/L	1.67
UA	22D	C	2023/02/28	Boron, total	mg/L	2.40
UA	22D	C	2023/05/31	Boron, total	mg/L	1.57
UA	22D	C	2023/08/22	Boron, total	mg/L	1.30
UA	22D	C	2023/11/15	Boron, total	mg/L	1.50
UA	22D	C	2019/09/17	Cadmium, total	mg/L	<0.0002
UA	22D	C	2019/12/11	Cadmium, total	mg/L	<0.0002
UA	22D	C	2020/03/11	Cadmium, total	mg/L	<0.0002
UA	22D	C	2020/06/03	Cadmium, total	mg/L	<0.0002
UA	22D	C	2020/09/02	Cadmium, total	mg/L	<0.0002
UA	22D	C	2020/12/09	Cadmium, total	mg/L	<0.0002
UA	22D	C	2021/03/19	Cadmium, total	mg/L	<0.0002
UA	22D	C	2021/06/23	Cadmium, total	mg/L	<0.0002
UA	22D	C	2021/09/08	Cadmium, total	mg/L	<0.0002
UA	22D	C	2021/12/08	Cadmium, total	mg/L	<0.0002
UA	22D	C	2022/03/22	Cadmium, total	mg/L	<0.0002
UA	22D	C	2022/09/13	Cadmium, total	mg/L	<0.0002
UA	22D	C	2023/02/28	Cadmium, total	mg/L	<0.0002
UA	22D	C	2023/05/31	Cadmium, total	mg/L	<0.0005
UA	22D	C	2023/08/22	Cadmium, total	mg/L	<0.00017
UA	22D	C	2023/11/15	Cadmium, total	mg/L	<0.00017
UA	22D	C	2019/09/17	Calcium, total	mg/L	130
UA	22D	C	2019/12/11	Calcium, total	mg/L	125
UA	22D	C	2020/03/11	Calcium, total	mg/L	127
UA	22D	C	2020/06/03	Calcium, total	mg/L	133
UA	22D	C	2020/09/02	Calcium, total	mg/L	124
UA	22D	C	2020/12/09	Calcium, total	mg/L	185
UA	22D	C	2021/03/19	Calcium, total	mg/L	128
UA	22D	C	2021/06/23	Calcium, total	mg/L	135
UA	22D	C	2021/09/08	Calcium, total	mg/L	129
UA	22D	C	2021/12/08	Calcium, total	mg/L	119
UA	22D	C	2022/03/22	Calcium, total	mg/L	132
UA	22D	C	2022/09/13	Calcium, total	mg/L	124
UA	22D	C	2023/02/28	Calcium, total	mg/L	137
UA	22D	C	2023/05/31	Calcium, total	mg/L	113
UA	22D	C	2023/08/22	Calcium, total	mg/L	120
UA	22D	C	2023/11/15	Calcium, total	mg/L	120
UA	22D	C	2019/09/17	Chloride, total	mg/L	71.0
UA	22D	C	2019/12/11	Chloride, total	mg/L	85.0

UA	22D	C	2020/03/11	Chloride, total	mg/L	84.0
UA	22D	C	2020/06/03	Chloride, total	mg/L	94.0
UA	22D	C	2020/09/02	Chloride, total	mg/L	93.0
UA	22D	C	2020/12/09	Chloride, total	mg/L	98.0
UA	22D	C	2021/03/19	Chloride, total	mg/L	95.0
UA	22D	C	2021/06/23	Chloride, total	mg/L	103
UA	22D	C	2021/09/08	Chloride, total	mg/L	100
UA	22D	C	2021/12/08	Chloride, total	mg/L	112
UA	22D	C	2022/03/22	Chloride, total	mg/L	104
UA	22D	C	2022/09/13	Chloride, total	mg/L	103
UA	22D	C	2023/02/28	Chloride, total	mg/L	113
UA	22D	C	2023/05/31	Chloride, total	mg/L	110
UA	22D	C	2023/08/22	Chloride, total	mg/L	97.0
UA	22D	C	2023/11/15	Chloride, total	mg/L	93.0
UA	22D	C	2023/05/31	Iron, dissolved	mg/L	1.92
UA	22D	C	2023/08/22	Iron, dissolved	mg/L	2.20
UA	22D	C	2019/09/17	Lithium, total	mg/L	0.0158
UA	22D	C	2019/12/11	Lithium, total	mg/L	0.0170
UA	22D	C	2020/03/11	Lithium, total	mg/L	0.0168
UA	22D	C	2020/06/03	Lithium, total	mg/L	0.0176
UA	22D	C	2020/09/02	Lithium, total	mg/L	0.0148
UA	22D	C	2020/12/09	Lithium, total	mg/L	0.0147
UA	22D	C	2021/03/19	Lithium, total	mg/L	0.0148
UA	22D	C	2021/06/23	Lithium, total	mg/L	0.0163
UA	22D	C	2021/09/08	Lithium, total	mg/L	0.0155
UA	22D	C	2021/12/08	Lithium, total	mg/L	0.0156
UA	22D	C	2022/03/22	Lithium, total	mg/L	0.0175
UA	22D	C	2022/09/13	Lithium, total	mg/L	0.0123
UA	22D	C	2023/02/28	Lithium, total	mg/L	0.0129
UA	22D	C	2023/05/31	Lithium, total	mg/L	0.0150
UA	22D	C	2023/08/22	Lithium, total	mg/L	0.0170
UA	22D	C	2023/11/15	Lithium, total	mg/L	0.0190
UA	22D	C	2019/09/17	Magnesium, total	mg/L	42.6
UA	22D	C	2020/03/11	Magnesium, total	mg/L	42.4
UA	22D	C	2020/06/03	Magnesium, total	mg/L	41.7
UA	22D	C	2021/03/19	Magnesium, total	mg/L	44.4
UA	22D	C	2021/09/08	Magnesium, total	mg/L	41.9
UA	22D	C	2022/03/22	Magnesium, total	mg/L	43.3
UA	22D	C	2022/09/13	Magnesium, total	mg/L	41.6
UA	22D	C	2023/02/28	Magnesium, total	mg/L	42.2
UA	22D	C	2023/05/31	Magnesium, total	mg/L	39.4
UA	22D	C	2023/08/22	Magnesium, total	mg/L	41.0
UA	22D	C	2023/11/15	Magnesium, total	mg/L	40.0
UA	22D	C	2023/05/31	Manganese, dissolved	mg/L	0.0648
UA	22D	C	2023/08/22	Manganese, dissolved	mg/L	0.0650
UA	22D	C	2023/05/31	Phosphate, dissolved	mg/L	0.0280
UA	22D	C	2023/08/22	Phosphate, dissolved	mg/L	<0.073
UA	22D	C	2019/09/17	Potassium, total	mg/L	3.22
UA	22D	C	2020/03/11	Potassium, total	mg/L	3.38
UA	22D	C	2020/06/03	Potassium, total	mg/L	3.25
UA	22D	C	2021/03/19	Potassium, total	mg/L	3.46
UA	22D	C	2021/09/08	Potassium, total	mg/L	3.30
UA	22D	C	2022/03/22	Potassium, total	mg/L	3.39
UA	22D	C	2022/09/13	Potassium, total	mg/L	3.16
UA	22D	C	2023/02/28	Potassium, total	mg/L	3.30
UA	22D	C	2023/05/31	Potassium, total	mg/L	3.32
UA	22D	C	2023/08/22	Potassium, total	mg/L	3.10
UA	22D	C	2023/11/15	Potassium, total	mg/L	3.20
UA	22D	C	2023/05/31	Silicon, dissolved	mg/L	7.29
UA	22D	C	2023/08/22	Silicon, dissolved	mg/L	9.00
UA	22D	C	2019/09/17	Sodium, total	mg/L	33.0
UA	22D	C	2020/03/11	Sodium, total	mg/L	37.6

UA	22D	C	2020/06/03	Sodium, total	mg/L	40.2
UA	22D	C	2021/03/19	Sodium, total	mg/L	43.3
UA	22D	C	2021/09/08	Sodium, total	mg/L	41.8
UA	22D	C	2022/03/22	Sodium, total	mg/L	45.4
UA	22D	C	2022/09/13	Sodium, total	mg/L	41.9
UA	22D	C	2023/02/28	Sodium, total	mg/L	48.9
UA	22D	C	2023/05/31	Sodium, total	mg/L	47.2
UA	22D	C	2023/08/22	Sodium, total	mg/L	44.0
UA	22D	C	2023/11/15	Sodium, total	mg/L	49.0
UA	22D	C	2019/09/17	Sulfate, total	mg/L	109
UA	22D	C	2019/12/11	Sulfate, total	mg/L	114
UA	22D	C	2020/03/11	Sulfate, total	mg/L	103
UA	22D	C	2020/06/03	Sulfate, total	mg/L	118
UA	22D	C	2020/09/02	Sulfate, total	mg/L	105
UA	22D	C	2020/12/09	Sulfate, total	mg/L	114
UA	22D	C	2021/03/19	Sulfate, total	mg/L	103
UA	22D	C	2021/06/23	Sulfate, total	mg/L	107
UA	22D	C	2021/09/08	Sulfate, total	mg/L	107
UA	22D	C	2021/12/08	Sulfate, total	mg/L	103
UA	22D	C	2022/03/22	Sulfate, total	mg/L	103
UA	22D	C	2022/09/13	Sulfate, total	mg/L	96.0
UA	22D	C	2023/02/28	Sulfate, total	mg/L	112
UA	22D	C	2023/05/31	Sulfate, total	mg/L	104
UA	22D	C	2023/08/22	Sulfate, total	mg/L	96.0
UA	22D	C	2023/11/15	Sulfate, total	mg/L	89.0
UA	22D	C	2019/09/17	Temperature (Celsius)	degrees C	14.9
UA	22D	C	2019/12/11	Temperature (Celsius)	degrees C	14.0
UA	22D	C	2020/03/11	Temperature (Celsius)	degrees C	12.5
UA	22D	C	2020/06/03	Temperature (Celsius)	degrees C	15.1
UA	22D	C	2020/06/25	Temperature (Celsius)	degrees C	15.5
UA	22D	C	2020/09/02	Temperature (Celsius)	degrees C	15.6
UA	22D	C	2020/12/09	Temperature (Celsius)	degrees C	14.5
UA	22D	C	2021/03/19	Temperature (Celsius)	degrees C	14.5
UA	22D	C	2021/06/23	Temperature (Celsius)	degrees C	15.8
UA	22D	C	2021/09/08	Temperature (Celsius)	degrees C	16.3
UA	22D	C	2021/12/08	Temperature (Celsius)	degrees C	14.6
UA	22D	C	2022/03/22	Temperature (Celsius)	degrees C	14.8
UA	22D	C	2022/06/07	Temperature (Celsius)	degrees C	15.8
UA	22D	C	2022/09/13	Temperature (Celsius)	degrees C	16.4
UA	22D	C	2022/12/27	Temperature (Celsius)	degrees C	14.7
UA	22D	C	2023/02/28	Temperature (Celsius)	degrees C	14.8
UA	22D	C	2023/05/31	Temperature (Celsius)	degrees C	15.9
UA	22D	C	2023/08/22	Temperature (Celsius)	degrees C	18.0
UA	22D	C	2023/11/15	Temperature (Celsius)	degrees C	16.2
UA	22D	C	2019/09/17	Total Dissolved Solids	mg/L	660
UA	22D	C	2019/12/11	Total Dissolved Solids	mg/L	590
UA	22D	C	2020/03/11	Total Dissolved Solids	mg/L	636
UA	22D	C	2020/06/03	Total Dissolved Solids	mg/L	616
UA	22D	C	2020/09/02	Total Dissolved Solids	mg/L	550
UA	22D	C	2020/12/09	Total Dissolved Solids	mg/L	608
UA	22D	C	2021/03/19	Total Dissolved Solids	mg/L	630
UA	22D	C	2021/06/23	Total Dissolved Solids	mg/L	640
UA	22D	C	2021/09/08	Total Dissolved Solids	mg/L	582
UA	22D	C	2021/12/08	Total Dissolved Solids	mg/L	578
UA	22D	C	2022/03/22	Total Dissolved Solids	mg/L	616
UA	22D	C	2022/09/13	Total Dissolved Solids	mg/L	686
UA	22D	C	2023/02/28	Total Dissolved Solids	mg/L	680
UA	22D	C	2023/05/31	Total Dissolved Solids	mg/L	640
UA	22D	C	2023/08/22	Total Dissolved Solids	mg/L	690
UA	22D	C	2023/11/15	Total Dissolved Solids	mg/L	640
UA	23	C	2013/03/08	pH (field)	SU	7.1
UA	23	C	2013/06/07	pH (field)	SU	7.2

UA	23	C	2013/09/03	pH (field)	SU	7.6
UA	23	C	2013/12/10	pH (field)	SU	7.5
UA	23	C	2014/03/25	pH (field)	SU	7.6
UA	23	C	2014/08/19	pH (field)	SU	7.5
UA	23	C	2014/09/30	pH (field)	SU	7.5
UA	23	C	2015/03/18	pH (field)	SU	7.5
UA	23	C	2015/09/16	pH (field)	SU	7.4
UA	23	C	2015/12/10	pH (field)	SU	7.5
UA	23	C	2016/03/09	pH (field)	SU	7.4
UA	23	C	2016/06/07	pH (field)	SU	7.5
UA	23	C	2016/09/15	pH (field)	SU	7.5
UA	23	C	2016/12/07	pH (field)	SU	7.4
UA	23	C	2017/02/21	pH (field)	SU	7.3
UA	23	C	2017/04/25	pH (field)	SU	7.3
UA	23	C	2017/06/08	pH (field)	SU	7.3
UA	23	C	2017/09/06	pH (field)	SU	7.4
UA	23	C	2017/11/15	pH (field)	SU	7.8
UA	23	C	2018/03/26	pH (field)	SU	7.6
UA	23	C	2018/06/13	pH (field)	SU	7.1
UA	23	C	2018/09/12	pH (field)	SU	7.4
UA	23	C	2018/12/12	pH (field)	SU	7.5
UA	23	C	2019/03/13	pH (field)	SU	7.6
UA	23	C	2019/06/19	pH (field)	SU	7.4
UA	23	C	2019/09/18	pH (field)	SU	7.5
UA	23	C	2019/12/11	pH (field)	SU	7.5
UA	23	C	2020/03/11	pH (field)	SU	7.3
UA	23	C	2020/06/24	pH (field)	SU	7.7
UA	23	C	2020/09/02	pH (field)	SU	7.6
UA	23	C	2020/12/10	pH (field)	SU	7.6
UA	23	C	2021/03/19	pH (field)	SU	7.5
UA	23	C	2021/06/24	pH (field)	SU	7.3
UA	23	C	2021/09/09	pH (field)	SU	7.4
UA	23	C	2021/12/08	pH (field)	SU	7.3
UA	23	C	2022/03/22	pH (field)	SU	7.4
UA	23	C	2022/06/07	pH (field)	SU	7.4
UA	23	C	2022/09/13	pH (field)	SU	7.4
UA	23	C	2022/12/27	pH (field)	SU	7.4
UA	23	C	2023/02/28	pH (field)	SU	7.4
UA	23	C	2023/05/31	pH (field)	SU	7.4
UA	23	C	2023/08/22	pH (field)	SU	7.4
UA	23	C	2023/11/15	pH (field)	SU	7.5
UA	23	C	2015/12/10	Oxidation Reduction Potential	mV	-27.0
UA	23	C	2016/03/09	Oxidation Reduction Potential	mV	-36.0
UA	23	C	2016/06/07	Oxidation Reduction Potential	mV	24.0
UA	23	C	2016/09/15	Oxidation Reduction Potential	mV	-4.00
UA	23	C	2016/12/07	Oxidation Reduction Potential	mV	105
UA	23	C	2017/02/21	Oxidation Reduction Potential	mV	117
UA	23	C	2017/04/25	Oxidation Reduction Potential	mV	33.0
UA	23	C	2017/06/08	Oxidation Reduction Potential	mV	-16.0
UA	23	C	2017/11/15	Oxidation Reduction Potential	mV	-56.0
UA	23	C	2018/06/13	Oxidation Reduction Potential	mV	21.0
UA	23	C	2018/09/12	Oxidation Reduction Potential	mV	81.0
UA	23	C	2018/12/12	Oxidation Reduction Potential	mV	101
UA	23	C	2019/03/13	Oxidation Reduction Potential	mV	-38.0
UA	23	C	2019/06/19	Oxidation Reduction Potential	mV	17.0
UA	23	C	2019/09/18	Oxidation Reduction Potential	mV	79.0
UA	23	C	2019/12/11	Oxidation Reduction Potential	mV	30.0
UA	23	C	2020/03/11	Oxidation Reduction Potential	mV	139
UA	23	C	2020/06/24	Oxidation Reduction Potential	mV	75.0
UA	23	C	2020/09/02	Oxidation Reduction Potential	mV	45.0
UA	23	C	2020/12/10	Oxidation Reduction Potential	mV	-71.0
UA	23	C	2021/03/19	Oxidation Reduction Potential	mV	-31.0

UA	23	C	2021/06/24	Oxidation Reduction Potential	mV	13.0
UA	23	C	2021/09/09	Oxidation Reduction Potential	mV	-58.0
UA	23	C	2021/12/08	Oxidation Reduction Potential	mV	5.00
UA	23	C	2022/03/22	Oxidation Reduction Potential	mV	-115
UA	23	C	2022/06/07	Oxidation Reduction Potential	mV	18.0
UA	23	C	2022/09/13	Oxidation Reduction Potential	mV	-7.00
UA	23	C	2022/12/27	Oxidation Reduction Potential	mV	-191
UA	23	C	2023/02/28	Oxidation Reduction Potential	mV	-125
UA	23	C	2023/05/31	Oxidation Reduction Potential	mV	-127
UA	23	C	2023/08/22	Oxidation Reduction Potential	mV	-124
UA	23	C	2023/11/15	Oxidation Reduction Potential	mV	-88.1
UA	23	C	2015/12/10	Eh	V	0.17
UA	23	C	2016/03/09	Eh	V	0.16
UA	23	C	2016/06/07	Eh	V	0.22
UA	23	C	2016/09/15	Eh	V	0.19
UA	23	C	2016/12/07	Eh	V	0.30
UA	23	C	2017/02/21	Eh	V	0.31
UA	23	C	2017/04/25	Eh	V	0.22
UA	23	C	2017/06/08	Eh	V	0.18
UA	23	C	2017/11/15	Eh	V	0.14
UA	23	C	2018/06/13	Eh	V	0.22
UA	23	C	2018/09/12	Eh	V	0.28
UA	23	C	2018/12/12	Eh	V	0.30
UA	23	C	2019/03/13	Eh	V	0.16
UA	23	C	2019/06/19	Eh	V	0.21
UA	23	C	2019/09/18	Eh	V	0.28
UA	23	C	2019/12/11	Eh	V	0.23
UA	23	C	2020/03/11	Eh	V	0.34
UA	23	C	2020/06/24	Eh	V	0.27
UA	23	C	2020/09/02	Eh	V	0.24
UA	23	C	2020/12/10	Eh	V	0.13
UA	23	C	2021/03/19	Eh	V	0.17
UA	23	C	2021/06/24	Eh	V	0.21
UA	23	C	2021/09/09	Eh	V	0.14
UA	23	C	2021/12/08	Eh	V	0.20
UA	23	C	2022/03/22	Eh	V	0.082
UA	23	C	2022/06/07	Eh	V	0.22
UA	23	C	2022/09/13	Eh	V	0.19
UA	23	C	2022/12/27	Eh	V	0.0064
UA	23	C	2023/02/28	Eh	V	0.072
UA	23	C	2023/05/31	Eh	V	0.070
UA	23	C	2023/08/22	Eh	V	0.071
UA	23	C	2023/11/15	Eh	V	0.11
UA	23	C	2019/09/18	Alkalinity, bicarbonate	mg/L CaCO3	159
UA	23	C	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	163
UA	23	C	2021/02/24	Alkalinity, bicarbonate	mg/L CaCO3	166
UA	23	C	2021/03/04	Alkalinity, bicarbonate	mg/L CaCO3	164
UA	23	C	2021/03/09	Alkalinity, bicarbonate	mg/L CaCO3	161
UA	23	C	2021/03/18	Alkalinity, bicarbonate	mg/L CaCO3	169
UA	23	C	2021/03/19	Alkalinity, bicarbonate	mg/L CaCO3	164
UA	23	C	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	179
UA	23	C	2021/09/09	Alkalinity, bicarbonate	mg/L CaCO3	160
UA	23	C	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	158
UA	23	C	2022/09/13	Alkalinity, bicarbonate	mg/L CaCO3	162
UA	23	C	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	171
UA	23	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	169
UA	23	C	2023/08/22	Alkalinity, bicarbonate	mg/L CaCO3	150
UA	23	C	2023/11/15	Alkalinity, bicarbonate	mg/L CaCO3	170
UA	23	C	2013/06/07	Arsenic, total	mg/L	<0.0007
UA	23	C	2013/09/03	Arsenic, total	mg/L	<0.0007
UA	23	C	2015/12/10	Arsenic, total	mg/L	<0.0002
UA	23	C	2016/03/09	Arsenic, total	mg/L	<0.0002

UA	23	C	2016/06/07	Arsenic, total	mg/L	<0.0002
UA	23	C	2016/09/15	Arsenic, total	mg/L	<0.0002
UA	23	C	2016/12/07	Arsenic, total	mg/L	<0.0002
UA	23	C	2017/02/21	Arsenic, total	mg/L	<0.0002
UA	23	C	2017/04/25	Arsenic, total	mg/L	<0.0002
UA	23	C	2017/06/08	Arsenic, total	mg/L	<0.0002
UA	23	C	2018/06/13	Arsenic, total	mg/L	<0.0004
UA	23	C	2018/09/12	Arsenic, total	mg/L	<0.0004
UA	23	C	2018/12/12	Arsenic, total	mg/L	<0.0004
UA	23	C	2019/03/13	Arsenic, total	mg/L	<0.0004
UA	23	C	2019/06/19	Arsenic, total	mg/L	<0.0004
UA	23	C	2019/09/18	Arsenic, total	mg/L	<0.0004
UA	23	C	2019/12/11	Arsenic, total	mg/L	<0.0004
UA	23	C	2020/03/11	Arsenic, total	mg/L	<0.0004
UA	23	C	2020/06/24	Arsenic, total	mg/L	<0.0004
UA	23	C	2020/09/02	Arsenic, total	mg/L	<0.0004
UA	23	C	2020/12/10	Arsenic, total	mg/L	<0.0004
UA	23	C	2021/02/24	Arsenic, total	mg/L	<0.0000004
UA	23	C	2021/03/04	Arsenic, total	mg/L	<0.0004
UA	23	C	2021/03/09	Arsenic, total	mg/L	<0.0004
UA	23	C	2021/03/18	Arsenic, total	mg/L	<0.0004
UA	23	C	2021/03/19	Arsenic, total	mg/L	<0.0004
UA	23	C	2021/03/30	Arsenic, total	mg/L	<0.0004
UA	23	C	2021/06/24	Arsenic, total	mg/L	<0.0004
UA	23	C	2021/09/09	Arsenic, total	mg/L	<0.0004
UA	23	C	2021/12/08	Arsenic, total	mg/L	<0.0004
UA	23	C	2022/03/22	Arsenic, total	mg/L	<0.0004
UA	23	C	2022/06/07	Arsenic, total	mg/L	0.000700
UA	23	C	2022/09/13	Arsenic, total	mg/L	0.000500
UA	23	C	2022/12/27	Arsenic, total	mg/L	0.00110
UA	23	C	2023/02/28	Arsenic, total	mg/L	0.00130
UA	23	C	2023/05/31	Arsenic, total	mg/L	<0.0087
UA	23	C	2023/08/22	Arsenic, total	mg/L	0.000890
UA	23	C	2023/11/15	Arsenic, total	mg/L	0.000830
UA	23	C	2013/06/07	Barium, total	mg/L	0.116
UA	23	C	2013/09/03	Barium, total	mg/L	0.0500
UA	23	C	2015/12/10	Barium, total	mg/L	0.0530
UA	23	C	2016/03/09	Barium, total	mg/L	0.0792
UA	23	C	2016/06/07	Barium, total	mg/L	0.0588
UA	23	C	2016/09/15	Barium, total	mg/L	0.0359
UA	23	C	2016/12/07	Barium, total	mg/L	0.0307
UA	23	C	2017/02/21	Barium, total	mg/L	0.0289
UA	23	C	2017/04/25	Barium, total	mg/L	0.0283
UA	23	C	2017/06/08	Barium, total	mg/L	0.0291
UA	23	C	2018/06/13	Barium, total	mg/L	0.0317
UA	23	C	2018/09/12	Barium, total	mg/L	0.0359
UA	23	C	2018/12/12	Barium, total	mg/L	0.0342
UA	23	C	2019/03/13	Barium, total	mg/L	0.0261
UA	23	C	2019/06/19	Barium, total	mg/L	0.0352
UA	23	C	2019/09/18	Barium, total	mg/L	0.0347
UA	23	C	2019/12/11	Barium, total	mg/L	0.0362
UA	23	C	2020/03/11	Barium, total	mg/L	0.0354
UA	23	C	2020/06/24	Barium, total	mg/L	0.0344
UA	23	C	2020/09/02	Barium, total	mg/L	0.0360
UA	23	C	2020/12/10	Barium, total	mg/L	0.0515
UA	23	C	2021/02/24	Barium, total	mg/L	0.0379
UA	23	C	2021/03/19	Barium, total	mg/L	0.0378
UA	23	C	2021/06/24	Barium, total	mg/L	0.0360
UA	23	C	2021/09/09	Barium, total	mg/L	0.0363
UA	23	C	2021/12/08	Barium, total	mg/L	0.0367
UA	23	C	2022/03/22	Barium, total	mg/L	0.0412
UA	23	C	2022/06/07	Barium, total	mg/L	0.0410

UA	23	C	2022/09/13	Barium, total	mg/L	0.0445
UA	23	C	2022/12/27	Barium, total	mg/L	0.0467
UA	23	C	2023/02/28	Barium, total	mg/L	0.0685
UA	23	C	2023/05/31	Barium, total	mg/L	0.0481
UA	23	C	2023/08/22	Barium, total	mg/L	0.0420
UA	23	C	2023/11/15	Barium, total	mg/L	0.0400
UA	23	C	2013/06/07	Boron, total	mg/L	2.88
UA	23	C	2013/09/03	Boron, total	mg/L	7.43
UA	23	C	2015/12/10	Boron, total	mg/L	5.63
UA	23	C	2016/03/09	Boron, total	mg/L	7.24
UA	23	C	2016/06/07	Boron, total	mg/L	8.50
UA	23	C	2016/09/15	Boron, total	mg/L	8.25
UA	23	C	2016/12/07	Boron, total	mg/L	7.99
UA	23	C	2017/02/21	Boron, total	mg/L	7.78
UA	23	C	2017/04/25	Boron, total	mg/L	7.31
UA	23	C	2017/06/08	Boron, total	mg/L	7.04
UA	23	C	2017/11/15	Boron, total	mg/L	8.09
UA	23	C	2018/06/13	Boron, total	mg/L	8.93
UA	23	C	2018/09/12	Boron, total	mg/L	7.68
UA	23	C	2018/12/12	Boron, total	mg/L	8.47
UA	23	C	2019/03/13	Boron, total	mg/L	7.49
UA	23	C	2019/06/19	Boron, total	mg/L	8.47
UA	23	C	2019/09/18	Boron, total	mg/L	9.35
UA	23	C	2019/12/11	Boron, total	mg/L	8.83
UA	23	C	2020/03/11	Boron, total	mg/L	8.26
UA	23	C	2020/06/24	Boron, total	mg/L	8.38
UA	23	C	2020/09/02	Boron, total	mg/L	8.07
UA	23	C	2020/12/10	Boron, total	mg/L	10.2
UA	23	C	2021/02/24	Boron, total	mg/L	8.52
UA	23	C	2021/03/04	Boron, total	mg/L	8.53
UA	23	C	2021/03/09	Boron, total	mg/L	7.60
UA	23	C	2021/03/18	Boron, total	mg/L	8.30
UA	23	C	2021/03/19	Boron, total	mg/L	8.09
UA	23	C	2021/03/30	Boron, total	mg/L	8.92
UA	23	C	2021/06/24	Boron, total	mg/L	8.22
UA	23	C	2021/09/09	Boron, total	mg/L	9.05
UA	23	C	2021/12/08	Boron, total	mg/L	8.05
UA	23	C	2022/03/22	Boron, total	mg/L	9.61
UA	23	C	2022/06/07	Boron, total	mg/L	9.40
UA	23	C	2022/09/13	Boron, total	mg/L	8.20
UA	23	C	2022/12/27	Boron, total	mg/L	9.90
UA	23	C	2023/02/28	Boron, total	mg/L	12.8
UA	23	C	2023/05/31	Boron, total	mg/L	8.79
UA	23	C	2023/08/22	Boron, total	mg/L	8.10
UA	23	C	2023/11/15	Boron, total	mg/L	8.70
UA	23	C	2013/06/07	Cadmium, total	mg/L	<0.0003
UA	23	C	2013/09/03	Cadmium, total	mg/L	<0.0003
UA	23	C	2015/12/10	Cadmium, total	mg/L	<0.0002
UA	23	C	2016/03/09	Cadmium, total	mg/L	<0.0002
UA	23	C	2016/06/07	Cadmium, total	mg/L	<0.0002
UA	23	C	2016/09/15	Cadmium, total	mg/L	<0.0002
UA	23	C	2016/12/07	Cadmium, total	mg/L	<0.0002
UA	23	C	2017/02/21	Cadmium, total	mg/L	<0.0002
UA	23	C	2017/04/25	Cadmium, total	mg/L	<0.0002
UA	23	C	2017/06/08	Cadmium, total	mg/L	<0.0002
UA	23	C	2018/06/13	Cadmium, total	mg/L	<0.0002
UA	23	C	2018/09/12	Cadmium, total	mg/L	<0.0002
UA	23	C	2018/12/12	Cadmium, total	mg/L	<0.0002
UA	23	C	2019/03/13	Cadmium, total	mg/L	<0.0002
UA	23	C	2019/06/19	Cadmium, total	mg/L	<0.0002
UA	23	C	2019/09/18	Cadmium, total	mg/L	<0.0002
UA	23	C	2019/12/11	Cadmium, total	mg/L	<0.0002

UA	23	C	2020/03/11	Cadmium, total	mg/L	<0.0002
UA	23	C	2020/06/24	Cadmium, total	mg/L	<0.0002
UA	23	C	2020/09/02	Cadmium, total	mg/L	<0.0002
UA	23	C	2020/12/10	Cadmium, total	mg/L	<0.0002
UA	23	C	2021/02/24	Cadmium, total	mg/L	<0.0000002
UA	23	C	2021/03/19	Cadmium, total	mg/L	<0.0002
UA	23	C	2021/06/24	Cadmium, total	mg/L	<0.0002
UA	23	C	2021/09/09	Cadmium, total	mg/L	<0.0002
UA	23	C	2021/12/08	Cadmium, total	mg/L	<0.0002
UA	23	C	2022/03/22	Cadmium, total	mg/L	<0.0002
UA	23	C	2022/06/07	Cadmium, total	mg/L	<0.0002
UA	23	C	2022/09/13	Cadmium, total	mg/L	<0.0002
UA	23	C	2022/12/27	Cadmium, total	mg/L	<0.0002
UA	23	C	2023/02/28	Cadmium, total	mg/L	<0.0002
UA	23	C	2023/05/31	Cadmium, total	mg/L	<0.0005
UA	23	C	2023/08/22	Cadmium, total	mg/L	<0.00017
UA	23	C	2023/11/15	Cadmium, total	mg/L	<0.00017
UA	23	C	2015/12/10	Calcium, total	mg/L	105
UA	23	C	2016/03/09	Calcium, total	mg/L	136
UA	23	C	2016/06/07	Calcium, total	mg/L	148
UA	23	C	2016/09/15	Calcium, total	mg/L	119
UA	23	C	2016/12/07	Calcium, total	mg/L	115
UA	23	C	2017/02/21	Calcium, total	mg/L	114
UA	23	C	2017/04/25	Calcium, total	mg/L	110
UA	23	C	2017/06/08	Calcium, total	mg/L	119
UA	23	C	2017/11/15	Calcium, total	mg/L	119
UA	23	C	2018/06/13	Calcium, total	mg/L	120
UA	23	C	2018/09/12	Calcium, total	mg/L	123
UA	23	C	2018/12/12	Calcium, total	mg/L	117
UA	23	C	2019/03/13	Calcium, total	mg/L	91.9
UA	23	C	2019/06/19	Calcium, total	mg/L	125
UA	23	C	2019/09/18	Calcium, total	mg/L	125
UA	23	C	2019/12/11	Calcium, total	mg/L	121
UA	23	C	2020/03/11	Calcium, total	mg/L	120
UA	23	C	2020/06/24	Calcium, total	mg/L	113
UA	23	C	2020/09/02	Calcium, total	mg/L	117
UA	23	C	2020/12/10	Calcium, total	mg/L	114
UA	23	C	2021/02/24	Calcium, total	mg/L	118
UA	23	C	2021/03/04	Calcium, total	mg/L	109
UA	23	C	2021/03/09	Calcium, total	mg/L	110
UA	23	C	2021/03/18	Calcium, total	mg/L	117
UA	23	C	2021/03/19	Calcium, total	mg/L	115
UA	23	C	2021/03/30	Calcium, total	mg/L	118
UA	23	C	2021/06/24	Calcium, total	mg/L	120
UA	23	C	2021/09/09	Calcium, total	mg/L	121
UA	23	C	2021/12/08	Calcium, total	mg/L	106
UA	23	C	2022/03/22	Calcium, total	mg/L	116
UA	23	C	2022/06/07	Calcium, total	mg/L	115
UA	23	C	2022/09/13	Calcium, total	mg/L	115
UA	23	C	2022/12/27	Calcium, total	mg/L	120
UA	23	C	2023/02/28	Calcium, total	mg/L	122
UA	23	C	2023/05/31	Calcium, total	mg/L	105
UA	23	C	2023/08/22	Calcium, total	mg/L	110
UA	23	C	2023/11/15	Calcium, total	mg/L	110
UA	23	C	2013/03/08	Chloride, total	mg/L	57.0
UA	23	C	2013/06/07	Chloride, total	mg/L	22.0
UA	23	C	2013/09/03	Chloride, total	mg/L	62.0
UA	23	C	2013/12/10	Chloride, total	mg/L	54.0
UA	23	C	2014/03/25	Chloride, total	mg/L	<1
UA	23	C	2014/09/30	Chloride, total	mg/L	63.0
UA	23	C	2015/03/18	Chloride, total	mg/L	62.0
UA	23	C	2015/09/16	Chloride, total	mg/L	58.0

UA	23	C	2015/12/10	Chloride, total	mg/L	44.0
UA	23	C	2016/03/09	Chloride, total	mg/L	68.0
UA	23	C	2016/06/07	Chloride, total	mg/L	70.0
UA	23	C	2016/09/15	Chloride, total	mg/L	68.0
UA	23	C	2016/12/07	Chloride, total	mg/L	64.0
UA	23	C	2017/02/21	Chloride, total	mg/L	58.0
UA	23	C	2017/04/25	Chloride, total	mg/L	62.0
UA	23	C	2017/06/08	Chloride, total	mg/L	66.0
UA	23	C	2017/09/06	Chloride, total	mg/L	63.0
UA	23	C	2017/11/15	Chloride, total	mg/L	60.0
UA	23	C	2018/03/26	Chloride, total	mg/L	60.0
UA	23	C	2018/06/13	Chloride, total	mg/L	63.0
UA	23	C	2018/09/12	Chloride, total	mg/L	61.0
UA	23	C	2018/12/12	Chloride, total	mg/L	57.0
UA	23	C	2019/03/13	Chloride, total	mg/L	58.0
UA	23	C	2019/06/19	Chloride, total	mg/L	58.0
UA	23	C	2019/09/18	Chloride, total	mg/L	56.0
UA	23	C	2019/12/11	Chloride, total	mg/L	60.0
UA	23	C	2020/03/11	Chloride, total	mg/L	59.0
UA	23	C	2020/06/24	Chloride, total	mg/L	65.0
UA	23	C	2020/09/02	Chloride, total	mg/L	61.0
UA	23	C	2020/12/10	Chloride, total	mg/L	62.0
UA	23	C	2021/02/24	Chloride, total	mg/L	64.0
UA	23	C	2021/03/04	Chloride, total	mg/L	63.0
UA	23	C	2021/03/09	Chloride, total	mg/L	61.0
UA	23	C	2021/03/18	Chloride, total	mg/L	55.0
UA	23	C	2021/03/19	Chloride, total	mg/L	60.0
UA	23	C	2021/03/30	Chloride, total	mg/L	58.0
UA	23	C	2021/06/24	Chloride, total	mg/L	58.0
UA	23	C	2021/09/09	Chloride, total	mg/L	57.0
UA	23	C	2021/12/08	Chloride, total	mg/L	58.0
UA	23	C	2022/03/22	Chloride, total	mg/L	58.0
UA	23	C	2022/06/07	Chloride, total	mg/L	53.0
UA	23	C	2022/09/13	Chloride, total	mg/L	50.0
UA	23	C	2022/12/27	Chloride, total	mg/L	64.0
UA	23	C	2023/02/28	Chloride, total	mg/L	66.0
UA	23	C	2023/05/31	Chloride, total	mg/L	55.0
UA	23	C	2023/08/22	Chloride, total	mg/L	53.0
UA	23	C	2023/11/15	Chloride, total	mg/L	56.0
UA	23	C	2013/12/10	Iron, dissolved	mg/L	<0.007
UA	23	C	2014/03/25	Iron, dissolved	mg/L	<0.007
UA	23	C	2014/08/19	Iron, dissolved	mg/L	<0.007
UA	23	C	2014/09/30	Iron, dissolved	mg/L	<0.007
UA	23	C	2015/03/18	Iron, dissolved	mg/L	<0.007
UA	23	C	2015/09/16	Iron, dissolved	mg/L	<0.007
UA	23	C	2016/03/09	Iron, dissolved	mg/L	<0.007
UA	23	C	2016/09/15	Iron, dissolved	mg/L	<0.007
UA	23	C	2017/02/21	Iron, dissolved	mg/L	<0.007
UA	23	C	2017/09/06	Iron, dissolved	mg/L	<0.007
UA	23	C	2018/03/26	Iron, dissolved	mg/L	<0.007
UA	23	C	2021/02/24	Iron, dissolved	mg/L	0.0418
UA	23	C	2021/03/04	Iron, dissolved	mg/L	0.0786
UA	23	C	2021/03/09	Iron, dissolved	mg/L	0.0550
UA	23	C	2021/03/18	Iron, dissolved	mg/L	0.0278
UA	23	C	2021/03/30	Iron, dissolved	mg/L	<0.0115
UA	23	C	2023/05/31	Iron, dissolved	mg/L	0.148
UA	23	C	2023/08/22	Iron, dissolved	mg/L	0.140
UA	23	C	2015/12/10	Lithium, total	mg/L	0.00360
UA	23	C	2016/03/09	Lithium, total	mg/L	0.00390
UA	23	C	2016/06/07	Lithium, total	mg/L	0.00520
UA	23	C	2016/09/15	Lithium, total	mg/L	0.00520
UA	23	C	2016/12/07	Lithium, total	mg/L	0.00550

UA	23	C	2017/02/21	Lithium, total	mg/L	0.00490
UA	23	C	2017/04/25	Lithium, total	mg/L	0.00570
UA	23	C	2017/06/08	Lithium, total	mg/L	0.00480
UA	23	C	2018/06/13	Lithium, total	mg/L	0.00530
UA	23	C	2018/09/12	Lithium, total	mg/L	0.00670
UA	23	C	2018/12/12	Lithium, total	mg/L	0.00570
UA	23	C	2019/03/13	Lithium, total	mg/L	0.00480
UA	23	C	2019/06/19	Lithium, total	mg/L	0.00560
UA	23	C	2019/09/18	Lithium, total	mg/L	0.00600
UA	23	C	2019/12/11	Lithium, total	mg/L	0.00560
UA	23	C	2020/03/11	Lithium, total	mg/L	0.00520
UA	23	C	2020/06/24	Lithium, total	mg/L	0.00540
UA	23	C	2020/09/02	Lithium, total	mg/L	0.00460
UA	23	C	2020/12/10	Lithium, total	mg/L	0.00500
UA	23	C	2021/02/24	Lithium, total	mg/L	<0.005
UA	23	C	2021/03/04	Lithium, total	mg/L	0.00510
UA	23	C	2021/03/09	Lithium, total	mg/L	0.00450
UA	23	C	2021/03/18	Lithium, total	mg/L	0.00500
UA	23	C	2021/03/19	Lithium, total	mg/L	0.00490
UA	23	C	2021/03/30	Lithium, total	mg/L	0.00560
UA	23	C	2021/06/24	Lithium, total	mg/L	0.00490
UA	23	C	2021/09/09	Lithium, total	mg/L	0.00500
UA	23	C	2021/12/08	Lithium, total	mg/L	0.00470
UA	23	C	2022/03/22	Lithium, total	mg/L	0.00560
UA	23	C	2022/06/07	Lithium, total	mg/L	0.00460
UA	23	C	2022/09/13	Lithium, total	mg/L	0.00390
UA	23	C	2022/12/27	Lithium, total	mg/L	0.00520
UA	23	C	2023/02/28	Lithium, total	mg/L	0.00420
UA	23	C	2023/05/31	Lithium, total	mg/L	<0.0019
UA	23	C	2023/08/22	Lithium, total	mg/L	0.00630
UA	23	C	2023/11/15	Lithium, total	mg/L	0.00660
UA	23	C	2019/09/18	Magnesium, total	mg/L	83.4
UA	23	C	2020/03/11	Magnesium, total	mg/L	84.1
UA	23	C	2020/06/24	Magnesium, total	mg/L	84.0
UA	23	C	2021/02/24	Magnesium, total	mg/L	85.5
UA	23	C	2021/03/04	Magnesium, total	mg/L	76.3
UA	23	C	2021/03/09	Magnesium, total	mg/L	79.0
UA	23	C	2021/03/18	Magnesium, total	mg/L	83.7
UA	23	C	2021/03/19	Magnesium, total	mg/L	81.0
UA	23	C	2021/03/30	Magnesium, total	mg/L	85.6
UA	23	C	2021/09/09	Magnesium, total	mg/L	86.5
UA	23	C	2022/03/22	Magnesium, total	mg/L	79.0
UA	23	C	2022/09/13	Magnesium, total	mg/L	78.9
UA	23	C	2023/02/28	Magnesium, total	mg/L	80.5
UA	23	C	2023/05/31	Magnesium, total	mg/L	77.5
UA	23	C	2023/08/22	Magnesium, total	mg/L	78.0
UA	23	C	2023/11/15	Magnesium, total	mg/L	75.0
UA	23	C	2013/03/08	Manganese, dissolved	mg/L	0.600
UA	23	C	2013/12/10	Manganese, dissolved	mg/L	0.148
UA	23	C	2014/03/25	Manganese, dissolved	mg/L	0.0123
UA	23	C	2014/08/19	Manganese, dissolved	mg/L	0.0231
UA	23	C	2014/09/30	Manganese, dissolved	mg/L	0.0681
UA	23	C	2015/03/18	Manganese, dissolved	mg/L	0.147
UA	23	C	2015/09/16	Manganese, dissolved	mg/L	0.0510
UA	23	C	2016/03/09	Manganese, dissolved	mg/L	0.0266
UA	23	C	2016/09/15	Manganese, dissolved	mg/L	0.274
UA	23	C	2017/02/21	Manganese, dissolved	mg/L	0.542
UA	23	C	2017/09/06	Manganese, dissolved	mg/L	0.680
UA	23	C	2018/03/26	Manganese, dissolved	mg/L	0.725
UA	23	C	2021/02/24	Manganese, dissolved	mg/L	1.04
UA	23	C	2021/03/04	Manganese, dissolved	mg/L	1.21
UA	23	C	2021/03/09	Manganese, dissolved	mg/L	0.970

UA	23	C	2021/03/18	Manganese, dissolved	mg/L	0.955
UA	23	C	2021/03/30	Manganese, dissolved	mg/L	1.01
UA	23	C	2023/05/31	Manganese, dissolved	mg/L	1.16
UA	23	C	2023/08/22	Manganese, dissolved	mg/L	1.10
UA	23	C	2023/05/31	Phosphate, dissolved	mg/L	0.0310
UA	23	C	2023/08/22	Phosphate, dissolved	mg/L	<0.073
UA	23	C	2019/09/18	Potassium, total	mg/L	3.08
UA	23	C	2020/03/11	Potassium, total	mg/L	3.23
UA	23	C	2020/06/24	Potassium, total	mg/L	3.02
UA	23	C	2021/02/24	Potassium, total	mg/L	2.80
UA	23	C	2021/03/04	Potassium, total	mg/L	2.92
UA	23	C	2021/03/09	Potassium, total	mg/L	2.60
UA	23	C	2021/03/18	Potassium, total	mg/L	3.25
UA	23	C	2021/03/19	Potassium, total	mg/L	3.18
UA	23	C	2021/03/30	Potassium, total	mg/L	3.07
UA	23	C	2021/09/09	Potassium, total	mg/L	3.35
UA	23	C	2022/03/22	Potassium, total	mg/L	3.08
UA	23	C	2022/09/13	Potassium, total	mg/L	3.08
UA	23	C	2023/02/28	Potassium, total	mg/L	2.99
UA	23	C	2023/05/31	Potassium, total	mg/L	3.16
UA	23	C	2023/08/22	Potassium, total	mg/L	2.90
UA	23	C	2023/11/15	Potassium, total	mg/L	3.00
UA	23	C	2023/05/31	Silicon, dissolved	mg/L	5.38
UA	23	C	2023/08/22	Silicon, dissolved	mg/L	6.60
UA	23	C	2019/09/18	Sodium, total	mg/L	42.6
UA	23	C	2020/03/11	Sodium, total	mg/L	42.1
UA	23	C	2020/06/24	Sodium, total	mg/L	45.3
UA	23	C	2021/02/24	Sodium, total	mg/L	47.9
UA	23	C	2021/03/04	Sodium, total	mg/L	46.2
UA	23	C	2021/03/09	Sodium, total	mg/L	43.0
UA	23	C	2021/03/18	Sodium, total	mg/L	46.6
UA	23	C	2021/03/19	Sodium, total	mg/L	45.2
UA	23	C	2021/03/30	Sodium, total	mg/L	47.3
UA	23	C	2021/09/09	Sodium, total	mg/L	40.5
UA	23	C	2022/03/22	Sodium, total	mg/L	45.0
UA	23	C	2022/09/13	Sodium, total	mg/L	43.4
UA	23	C	2023/02/28	Sodium, total	mg/L	46.3
UA	23	C	2023/05/31	Sodium, total	mg/L	46.0
UA	23	C	2023/08/22	Sodium, total	mg/L	44.0
UA	23	C	2023/11/15	Sodium, total	mg/L	44.0
UA	23	C	2013/03/08	Sulfate, total	mg/L	478
UA	23	C	2013/06/07	Sulfate, total	mg/L	152
UA	23	C	2013/09/03	Sulfate, total	mg/L	456
UA	23	C	2013/12/10	Sulfate, total	mg/L	357
UA	23	C	2014/03/25	Sulfate, total	mg/L	17.0
UA	23	C	2014/09/30	Sulfate, total	mg/L	472
UA	23	C	2015/03/18	Sulfate, total	mg/L	421
UA	23	C	2015/09/16	Sulfate, total	mg/L	458
UA	23	C	2015/12/10	Sulfate, total	mg/L	323
UA	23	C	2016/03/09	Sulfate, total	mg/L	477
UA	23	C	2016/06/07	Sulfate, total	mg/L	483
UA	23	C	2016/09/15	Sulfate, total	mg/L	470
UA	23	C	2016/12/07	Sulfate, total	mg/L	408
UA	23	C	2017/02/21	Sulfate, total	mg/L	390
UA	23	C	2017/04/25	Sulfate, total	mg/L	439
UA	23	C	2017/06/08	Sulfate, total	mg/L	485
UA	23	C	2017/09/06	Sulfate, total	mg/L	456
UA	23	C	2017/11/15	Sulfate, total	mg/L	420
UA	23	C	2018/03/26	Sulfate, total	mg/L	402
UA	23	C	2018/06/13	Sulfate, total	mg/L	489
UA	23	C	2018/09/12	Sulfate, total	mg/L	462
UA	23	C	2018/12/12	Sulfate, total	mg/L	420

UA	23	C	2019/03/13	Sulfate, total	mg/L	382
UA	23	C	2019/06/19	Sulfate, total	mg/L	424
UA	23	C	2019/09/18	Sulfate, total	mg/L	475
UA	23	C	2019/12/11	Sulfate, total	mg/L	433
UA	23	C	2020/03/11	Sulfate, total	mg/L	440
UA	23	C	2020/06/24	Sulfate, total	mg/L	473
UA	23	C	2020/09/02	Sulfate, total	mg/L	451
UA	23	C	2020/12/10	Sulfate, total	mg/L	554
UA	23	C	2021/02/24	Sulfate, total	mg/L	407
UA	23	C	2021/03/04	Sulfate, total	mg/L	404
UA	23	C	2021/03/09	Sulfate, total	mg/L	431
UA	23	C	2021/03/18	Sulfate, total	mg/L	423
UA	23	C	2021/03/19	Sulfate, total	mg/L	397
UA	23	C	2021/03/30	Sulfate, total	mg/L	426
UA	23	C	2021/06/24	Sulfate, total	mg/L	429
UA	23	C	2021/09/09	Sulfate, total	mg/L	455
UA	23	C	2021/12/08	Sulfate, total	mg/L	413
UA	23	C	2022/03/22	Sulfate, total	mg/L	421
UA	23	C	2022/06/07	Sulfate, total	mg/L	442
UA	23	C	2022/09/13	Sulfate, total	mg/L	471
UA	23	C	2022/12/27	Sulfate, total	mg/L	441
UA	23	C	2023/02/28	Sulfate, total	mg/L	433
UA	23	C	2023/05/31	Sulfate, total	mg/L	450
UA	23	C	2023/08/22	Sulfate, total	mg/L	460
UA	23	C	2023/11/15	Sulfate, total	mg/L	430
UA	23	C	2013/03/08	Temperature (Celsius)	degrees C	11.2
UA	23	C	2013/06/07	Temperature (Celsius)	degrees C	12.7
UA	23	C	2013/09/03	Temperature (Celsius)	degrees C	14.3
UA	23	C	2013/12/10	Temperature (Celsius)	degrees C	9.90
UA	23	C	2014/03/25	Temperature (Celsius)	degrees C	10.4
UA	23	C	2014/08/19	Temperature (Celsius)	degrees C	13.3
UA	23	C	2014/09/30	Temperature (Celsius)	degrees C	12.0
UA	23	C	2015/03/18	Temperature (Celsius)	degrees C	12.2
UA	23	C	2015/09/16	Temperature (Celsius)	degrees C	12.6
UA	23	C	2015/12/10	Temperature (Celsius)	degrees C	12.6
UA	23	C	2016/03/09	Temperature (Celsius)	degrees C	11.3
UA	23	C	2016/06/07	Temperature (Celsius)	degrees C	11.5
UA	23	C	2016/09/15	Temperature (Celsius)	degrees C	13.4
UA	23	C	2016/12/07	Temperature (Celsius)	degrees C	10.1
UA	23	C	2017/02/21	Temperature (Celsius)	degrees C	12.9
UA	23	C	2017/04/25	Temperature (Celsius)	degrees C	20.2
UA	23	C	2017/06/08	Temperature (Celsius)	degrees C	20.8
UA	23	C	2017/09/06	Temperature (Celsius)	degrees C	11.9
UA	23	C	2017/11/15	Temperature (Celsius)	degrees C	11.9
UA	23	C	2018/03/26	Temperature (Celsius)	degrees C	12.8
UA	23	C	2018/06/13	Temperature (Celsius)	degrees C	13.3
UA	23	C	2018/09/12	Temperature (Celsius)	degrees C	12.5
UA	23	C	2018/12/12	Temperature (Celsius)	degrees C	11.5
UA	23	C	2019/03/13	Temperature (Celsius)	degrees C	12.4
UA	23	C	2019/06/19	Temperature (Celsius)	degrees C	12.0
UA	23	C	2019/09/18	Temperature (Celsius)	degrees C	12.4
UA	23	C	2019/12/11	Temperature (Celsius)	degrees C	11.7
UA	23	C	2020/03/11	Temperature (Celsius)	degrees C	11.3
UA	23	C	2020/06/24	Temperature (Celsius)	degrees C	12.6
UA	23	C	2020/09/02	Temperature (Celsius)	degrees C	12.4
UA	23	C	2020/12/10	Temperature (Celsius)	degrees C	11.8
UA	23	C	2021/03/19	Temperature (Celsius)	degrees C	11.9
UA	23	C	2021/06/24	Temperature (Celsius)	degrees C	12.4
UA	23	C	2021/09/09	Temperature (Celsius)	degrees C	12.7
UA	23	C	2021/12/08	Temperature (Celsius)	degrees C	12.5
UA	23	C	2022/03/22	Temperature (Celsius)	degrees C	12.5
UA	23	C	2022/06/07	Temperature (Celsius)	degrees C	12.8

UA	23	C	2022/09/13	Temperature (Celsius)	degrees C	12.9
UA	23	C	2022/12/27	Temperature (Celsius)	degrees C	12.3
UA	23	C	2023/02/28	Temperature (Celsius)	degrees C	12.5
UA	23	C	2023/05/31	Temperature (Celsius)	degrees C	13.0
UA	23	C	2023/08/22	Temperature (Celsius)	degrees C	15.0
UA	23	C	2023/11/15	Temperature (Celsius)	degrees C	13.6
UA	23	C	2013/03/08	Total Dissolved Solids	mg/L	840
UA	23	C	2013/06/07	Total Dissolved Solids	mg/L	574
UA	23	C	2013/09/03	Total Dissolved Solids	mg/L	1,030
UA	23	C	2013/12/10	Total Dissolved Solids	mg/L	852
UA	23	C	2014/03/25	Total Dissolved Solids	mg/L	166
UA	23	C	2014/08/19	Total Dissolved Solids	mg/L	952
UA	23	C	2014/09/30	Total Dissolved Solids	mg/L	1,010
UA	23	C	2015/03/18	Total Dissolved Solids	mg/L	894
UA	23	C	2015/09/16	Total Dissolved Solids	mg/L	964
UA	23	C	2015/12/10	Total Dissolved Solids	mg/L	858
UA	23	C	2016/03/09	Total Dissolved Solids	mg/L	908
UA	23	C	2016/06/07	Total Dissolved Solids	mg/L	1,000
UA	23	C	2016/09/15	Total Dissolved Solids	mg/L	992
UA	23	C	2016/12/07	Total Dissolved Solids	mg/L	820
UA	23	C	2017/02/21	Total Dissolved Solids	mg/L	848
UA	23	C	2017/04/25	Total Dissolved Solids	mg/L	908
UA	23	C	2017/06/08	Total Dissolved Solids	mg/L	990
UA	23	C	2017/09/06	Total Dissolved Solids	mg/L	926
UA	23	C	2017/11/15	Total Dissolved Solids	mg/L	944
UA	23	C	2018/03/26	Total Dissolved Solids	mg/L	864
UA	23	C	2018/06/13	Total Dissolved Solids	mg/L	956
UA	23	C	2018/09/12	Total Dissolved Solids	mg/L	996
UA	23	C	2018/12/12	Total Dissolved Solids	mg/L	880
UA	23	C	2019/03/13	Total Dissolved Solids	mg/L	862
UA	23	C	2019/06/19	Total Dissolved Solids	mg/L	884
UA	23	C	2019/09/18	Total Dissolved Solids	mg/L	980
UA	23	C	2019/12/11	Total Dissolved Solids	mg/L	916
UA	23	C	2020/03/11	Total Dissolved Solids	mg/L	930
UA	23	C	2020/06/24	Total Dissolved Solids	mg/L	978
UA	23	C	2020/09/02	Total Dissolved Solids	mg/L	908
UA	23	C	2020/12/10	Total Dissolved Solids	mg/L	892
UA	23	C	2021/02/24	Total Dissolved Solids	mg/L	884
UA	23	C	2021/03/04	Total Dissolved Solids	mg/L	880
UA	23	C	2021/03/09	Total Dissolved Solids	mg/L	874
UA	23	C	2021/03/18	Total Dissolved Solids	mg/L	912
UA	23	C	2021/03/19	Total Dissolved Solids	mg/L	870
UA	23	C	2021/03/30	Total Dissolved Solids	mg/L	860
UA	23	C	2021/06/24	Total Dissolved Solids	mg/L	840
UA	23	C	2021/09/09	Total Dissolved Solids	mg/L	868
UA	23	C	2021/12/08	Total Dissolved Solids	mg/L	828
UA	23	C	2022/03/22	Total Dissolved Solids	mg/L	826
UA	23	C	2022/06/07	Total Dissolved Solids	mg/L	984
UA	23	C	2022/09/13	Total Dissolved Solids	mg/L	1,020
UA	23	C	2022/12/27	Total Dissolved Solids	mg/L	880
UA	23	C	2023/02/28	Total Dissolved Solids	mg/L	856
UA	23	C	2023/05/31	Total Dissolved Solids	mg/L	876
UA	23	C	2023/08/22	Total Dissolved Solids	mg/L	950
UA	23	C	2023/11/15	Total Dissolved Solids	mg/L	890
UA	27	C	2013/03/08	pH (field)	SU	7.2
UA	27	C	2013/06/26	pH (field)	SU	7.3
UA	27	C	2013/09/03	pH (field)	SU	8.0
UA	27	C	2013/12/10	pH (field)	SU	7.8
UA	27	C	2014/03/25	pH (field)	SU	7.2
UA	27	C	2014/08/19	pH (field)	SU	7.4
UA	27	C	2014/09/30	pH (field)	SU	7.4
UA	27	C	2015/03/18	pH (field)	SU	7.4

UA	27	C	2015/09/16	pH (field)	SU	7.4
UA	27	C	2016/03/08	pH (field)	SU	7.2
UA	27	C	2016/09/15	pH (field)	SU	7.4
UA	27	C	2017/02/21	pH (field)	SU	7.3
UA	27	C	2017/09/06	pH (field)	SU	7.1
UA	27	C	2018/03/26	pH (field)	SU	7.3
UA	27	C	2018/09/12	pH (field)	SU	7.1
UA	27	C	2018/12/12	pH (field)	SU	7.2
UA	27	C	2019/03/13	pH (field)	SU	7.2
UA	27	C	2019/12/11	pH (field)	SU	7.2
UA	27	C	2020/03/11	pH (field)	SU	7.2
UA	27	C	2020/09/02	pH (field)	SU	7.3
UA	27	C	2020/12/09	pH (field)	SU	7.2
UA	27	C	2021/03/17	pH (field)	SU	7.1
UA	27	C	2021/06/24	pH (field)	SU	7.0
UA	27	C	2021/09/09	pH (field)	SU	7.0
UA	27	C	2021/12/08	pH (field)	SU	7.1
UA	27	C	2022/03/22	pH (field)	SU	7.1
UA	27	C	2022/06/07	pH (field)	SU	7.1
UA	27	C	2022/09/13	pH (field)	SU	7.1
UA	27	C	2022/12/27	pH (field)	SU	7.2
UA	27	C	2023/02/28	pH (field)	SU	7.0
UA	27	C	2023/05/31	pH (field)	SU	7.0
UA	27	C	2023/08/24	pH (field)	SU	7.3
UA	27	C	2023/11/14	pH (field)	SU	7.3
UA	27	C	2018/09/12	Oxidation Reduction Potential	mV	-41.0
UA	27	C	2018/12/12	Oxidation Reduction Potential	mV	-29.0
UA	27	C	2019/03/13	Oxidation Reduction Potential	mV	-38.0
UA	27	C	2019/12/11	Oxidation Reduction Potential	mV	-30.0
UA	27	C	2020/03/11	Oxidation Reduction Potential	mV	9.00
UA	27	C	2020/09/02	Oxidation Reduction Potential	mV	-11.0
UA	27	C	2020/12/09	Oxidation Reduction Potential	mV	-7.00
UA	27	C	2021/03/17	Oxidation Reduction Potential	mV	-51.0
UA	27	C	2021/06/24	Oxidation Reduction Potential	mV	-63.0
UA	27	C	2021/09/09	Oxidation Reduction Potential	mV	-14.0
UA	27	C	2021/12/08	Oxidation Reduction Potential	mV	-21.0
UA	27	C	2022/03/22	Oxidation Reduction Potential	mV	-60.0
UA	27	C	2022/06/07	Oxidation Reduction Potential	mV	63.0
UA	27	C	2022/09/13	Oxidation Reduction Potential	mV	104
UA	27	C	2022/12/27	Oxidation Reduction Potential	mV	-80.0
UA	27	C	2023/02/28	Oxidation Reduction Potential	mV	-49.1
UA	27	C	2023/05/31	Oxidation Reduction Potential	mV	-16.0
UA	27	C	2023/08/24	Oxidation Reduction Potential	mV	-33.7
UA	27	C	2023/11/14	Oxidation Reduction Potential	mV	-50.4
UA	27	C	2018/09/12	Eh	V	0.15
UA	27	C	2018/12/12	Eh	V	0.17
UA	27	C	2019/03/13	Eh	V	0.16
UA	27	C	2019/12/11	Eh	V	0.17
UA	27	C	2020/03/11	Eh	V	0.21
UA	27	C	2020/09/02	Eh	V	0.19
UA	27	C	2020/12/09	Eh	V	0.19
UA	27	C	2021/03/17	Eh	V	0.15
UA	27	C	2021/06/24	Eh	V	0.13
UA	27	C	2021/09/09	Eh	V	0.18
UA	27	C	2021/12/08	Eh	V	0.18
UA	27	C	2022/03/22	Eh	V	0.14
UA	27	C	2022/06/07	Eh	V	0.26
UA	27	C	2022/09/13	Eh	V	0.30
UA	27	C	2022/12/27	Eh	V	0.12
UA	27	C	2023/02/28	Eh	V	0.15
UA	27	C	2023/05/31	Eh	V	0.18
UA	27	C	2023/08/24	Eh	V	0.16

UA	27	C	2023/11/14	Eh	V	0.15
UA	27	C	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	352
UA	27	C	2021/03/17	Alkalinity, bicarbonate	mg/L CaCO3	326
UA	27	C	2021/09/09	Alkalinity, bicarbonate	mg/L CaCO3	342
UA	27	C	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	333
UA	27	C	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	323
UA	27	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	334
UA	27	C	2023/08/24	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	27	C	2023/11/14	Alkalinity, bicarbonate	mg/L CaCO3	350
UA	27	C	2013/06/26	Arsenic, total	mg/L	<0.0007
UA	27	C	2013/09/03	Arsenic, total	mg/L	<0.0007
UA	27	C	2018/09/12	Arsenic, total	mg/L	<0.0004
UA	27	C	2018/12/12	Arsenic, total	mg/L	0.00110
UA	27	C	2019/03/13	Arsenic, total	mg/L	0.00150
UA	27	C	2019/12/11	Arsenic, total	mg/L	0.00120
UA	27	C	2020/03/11	Arsenic, total	mg/L	<0.0004
UA	27	C	2020/09/02	Arsenic, total	mg/L	<0.0004
UA	27	C	2020/12/09	Arsenic, total	mg/L	<0.0004
UA	27	C	2021/03/17	Arsenic, total	mg/L	0.00110
UA	27	C	2021/06/24	Arsenic, total	mg/L	<0.0004
UA	27	C	2021/09/09	Arsenic, total	mg/L	<0.0004
UA	27	C	2021/12/08	Arsenic, total	mg/L	<0.0004
UA	27	C	2022/03/22	Arsenic, total	mg/L	<0.0004
UA	27	C	2022/06/07	Arsenic, total	mg/L	0.000500
UA	27	C	2022/09/13	Arsenic, total	mg/L	0.000700
UA	27	C	2022/12/27	Arsenic, total	mg/L	0.00110
UA	27	C	2023/02/28	Arsenic, total	mg/L	0.00130
UA	27	C	2023/05/31	Arsenic, total	mg/L	<0.0087
UA	27	C	2023/08/24	Arsenic, total	mg/L	0.00100
UA	27	C	2023/11/14	Arsenic, total	mg/L	0.00120
UA	27	C	2013/06/26	Barium, total	mg/L	0.130
UA	27	C	2013/09/03	Barium, total	mg/L	0.0905
UA	27	C	2018/09/12	Barium, total	mg/L	0.111
UA	27	C	2018/12/12	Barium, total	mg/L	0.0892
UA	27	C	2019/03/13	Barium, total	mg/L	0.0895
UA	27	C	2019/12/11	Barium, total	mg/L	0.0919
UA	27	C	2020/03/11	Barium, total	mg/L	0.0818
UA	27	C	2020/09/02	Barium, total	mg/L	0.0918
UA	27	C	2020/12/09	Barium, total	mg/L	0.122
UA	27	C	2021/03/17	Barium, total	mg/L	0.0923
UA	27	C	2021/06/24	Barium, total	mg/L	0.0874
UA	27	C	2021/09/09	Barium, total	mg/L	0.0913
UA	27	C	2021/12/08	Barium, total	mg/L	0.0885
UA	27	C	2022/03/22	Barium, total	mg/L	0.0863
UA	27	C	2022/06/07	Barium, total	mg/L	0.0838
UA	27	C	2022/09/13	Barium, total	mg/L	0.0806
UA	27	C	2022/12/27	Barium, total	mg/L	0.0731
UA	27	C	2023/02/28	Barium, total	mg/L	0.0971
UA	27	C	2023/05/31	Barium, total	mg/L	0.0837
UA	27	C	2023/08/24	Barium, total	mg/L	0.0840
UA	27	C	2023/11/14	Barium, total	mg/L	0.0840
UA	27	C	2013/06/26	Boron, total	mg/L	3.98
UA	27	C	2013/09/03	Boron, total	mg/L	4.68
UA	27	C	2018/09/12	Boron, total	mg/L	3.94
UA	27	C	2018/12/12	Boron, total	mg/L	4.02
UA	27	C	2019/03/13	Boron, total	mg/L	4.31
UA	27	C	2019/12/11	Boron, total	mg/L	3.21
UA	27	C	2020/03/11	Boron, total	mg/L	2.82
UA	27	C	2020/09/02	Boron, total	mg/L	2.29
UA	27	C	2020/12/09	Boron, total	mg/L	2.12
UA	27	C	2021/03/17	Boron, total	mg/L	2.73
UA	27	C	2021/06/24	Boron, total	mg/L	2.37

UA	27	C	2021/09/09	Boron, total	mg/L	2.57
UA	27	C	2021/12/08	Boron, total	mg/L	2.22
UA	27	C	2022/03/22	Boron, total	mg/L	2.41
UA	27	C	2022/06/07	Boron, total	mg/L	2.22
UA	27	C	2022/09/13	Boron, total	mg/L	2.07
UA	27	C	2022/12/27	Boron, total	mg/L	2.34
UA	27	C	2023/02/28	Boron, total	mg/L	2.73
UA	27	C	2023/05/31	Boron, total	mg/L	2.27
UA	27	C	2023/08/24	Boron, total	mg/L	2.00
UA	27	C	2023/11/14	Boron, total	mg/L	2.40
UA	27	C	2013/06/26	Cadmium, total	mg/L	<0.0003
UA	27	C	2013/09/03	Cadmium, total	mg/L	<0.0003
UA	27	C	2018/09/12	Cadmium, total	mg/L	<0.0002
UA	27	C	2018/12/12	Cadmium, total	mg/L	<0.0002
UA	27	C	2019/03/13	Cadmium, total	mg/L	<0.0002
UA	27	C	2019/12/11	Cadmium, total	mg/L	<0.0002
UA	27	C	2020/03/11	Cadmium, total	mg/L	<0.0002
UA	27	C	2020/09/02	Cadmium, total	mg/L	<0.0002
UA	27	C	2020/12/09	Cadmium, total	mg/L	<0.0002
UA	27	C	2021/03/17	Cadmium, total	mg/L	<0.0002
UA	27	C	2021/06/24	Cadmium, total	mg/L	<0.0002
UA	27	C	2021/09/09	Cadmium, total	mg/L	<0.0002
UA	27	C	2021/12/08	Cadmium, total	mg/L	<0.0002
UA	27	C	2022/03/22	Cadmium, total	mg/L	<0.0002
UA	27	C	2022/06/07	Cadmium, total	mg/L	0.000500
UA	27	C	2022/09/13	Cadmium, total	mg/L	<0.0002
UA	27	C	2022/12/27	Cadmium, total	mg/L	0.000800
UA	27	C	2023/02/28	Cadmium, total	mg/L	0.000300
UA	27	C	2023/05/31	Cadmium, total	mg/L	<0.0005
UA	27	C	2023/08/24	Cadmium, total	mg/L	0.000250
UA	27	C	2023/11/14	Cadmium, total	mg/L	<0.00017
UA	27	C	2018/09/12	Calcium, total	mg/L	169
UA	27	C	2018/12/12	Calcium, total	mg/L	133
UA	27	C	2019/03/13	Calcium, total	mg/L	141
UA	27	C	2019/12/11	Calcium, total	mg/L	139
UA	27	C	2020/03/11	Calcium, total	mg/L	139
UA	27	C	2020/09/02	Calcium, total	mg/L	132
UA	27	C	2020/12/09	Calcium, total	mg/L	197
UA	27	C	2021/03/17	Calcium, total	mg/L	138
UA	27	C	2021/06/24	Calcium, total	mg/L	138
UA	27	C	2021/09/09	Calcium, total	mg/L	141
UA	27	C	2021/12/08	Calcium, total	mg/L	129
UA	27	C	2022/03/22	Calcium, total	mg/L	140
UA	27	C	2022/06/07	Calcium, total	mg/L	132
UA	27	C	2022/09/13	Calcium, total	mg/L	132
UA	27	C	2022/12/27	Calcium, total	mg/L	136
UA	27	C	2023/02/28	Calcium, total	mg/L	141
UA	27	C	2023/05/31	Calcium, total	mg/L	117
UA	27	C	2023/08/24	Calcium, total	mg/L	120
UA	27	C	2023/11/14	Calcium, total	mg/L	120
UA	27	C	2013/03/08	Chloride, total	mg/L	49.0
UA	27	C	2013/06/26	Chloride, total	mg/L	46.0
UA	27	C	2013/09/03	Chloride, total	mg/L	38.0
UA	27	C	2013/12/10	Chloride, total	mg/L	44.0
UA	27	C	2014/03/25	Chloride, total	mg/L	66.0
UA	27	C	2014/09/30	Chloride, total	mg/L	42.0
UA	27	C	2015/03/18	Chloride, total	mg/L	41.0
UA	27	C	2015/09/16	Chloride, total	mg/L	35.0
UA	27	C	2016/03/08	Chloride, total	mg/L	43.0
UA	27	C	2016/09/15	Chloride, total	mg/L	53.0
UA	27	C	2017/02/21	Chloride, total	mg/L	55.0
UA	27	C	2017/09/06	Chloride, total	mg/L	73.0

UA	27	C	2018/03/26	Chloride, total	mg/L	86.0
UA	27	C	2018/09/12	Chloride, total	mg/L	90.0
UA	27	C	2018/12/12	Chloride, total	mg/L	86.0
UA	27	C	2019/03/13	Chloride, total	mg/L	89.0
UA	27	C	2019/12/11	Chloride, total	mg/L	98.0
UA	27	C	2020/03/11	Chloride, total	mg/L	98.0
UA	27	C	2020/09/02	Chloride, total	mg/L	103
UA	27	C	2020/12/09	Chloride, total	mg/L	108
UA	27	C	2021/03/17	Chloride, total	mg/L	98.0
UA	27	C	2021/06/24	Chloride, total	mg/L	103
UA	27	C	2021/09/09	Chloride, total	mg/L	107
UA	27	C	2021/12/08	Chloride, total	mg/L	109
UA	27	C	2022/03/22	Chloride, total	mg/L	101
UA	27	C	2022/06/07	Chloride, total	mg/L	96.0
UA	27	C	2022/09/13	Chloride, total	mg/L	104
UA	27	C	2022/12/27	Chloride, total	mg/L	107
UA	27	C	2023/02/28	Chloride, total	mg/L	99.0
UA	27	C	2023/05/31	Chloride, total	mg/L	107
UA	27	C	2023/08/24	Chloride, total	mg/L	91.0
UA	27	C	2023/11/14	Chloride, total	mg/L	88.0
UA	27	C	2013/03/08	Iron, dissolved	mg/L	1.13
UA	27	C	2013/12/10	Iron, dissolved	mg/L	0.242
UA	27	C	2014/03/25	Iron, dissolved	mg/L	0.0499
UA	27	C	2014/08/19	Iron, dissolved	mg/L	<0.007
UA	27	C	2014/09/30	Iron, dissolved	mg/L	0.0943
UA	27	C	2015/03/18	Iron, dissolved	mg/L	0.274
UA	27	C	2015/09/16	Iron, dissolved	mg/L	0.0817
UA	27	C	2016/03/08	Iron, dissolved	mg/L	0.161
UA	27	C	2016/09/15	Iron, dissolved	mg/L	0.132
UA	27	C	2017/02/21	Iron, dissolved	mg/L	0.219
UA	27	C	2017/09/06	Iron, dissolved	mg/L	0.230
UA	27	C	2018/03/26	Iron, dissolved	mg/L	0.207
UA	27	C	2023/05/31	Iron, dissolved	mg/L	0.257
UA	27	C	2023/08/24	Iron, dissolved	mg/L	0.210
UA	27	C	2018/09/12	Lithium, total	mg/L	0.0227
UA	27	C	2018/12/12	Lithium, total	mg/L	0.0220
UA	27	C	2019/03/13	Lithium, total	mg/L	0.0225
UA	27	C	2019/12/11	Lithium, total	mg/L	0.0266
UA	27	C	2020/03/11	Lithium, total	mg/L	0.0266
UA	27	C	2020/09/02	Lithium, total	mg/L	0.0248
UA	27	C	2020/12/09	Lithium, total	mg/L	0.0234
UA	27	C	2021/03/17	Lithium, total	mg/L	0.0207
UA	27	C	2021/06/24	Lithium, total	mg/L	0.0253
UA	27	C	2021/09/09	Lithium, total	mg/L	0.0254
UA	27	C	2021/12/08	Lithium, total	mg/L	0.0226
UA	27	C	2022/03/22	Lithium, total	mg/L	0.0231
UA	27	C	2022/06/07	Lithium, total	mg/L	0.0224
UA	27	C	2022/09/13	Lithium, total	mg/L	0.0203
UA	27	C	2022/12/27	Lithium, total	mg/L	0.0187
UA	27	C	2023/02/28	Lithium, total	mg/L	0.0174
UA	27	C	2023/05/31	Lithium, total	mg/L	0.0225
UA	27	C	2023/08/24	Lithium, total	mg/L	0.0240
UA	27	C	2023/11/14	Lithium, total	mg/L	0.0230
UA	27	C	2020/03/11	Magnesium, total	mg/L	39.0
UA	27	C	2021/03/17	Magnesium, total	mg/L	40.0
UA	27	C	2021/09/09	Magnesium, total	mg/L	39.8
UA	27	C	2022/03/22	Magnesium, total	mg/L	38.9
UA	27	C	2023/02/28	Magnesium, total	mg/L	39.6
UA	27	C	2023/05/31	Magnesium, total	mg/L	35.4
UA	27	C	2023/08/24	Magnesium, total	mg/L	37.0
UA	27	C	2023/11/14	Magnesium, total	mg/L	37.0
UA	27	C	2013/03/08	Manganese, dissolved	mg/L	0.660

UA	27	C	2013/12/10	Manganese, dissolved	mg/L	0.702
UA	27	C	2014/03/25	Manganese, dissolved	mg/L	0.607
UA	27	C	2014/08/19	Manganese, dissolved	mg/L	0.650
UA	27	C	2014/09/30	Manganese, dissolved	mg/L	0.772
UA	27	C	2015/03/18	Manganese, dissolved	mg/L	0.758
UA	27	C	2015/09/16	Manganese, dissolved	mg/L	0.722
UA	27	C	2016/03/08	Manganese, dissolved	mg/L	0.703
UA	27	C	2016/09/15	Manganese, dissolved	mg/L	0.715
UA	27	C	2017/02/21	Manganese, dissolved	mg/L	0.711
UA	27	C	2017/09/06	Manganese, dissolved	mg/L	0.720
UA	27	C	2018/03/26	Manganese, dissolved	mg/L	0.687
UA	27	C	2023/05/31	Manganese, dissolved	mg/L	0.657
UA	27	C	2023/08/24	Manganese, dissolved	mg/L	0.660
UA	27	C	2023/05/31	Phosphate, dissolved	mg/L	0.147
UA	27	C	2023/08/24	Phosphate, dissolved	mg/L	0.230
UA	27	C	2020/03/11	Potassium, total	mg/L	3.88
UA	27	C	2021/03/17	Potassium, total	mg/L	3.64
UA	27	C	2021/09/09	Potassium, total	mg/L	4.12
UA	27	C	2022/03/22	Potassium, total	mg/L	3.83
UA	27	C	2023/02/28	Potassium, total	mg/L	3.08
UA	27	C	2023/05/31	Potassium, total	mg/L	3.60
UA	27	C	2023/08/24	Potassium, total	mg/L	3.50
UA	27	C	2023/11/14	Potassium, total	mg/L	3.20
UA	27	C	2023/05/31	Silicon, dissolved	mg/L	7.59
UA	27	C	2023/08/24	Silicon, dissolved	mg/L	9.40
UA	27	C	2020/03/11	Sodium, total	mg/L	52.1
UA	27	C	2021/03/17	Sodium, total	mg/L	53.7
UA	27	C	2021/09/09	Sodium, total	mg/L	50.5
UA	27	C	2022/03/22	Sodium, total	mg/L	58.4
UA	27	C	2023/02/28	Sodium, total	mg/L	51.1
UA	27	C	2023/05/31	Sodium, total	mg/L	54.8
UA	27	C	2023/08/24	Sodium, total	mg/L	52.0
UA	27	C	2023/11/14	Sodium, total	mg/L	51.0
UA	27	C	2013/03/08	Sulfate, total	mg/L	219
UA	27	C	2013/06/26	Sulfate, total	mg/L	152
UA	27	C	2013/09/03	Sulfate, total	mg/L	192
UA	27	C	2013/12/10	Sulfate, total	mg/L	169
UA	27	C	2014/03/25	Sulfate, total	mg/L	165
UA	27	C	2014/09/30	Sulfate, total	mg/L	215
UA	27	C	2015/03/18	Sulfate, total	mg/L	216
UA	27	C	2015/09/16	Sulfate, total	mg/L	228
UA	27	C	2016/03/08	Sulfate, total	mg/L	216
UA	27	C	2016/09/15	Sulfate, total	mg/L	173
UA	27	C	2017/02/21	Sulfate, total	mg/L	186
UA	27	C	2017/09/06	Sulfate, total	mg/L	150
UA	27	C	2018/03/26	Sulfate, total	mg/L	144
UA	27	C	2018/09/12	Sulfate, total	mg/L	144
UA	27	C	2018/12/12	Sulfate, total	mg/L	135
UA	27	C	2019/03/13	Sulfate, total	mg/L	124
UA	27	C	2019/12/11	Sulfate, total	mg/L	104
UA	27	C	2020/03/11	Sulfate, total	mg/L	109
UA	27	C	2020/09/02	Sulfate, total	mg/L	112
UA	27	C	2020/12/09	Sulfate, total	mg/L	120
UA	27	C	2021/03/17	Sulfate, total	mg/L	124
UA	27	C	2021/06/24	Sulfate, total	mg/L	122
UA	27	C	2021/09/09	Sulfate, total	mg/L	129
UA	27	C	2021/12/08	Sulfate, total	mg/L	115
UA	27	C	2022/03/22	Sulfate, total	mg/L	123
UA	27	C	2022/06/07	Sulfate, total	mg/L	121
UA	27	C	2022/09/13	Sulfate, total	mg/L	117
UA	27	C	2022/12/27	Sulfate, total	mg/L	139
UA	27	C	2023/02/28	Sulfate, total	mg/L	159

UA	27	C	2023/05/31	Sulfate, total	mg/L	118
UA	27	C	2023/08/24	Sulfate, total	mg/L	110
UA	27	C	2023/11/14	Sulfate, total	mg/L	120
UA	27	C	2013/03/08	Temperature (Celsius)	degrees C	10.9
UA	27	C	2013/06/26	Temperature (Celsius)	degrees C	12.8
UA	27	C	2013/09/03	Temperature (Celsius)	degrees C	12.9
UA	27	C	2013/12/10	Temperature (Celsius)	degrees C	10.0
UA	27	C	2014/03/25	Temperature (Celsius)	degrees C	9.90
UA	27	C	2014/08/19	Temperature (Celsius)	degrees C	13.1
UA	27	C	2014/09/30	Temperature (Celsius)	degrees C	12.1
UA	27	C	2015/03/18	Temperature (Celsius)	degrees C	11.8
UA	27	C	2015/09/16	Temperature (Celsius)	degrees C	13.1
UA	27	C	2016/03/08	Temperature (Celsius)	degrees C	11.3
UA	27	C	2016/09/15	Temperature (Celsius)	degrees C	14.9
UA	27	C	2017/02/21	Temperature (Celsius)	degrees C	12.7
UA	27	C	2017/09/06	Temperature (Celsius)	degrees C	12.7
UA	27	C	2018/03/26	Temperature (Celsius)	degrees C	11.8
UA	27	C	2018/09/12	Temperature (Celsius)	degrees C	17.1
UA	27	C	2018/12/12	Temperature (Celsius)	degrees C	11.5
UA	27	C	2019/03/13	Temperature (Celsius)	degrees C	11.2
UA	27	C	2019/12/11	Temperature (Celsius)	degrees C	11.6
UA	27	C	2020/03/11	Temperature (Celsius)	degrees C	11.1
UA	27	C	2020/09/02	Temperature (Celsius)	degrees C	13.5
UA	27	C	2020/12/09	Temperature (Celsius)	degrees C	12.2
UA	27	C	2021/03/17	Temperature (Celsius)	degrees C	11.7
UA	27	C	2021/06/24	Temperature (Celsius)	degrees C	12.4
UA	27	C	2021/09/09	Temperature (Celsius)	degrees C	12.6
UA	27	C	2021/12/08	Temperature (Celsius)	degrees C	11.9
UA	27	C	2022/03/22	Temperature (Celsius)	degrees C	11.6
UA	27	C	2022/06/07	Temperature (Celsius)	degrees C	12.5
UA	27	C	2022/09/13	Temperature (Celsius)	degrees C	14.7
UA	27	C	2022/12/27	Temperature (Celsius)	degrees C	11.1
UA	27	C	2023/02/28	Temperature (Celsius)	degrees C	11.6
UA	27	C	2023/05/31	Temperature (Celsius)	degrees C	12.0
UA	27	C	2023/08/24	Temperature (Celsius)	degrees C	12.5
UA	27	C	2023/11/14	Temperature (Celsius)	degrees C	12.7
UA	27	C	2013/03/08	Total Dissolved Solids	mg/L	654
UA	27	C	2013/06/26	Total Dissolved Solids	mg/L	600
UA	27	C	2013/09/03	Total Dissolved Solids	mg/L	618
UA	27	C	2013/12/10	Total Dissolved Solids	mg/L	602
UA	27	C	2014/03/25	Total Dissolved Solids	mg/L	518
UA	27	C	2014/08/19	Total Dissolved Solids	mg/L	636
UA	27	C	2014/09/30	Total Dissolved Solids	mg/L	644
UA	27	C	2015/03/18	Total Dissolved Solids	mg/L	652
UA	27	C	2015/09/16	Total Dissolved Solids	mg/L	660
UA	27	C	2016/03/08	Total Dissolved Solids	mg/L	638
UA	27	C	2016/09/15	Total Dissolved Solids	mg/L	634
UA	27	C	2017/02/21	Total Dissolved Solids	mg/L	442
UA	27	C	2017/09/06	Total Dissolved Solids	mg/L	680
UA	27	C	2018/03/26	Total Dissolved Solids	mg/L	666
UA	27	C	2018/09/12	Total Dissolved Solids	mg/L	808
UA	27	C	2018/12/12	Total Dissolved Solids	mg/L	694
UA	27	C	2019/03/13	Total Dissolved Solids	mg/L	700
UA	27	C	2019/12/11	Total Dissolved Solids	mg/L	654
UA	27	C	2020/03/11	Total Dissolved Solids	mg/L	668
UA	27	C	2020/09/02	Total Dissolved Solids	mg/L	642
UA	27	C	2020/12/09	Total Dissolved Solids	mg/L	674
UA	27	C	2021/03/17	Total Dissolved Solids	mg/L	722
UA	27	C	2021/06/24	Total Dissolved Solids	mg/L	670
UA	27	C	2021/09/09	Total Dissolved Solids	mg/L	712
UA	27	C	2021/12/08	Total Dissolved Solids	mg/L	634
UA	27	C	2022/03/22	Total Dissolved Solids	mg/L	648

UA	27	C	2022/06/07	Total Dissolved Solids	mg/L	752
UA	27	C	2022/09/13	Total Dissolved Solids	mg/L	698
UA	27	C	2022/12/27	Total Dissolved Solids	mg/L	634
UA	27	C	2023/02/28	Total Dissolved Solids	mg/L	636
UA	27	C	2023/05/31	Total Dissolved Solids	mg/L	658
UA	27	C	2023/08/24	Total Dissolved Solids	mg/L	660
UA	27	C	2023/11/14	Total Dissolved Solids	mg/L	660
UA	35	C	2015/12/09	pH (field)	SU	7.2
UA	35	C	2016/03/09	pH (field)	SU	7.1
UA	35	C	2016/06/07	pH (field)	SU	7.4
UA	35	C	2016/09/15	pH (field)	SU	7.4
UA	35	C	2016/12/07	pH (field)	SU	7.2
UA	35	C	2017/02/21	pH (field)	SU	7.2
UA	35	C	2017/04/25	pH (field)	SU	7.5
UA	35	C	2017/06/08	pH (field)	SU	7.1
UA	35	C	2017/11/15	pH (field)	SU	7.4
UA	35	C	2018/06/13	pH (field)	SU	6.8
UA	35	C	2018/09/12	pH (field)	SU	7.1
UA	35	C	2018/12/12	pH (field)	SU	6.9
UA	35	C	2019/03/13	pH (field)	SU	7.2
UA	35	C	2019/06/19	pH (field)	SU	7.0
UA	35	C	2019/09/17	pH (field)	SU	7.0
UA	35	C	2019/12/11	pH (field)	SU	7.1
UA	35	C	2020/03/11	pH (field)	SU	6.9
UA	35	C	2020/06/24	pH (field)	SU	7.3
UA	35	C	2020/09/02	pH (field)	SU	7.2
UA	35	C	2020/12/09	pH (field)	SU	7.0
UA	35	C	2021/03/17	pH (field)	SU	7.1
UA	35	C	2021/06/23	pH (field)	SU	7.0
UA	35	C	2021/09/08	pH (field)	SU	7.0
UA	35	C	2021/12/08	pH (field)	SU	6.9
UA	35	C	2022/03/22	pH (field)	SU	7.0
UA	35	C	2022/06/07	pH (field)	SU	7.0
UA	35	C	2022/09/14	pH (field)	SU	6.8
UA	35	C	2022/12/27	pH (field)	SU	7.0
UA	35	C	2023/02/28	pH (field)	SU	7.0
UA	35	C	2023/05/31	pH (field)	SU	6.9
UA	35	C	2023/08/24	pH (field)	SU	7.0
UA	35	C	2023/11/15	pH (field)	SU	6.9
UA	35	C	2015/12/09	Oxidation Reduction Potential	mV	148
UA	35	C	2016/03/09	Oxidation Reduction Potential	mV	162
UA	35	C	2016/06/07	Oxidation Reduction Potential	mV	51.0
UA	35	C	2016/09/15	Oxidation Reduction Potential	mV	145
UA	35	C	2016/12/07	Oxidation Reduction Potential	mV	126
UA	35	C	2017/02/21	Oxidation Reduction Potential	mV	77.0
UA	35	C	2017/04/25	Oxidation Reduction Potential	mV	80.0
UA	35	C	2017/06/08	Oxidation Reduction Potential	mV	65.0
UA	35	C	2017/11/15	Oxidation Reduction Potential	mV	-31.0
UA	35	C	2018/06/13	Oxidation Reduction Potential	mV	11.0
UA	35	C	2018/09/12	Oxidation Reduction Potential	mV	62.0
UA	35	C	2018/12/12	Oxidation Reduction Potential	mV	125
UA	35	C	2019/03/13	Oxidation Reduction Potential	mV	102
UA	35	C	2019/06/19	Oxidation Reduction Potential	mV	158
UA	35	C	2019/09/17	Oxidation Reduction Potential	mV	112
UA	35	C	2019/12/11	Oxidation Reduction Potential	mV	132
UA	35	C	2020/03/11	Oxidation Reduction Potential	mV	105
UA	35	C	2020/06/24	Oxidation Reduction Potential	mV	184
UA	35	C	2020/09/02	Oxidation Reduction Potential	mV	111
UA	35	C	2020/12/09	Oxidation Reduction Potential	mV	28.0
UA	35	C	2021/03/17	Oxidation Reduction Potential	mV	143
UA	35	C	2021/06/23	Oxidation Reduction Potential	mV	-36.0
UA	35	C	2021/09/08	Oxidation Reduction Potential	mV	63.0

UA	35	C	2021/12/08	Oxidation Reduction Potential	mV	17.0
UA	35	C	2022/03/22	Oxidation Reduction Potential	mV	10.0
UA	35	C	2022/06/07	Oxidation Reduction Potential	mV	66.0
UA	35	C	2022/09/14	Oxidation Reduction Potential	mV	191
UA	35	C	2022/12/27	Oxidation Reduction Potential	mV	7.00
UA	35	C	2023/02/28	Oxidation Reduction Potential	mV	108
UA	35	C	2023/05/31	Oxidation Reduction Potential	mV	105
UA	35	C	2023/08/24	Oxidation Reduction Potential	mV	162
UA	35	C	2023/11/15	Oxidation Reduction Potential	mV	228
UA	35	C	2015/12/09	Eh	V	0.34
UA	35	C	2016/03/09	Eh	V	0.36
UA	35	C	2016/06/07	Eh	V	0.25
UA	35	C	2016/09/15	Eh	V	0.34
UA	35	C	2016/12/07	Eh	V	0.32
UA	35	C	2017/02/21	Eh	V	0.27
UA	35	C	2017/04/25	Eh	V	0.28
UA	35	C	2017/06/08	Eh	V	0.26
UA	35	C	2017/11/15	Eh	V	0.16
UA	35	C	2018/06/13	Eh	V	0.21
UA	35	C	2018/09/12	Eh	V	0.26
UA	35	C	2018/12/12	Eh	V	0.32
UA	35	C	2019/03/13	Eh	V	0.30
UA	35	C	2019/06/19	Eh	V	0.36
UA	35	C	2019/09/17	Eh	V	0.31
UA	35	C	2019/12/11	Eh	V	0.33
UA	35	C	2020/03/11	Eh	V	0.30
UA	35	C	2020/06/24	Eh	V	0.38
UA	35	C	2020/09/02	Eh	V	0.31
UA	35	C	2020/12/09	Eh	V	0.22
UA	35	C	2021/03/17	Eh	V	0.34
UA	35	C	2021/06/23	Eh	V	0.16
UA	35	C	2021/09/08	Eh	V	0.26
UA	35	C	2021/12/08	Eh	V	0.21
UA	35	C	2022/03/22	Eh	V	0.21
UA	35	C	2022/06/07	Eh	V	0.26
UA	35	C	2022/09/14	Eh	V	0.39
UA	35	C	2022/12/27	Eh	V	0.20
UA	35	C	2023/02/28	Eh	V	0.31
UA	35	C	2023/05/31	Eh	V	0.30
UA	35	C	2023/08/24	Eh	V	0.36
UA	35	C	2023/11/15	Eh	V	0.42
UA	35	C	2019/09/17	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	35	C	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	220
UA	35	C	2021/03/17	Alkalinity, bicarbonate	mg/L CaCO3	195
UA	35	C	2021/09/08	Alkalinity, bicarbonate	mg/L CaCO3	208
UA	35	C	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	209
UA	35	C	2022/09/14	Alkalinity, bicarbonate	mg/L CaCO3	215
UA	35	C	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	269
UA	35	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	249
UA	35	C	2023/08/24	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	35	C	2023/11/15	Alkalinity, bicarbonate	mg/L CaCO3	310
UA	35	C	2015/12/09	Arsenic, total	mg/L	<0.0002
UA	35	C	2016/03/09	Arsenic, total	mg/L	<0.0002
UA	35	C	2016/06/07	Arsenic, total	mg/L	<0.0002
UA	35	C	2016/09/15	Arsenic, total	mg/L	<0.0002
UA	35	C	2016/12/07	Arsenic, total	mg/L	<0.0002
UA	35	C	2017/02/21	Arsenic, total	mg/L	<0.0002
UA	35	C	2017/04/25	Arsenic, total	mg/L	<0.0002
UA	35	C	2017/06/08	Arsenic, total	mg/L	<0.0002
UA	35	C	2018/06/13	Arsenic, total	mg/L	<0.0004
UA	35	C	2018/09/12	Arsenic, total	mg/L	<0.0004
UA	35	C	2018/12/12	Arsenic, total	mg/L	<0.0004

UA	35	C	2019/03/13	Arsenic, total	mg/L	0.00260
UA	35	C	2019/06/19	Arsenic, total	mg/L	0.0109
UA	35	C	2019/09/17	Arsenic, total	mg/L	0.00170
UA	35	C	2019/12/11	Arsenic, total	mg/L	0.00140
UA	35	C	2020/03/11	Arsenic, total	mg/L	<0.0004
UA	35	C	2020/06/24	Arsenic, total	mg/L	<0.0004
UA	35	C	2020/09/02	Arsenic, total	mg/L	0.00320
UA	35	C	2020/12/09	Arsenic, total	mg/L	0.00210
UA	35	C	2021/03/17	Arsenic, total	mg/L	<0.0004
UA	35	C	2021/06/23	Arsenic, total	mg/L	<0.0004
UA	35	C	2021/09/08	Arsenic, total	mg/L	<0.0004
UA	35	C	2021/12/08	Arsenic, total	mg/L	<0.0004
UA	35	C	2022/03/22	Arsenic, total	mg/L	<0.0004
UA	35	C	2022/06/07	Arsenic, total	mg/L	0.000500
UA	35	C	2022/09/14	Arsenic, total	mg/L	0.000800
UA	35	C	2022/12/27	Arsenic, total	mg/L	0.000800
UA	35	C	2023/02/28	Arsenic, total	mg/L	0.000800
UA	35	C	2023/05/31	Arsenic, total	mg/L	<0.0087
UA	35	C	2023/08/24	Arsenic, total	mg/L	<0.00023
UA	35	C	2023/11/15	Arsenic, total	mg/L	0.000900
UA	35	C	2015/12/09	Barium, total	mg/L	0.0739
UA	35	C	2016/03/09	Barium, total	mg/L	0.0568
UA	35	C	2016/06/07	Barium, total	mg/L	0.0371
UA	35	C	2016/09/15	Barium, total	mg/L	0.0371
UA	35	C	2016/12/07	Barium, total	mg/L	0.0499
UA	35	C	2017/02/21	Barium, total	mg/L	0.0478
UA	35	C	2017/04/25	Barium, total	mg/L	0.0335
UA	35	C	2017/06/08	Barium, total	mg/L	0.0376
UA	35	C	2018/06/13	Barium, total	mg/L	0.0344
UA	35	C	2018/09/12	Barium, total	mg/L	0.0343
UA	35	C	2018/12/12	Barium, total	mg/L	0.0339
UA	35	C	2019/03/13	Barium, total	mg/L	0.0310
UA	35	C	2019/06/19	Barium, total	mg/L	0.0593
UA	35	C	2019/09/17	Barium, total	mg/L	0.0422
UA	35	C	2019/12/11	Barium, total	mg/L	0.0505
UA	35	C	2020/03/11	Barium, total	mg/L	0.0510
UA	35	C	2020/06/24	Barium, total	mg/L	0.0317
UA	35	C	2020/09/02	Barium, total	mg/L	0.0644
UA	35	C	2020/12/09	Barium, total	mg/L	0.0752
UA	35	C	2021/03/17	Barium, total	mg/L	0.0333
UA	35	C	2021/06/23	Barium, total	mg/L	0.0363
UA	35	C	2021/09/08	Barium, total	mg/L	0.0338
UA	35	C	2021/12/08	Barium, total	mg/L	0.0556
UA	35	C	2022/03/22	Barium, total	mg/L	0.0318
UA	35	C	2022/06/07	Barium, total	mg/L	0.0557
UA	35	C	2022/09/14	Barium, total	mg/L	0.0666
UA	35	C	2022/12/27	Barium, total	mg/L	0.0631
UA	35	C	2023/02/28	Barium, total	mg/L	0.0591
UA	35	C	2023/05/31	Barium, total	mg/L	0.0381
UA	35	C	2023/08/24	Barium, total	mg/L	0.0470
UA	35	C	2023/11/15	Barium, total	mg/L	0.0470
UA	35	C	2015/12/09	Boron, total	mg/L	6.35
UA	35	C	2016/03/09	Boron, total	mg/L	7.02
UA	35	C	2016/06/07	Boron, total	mg/L	5.56
UA	35	C	2016/09/15	Boron, total	mg/L	6.87
UA	35	C	2016/12/07	Boron, total	mg/L	6.60
UA	35	C	2017/02/21	Boron, total	mg/L	6.13
UA	35	C	2017/04/25	Boron, total	mg/L	6.39
UA	35	C	2017/06/08	Boron, total	mg/L	8.19
UA	35	C	2017/11/15	Boron, total	mg/L	11.1
UA	35	C	2018/06/13	Boron, total	mg/L	5.56
UA	35	C	2018/09/12	Boron, total	mg/L	8.29

UA	35	C	2018/12/12	Boron, total	mg/L	5.85
UA	35	C	2019/03/13	Boron, total	mg/L	4.98
UA	35	C	2019/06/19	Boron, total	mg/L	12.0
UA	35	C	2019/09/17	Boron, total	mg/L	12.5
UA	35	C	2019/12/11	Boron, total	mg/L	16.6
UA	35	C	2020/03/11	Boron, total	mg/L	15.3
UA	35	C	2020/06/24	Boron, total	mg/L	11.7
UA	35	C	2020/09/02	Boron, total	mg/L	10.7
UA	35	C	2020/12/09	Boron, total	mg/L	14.0
UA	35	C	2021/03/17	Boron, total	mg/L	11.9
UA	35	C	2021/06/23	Boron, total	mg/L	11.8
UA	35	C	2021/09/08	Boron, total	mg/L	12.0
UA	35	C	2021/12/08	Boron, total	mg/L	12.2
UA	35	C	2022/03/22	Boron, total	mg/L	11.3
UA	35	C	2022/06/07	Boron, total	mg/L	15.3
UA	35	C	2022/09/14	Boron, total	mg/L	16.2
UA	35	C	2022/12/27	Boron, total	mg/L	18.1
UA	35	C	2023/02/28	Boron, total	mg/L	9.58
UA	35	C	2023/05/31	Boron, total	mg/L	12.6
UA	35	C	2023/08/24	Boron, total	mg/L	12.0
UA	35	C	2023/11/15	Boron, total	mg/L	11.0
UA	35	C	2015/12/09	Cadmium, total	mg/L	<0.0002
UA	35	C	2016/03/09	Cadmium, total	mg/L	<0.0002
UA	35	C	2016/06/07	Cadmium, total	mg/L	<0.0002
UA	35	C	2016/09/15	Cadmium, total	mg/L	<0.0002
UA	35	C	2016/12/07	Cadmium, total	mg/L	<0.0002
UA	35	C	2017/02/21	Cadmium, total	mg/L	<0.0002
UA	35	C	2017/04/25	Cadmium, total	mg/L	<0.0002
UA	35	C	2017/06/08	Cadmium, total	mg/L	<0.0002
UA	35	C	2018/06/13	Cadmium, total	mg/L	<0.0002
UA	35	C	2018/09/12	Cadmium, total	mg/L	<0.0002
UA	35	C	2018/12/12	Cadmium, total	mg/L	<0.0002
UA	35	C	2019/03/13	Cadmium, total	mg/L	<0.0002
UA	35	C	2019/06/19	Cadmium, total	mg/L	<0.0002
UA	35	C	2019/09/17	Cadmium, total	mg/L	<0.0002
UA	35	C	2019/12/11	Cadmium, total	mg/L	<0.0002
UA	35	C	2020/03/11	Cadmium, total	mg/L	<0.0002
UA	35	C	2020/06/24	Cadmium, total	mg/L	<0.0002
UA	35	C	2020/09/02	Cadmium, total	mg/L	<0.0002
UA	35	C	2020/12/09	Cadmium, total	mg/L	<0.0002
UA	35	C	2021/03/17	Cadmium, total	mg/L	<0.0002
UA	35	C	2021/06/23	Cadmium, total	mg/L	<0.0002
UA	35	C	2021/09/08	Cadmium, total	mg/L	<0.0002
UA	35	C	2021/12/08	Cadmium, total	mg/L	<0.0002
UA	35	C	2022/03/22	Cadmium, total	mg/L	<0.0002
UA	35	C	2022/06/07	Cadmium, total	mg/L	0.000400
UA	35	C	2022/09/14	Cadmium, total	mg/L	0.000500
UA	35	C	2022/12/27	Cadmium, total	mg/L	0.000500
UA	35	C	2023/02/28	Cadmium, total	mg/L	0.000500
UA	35	C	2023/05/31	Cadmium, total	mg/L	<0.0005
UA	35	C	2023/08/24	Cadmium, total	mg/L	<0.00017
UA	35	C	2023/11/15	Cadmium, total	mg/L	0.000290
UA	35	C	2015/12/09	Calcium, total	mg/L	177
UA	35	C	2016/03/09	Calcium, total	mg/L	203
UA	35	C	2016/06/07	Calcium, total	mg/L	161
UA	35	C	2016/09/15	Calcium, total	mg/L	162
UA	35	C	2016/12/07	Calcium, total	mg/L	175
UA	35	C	2017/02/21	Calcium, total	mg/L	189
UA	35	C	2017/04/25	Calcium, total	mg/L	159
UA	35	C	2017/06/08	Calcium, total	mg/L	211
UA	35	C	2017/11/15	Calcium, total	mg/L	256
UA	35	C	2018/06/13	Calcium, total	mg/L	186

UA	35	C	2018/09/12	Calcium, total	mg/L	180
UA	35	C	2018/12/12	Calcium, total	mg/L	208
UA	35	C	2019/03/13	Calcium, total	mg/L	157
UA	35	C	2019/06/19	Calcium, total	mg/L	257
UA	35	C	2019/09/17	Calcium, total	mg/L	241
UA	35	C	2019/12/11	Calcium, total	mg/L	281
UA	35	C	2020/03/11	Calcium, total	mg/L	340
UA	35	C	2020/06/24	Calcium, total	mg/L	224
UA	35	C	2020/09/02	Calcium, total	mg/L	221
UA	35	C	2020/12/09	Calcium, total	mg/L	425
UA	35	C	2021/03/17	Calcium, total	mg/L	286
UA	35	C	2021/06/23	Calcium, total	mg/L	254
UA	35	C	2021/09/08	Calcium, total	mg/L	259
UA	35	C	2021/12/08	Calcium, total	mg/L	305
UA	35	C	2022/03/22	Calcium, total	mg/L	264
UA	35	C	2022/06/07	Calcium, total	mg/L	423
UA	35	C	2022/09/14	Calcium, total	mg/L	426
UA	35	C	2022/12/27	Calcium, total	mg/L	347
UA	35	C	2023/02/28	Calcium, total	mg/L	268
UA	35	C	2023/05/31	Calcium, total	mg/L	291
UA	35	C	2023/08/24	Calcium, total	mg/L	320
UA	35	C	2023/11/15	Calcium, total	mg/L	320
UA	35	C	2015/12/09	Chloride, total	mg/L	45.0
UA	35	C	2016/03/09	Chloride, total	mg/L	44.0
UA	35	C	2016/06/07	Chloride, total	mg/L	45.0
UA	35	C	2016/09/15	Chloride, total	mg/L	42.0
UA	35	C	2016/12/07	Chloride, total	mg/L	45.0
UA	35	C	2017/02/21	Chloride, total	mg/L	41.0
UA	35	C	2017/04/25	Chloride, total	mg/L	43.0
UA	35	C	2017/06/08	Chloride, total	mg/L	40.0
UA	35	C	2017/11/15	Chloride, total	mg/L	38.0
UA	35	C	2018/06/13	Chloride, total	mg/L	35.0
UA	35	C	2018/09/12	Chloride, total	mg/L	63.0
UA	35	C	2018/12/12	Chloride, total	mg/L	46.0
UA	35	C	2019/03/13	Chloride, total	mg/L	38.0
UA	35	C	2019/06/19	Chloride, total	mg/L	52.0
UA	35	C	2019/09/17	Chloride, total	mg/L	53.0
UA	35	C	2019/12/11	Chloride, total	mg/L	46.0
UA	35	C	2020/03/11	Chloride, total	mg/L	37.0
UA	35	C	2020/06/24	Chloride, total	mg/L	54.0
UA	35	C	2020/09/02	Chloride, total	mg/L	59.0
UA	35	C	2020/12/09	Chloride, total	mg/L	49.0
UA	35	C	2021/03/17	Chloride, total	mg/L	27.0
UA	35	C	2021/06/23	Chloride, total	mg/L	60.0
UA	35	C	2021/09/08	Chloride, total	mg/L	56.0
UA	35	C	2021/12/08	Chloride, total	mg/L	46.0
UA	35	C	2022/03/22	Chloride, total	mg/L	29.0
UA	35	C	2022/06/07	Chloride, total	mg/L	35.0
UA	35	C	2022/09/14	Chloride, total	mg/L	30.0
UA	35	C	2022/12/27	Chloride, total	mg/L	33.0
UA	35	C	2023/02/28	Chloride, total	mg/L	26.0
UA	35	C	2023/05/31	Chloride, total	mg/L	32.0
UA	35	C	2023/08/24	Chloride, total	mg/L	37.0
UA	35	C	2023/11/15	Chloride, total	mg/L	24.0
UA	35	C	2023/05/31	Iron, dissolved	mg/L	<0.02
UA	35	C	2023/08/24	Iron, dissolved	mg/L	<0.047
UA	35	C	2015/12/09	Lithium, total	mg/L	0.0245
UA	35	C	2016/03/09	Lithium, total	mg/L	0.0226
UA	35	C	2016/06/07	Lithium, total	mg/L	0.0248
UA	35	C	2016/09/15	Lithium, total	mg/L	0.0305
UA	35	C	2016/12/07	Lithium, total	mg/L	0.0293
UA	35	C	2017/02/21	Lithium, total	mg/L	0.0226

UA	35	C	2017/04/25	Lithium, total	mg/L	0.0291
UA	35	C	2017/06/08	Lithium, total	mg/L	0.0280
UA	35	C	2018/06/13	Lithium, total	mg/L	0.0217
UA	35	C	2018/09/12	Lithium, total	mg/L	0.0332
UA	35	C	2018/12/12	Lithium, total	mg/L	0.0259
UA	35	C	2019/03/13	Lithium, total	mg/L	0.0183
UA	35	C	2019/06/19	Lithium, total	mg/L	0.0374
UA	35	C	2019/09/17	Lithium, total	mg/L	0.0371
UA	35	C	2019/12/11	Lithium, total	mg/L	0.0355
UA	35	C	2020/03/11	Lithium, total	mg/L	0.0290
UA	35	C	2020/06/24	Lithium, total	mg/L	0.0360
UA	35	C	2020/09/02	Lithium, total	mg/L	0.0337
UA	35	C	2020/12/09	Lithium, total	mg/L	0.0324
UA	35	C	2021/03/17	Lithium, total	mg/L	0.0162
UA	35	C	2021/06/23	Lithium, total	mg/L	0.0330
UA	35	C	2021/09/08	Lithium, total	mg/L	0.0349
UA	35	C	2021/12/08	Lithium, total	mg/L	0.0260
UA	35	C	2022/03/22	Lithium, total	mg/L	0.0190
UA	35	C	2022/06/07	Lithium, total	mg/L	0.0304
UA	35	C	2022/09/14	Lithium, total	mg/L	0.0240
UA	35	C	2022/12/27	Lithium, total	mg/L	0.0293
UA	35	C	2023/02/28	Lithium, total	mg/L	0.0128
UA	35	C	2023/05/31	Lithium, total	mg/L	0.0210
UA	35	C	2023/08/24	Lithium, total	mg/L	0.0340
UA	35	C	2023/11/15	Lithium, total	mg/L	0.0330
UA	35	C	2019/09/17	Magnesium, total	mg/L	37.9
UA	35	C	2020/03/11	Magnesium, total	mg/L	47.7
UA	35	C	2020/06/24	Magnesium, total	mg/L	33.5
UA	35	C	2021/03/17	Magnesium, total	mg/L	37.4
UA	35	C	2021/09/08	Magnesium, total	mg/L	36.7
UA	35	C	2022/03/22	Magnesium, total	mg/L	29.0
UA	35	C	2022/09/14	Magnesium, total	mg/L	47.1
UA	35	C	2023/02/28	Magnesium, total	mg/L	30.6
UA	35	C	2023/05/31	Magnesium, total	mg/L	31.7
UA	35	C	2023/08/24	Magnesium, total	mg/L	42.0
UA	35	C	2023/11/15	Magnesium, total	mg/L	39.0
UA	35	C	2023/05/31	Manganese, dissolved	mg/L	0.566
UA	35	C	2023/08/24	Manganese, dissolved	mg/L	0.500
UA	35	C	2023/05/31	Phosphate, dissolved	mg/L	0.0400
UA	35	C	2023/08/24	Phosphate, dissolved	mg/L	<0.073
UA	35	C	2019/09/17	Potassium, total	mg/L	14.0
UA	35	C	2020/03/11	Potassium, total	mg/L	14.8
UA	35	C	2020/06/24	Potassium, total	mg/L	14.9
UA	35	C	2021/03/17	Potassium, total	mg/L	10.2
UA	35	C	2021/09/08	Potassium, total	mg/L	15.8
UA	35	C	2022/03/22	Potassium, total	mg/L	11.2
UA	35	C	2022/09/14	Potassium, total	mg/L	17.1
UA	35	C	2023/02/28	Potassium, total	mg/L	10.2
UA	35	C	2023/05/31	Potassium, total	mg/L	14.0
UA	35	C	2023/08/24	Potassium, total	mg/L	14.0
UA	35	C	2023/11/15	Potassium, total	mg/L	13.0
UA	35	C	2023/05/31	Silicon, dissolved	mg/L	4.18
UA	35	C	2023/08/24	Silicon, dissolved	mg/L	5.80
UA	35	C	2019/09/17	Sodium, total	mg/L	39.6
UA	35	C	2020/03/11	Sodium, total	mg/L	48.2
UA	35	C	2020/06/24	Sodium, total	mg/L	44.4
UA	35	C	2021/03/17	Sodium, total	mg/L	30.1
UA	35	C	2021/09/08	Sodium, total	mg/L	42.0
UA	35	C	2022/03/22	Sodium, total	mg/L	27.2
UA	35	C	2022/09/14	Sodium, total	mg/L	30.4
UA	35	C	2023/02/28	Sodium, total	mg/L	25.6
UA	35	C	2023/05/31	Sodium, total	mg/L	30.8

UA	35	C	2023/08/24	Sodium, total	mg/L	30.0
UA	35	C	2023/11/15	Sodium, total	mg/L	28.0
UA	35	C	2015/12/09	Sulfate, total	mg/L	352
UA	35	C	2016/03/09	Sulfate, total	mg/L	465
UA	35	C	2016/06/07	Sulfate, total	mg/L	317
UA	35	C	2016/09/15	Sulfate, total	mg/L	374
UA	35	C	2016/12/07	Sulfate, total	mg/L	370
UA	35	C	2017/02/21	Sulfate, total	mg/L	381
UA	35	C	2017/04/25	Sulfate, total	mg/L	398
UA	35	C	2017/06/08	Sulfate, total	mg/L	500
UA	35	C	2017/11/15	Sulfate, total	mg/L	598
UA	35	C	2018/06/13	Sulfate, total	mg/L	420
UA	35	C	2018/09/12	Sulfate, total	mg/L	416
UA	35	C	2018/12/12	Sulfate, total	mg/L	327
UA	35	C	2019/03/13	Sulfate, total	mg/L	255
UA	35	C	2019/06/19	Sulfate, total	mg/L	512
UA	35	C	2019/09/17	Sulfate, total	mg/L	470
UA	35	C	2019/12/11	Sulfate, total	mg/L	637
UA	35	C	2020/03/11	Sulfate, total	mg/L	802
UA	35	C	2020/06/24	Sulfate, total	mg/L	479
UA	35	C	2020/09/02	Sulfate, total	mg/L	443
UA	35	C	2020/12/09	Sulfate, total	mg/L	846
UA	35	C	2021/03/17	Sulfate, total	mg/L	620
UA	35	C	2021/06/23	Sulfate, total	mg/L	530
UA	35	C	2021/09/08	Sulfate, total	mg/L	568
UA	35	C	2021/12/08	Sulfate, total	mg/L	818
UA	35	C	2022/03/22	Sulfate, total	mg/L	549
UA	35	C	2022/06/07	Sulfate, total	mg/L	939
UA	35	C	2022/09/14	Sulfate, total	mg/L	1,190
UA	35	C	2022/12/27	Sulfate, total	mg/L	819
UA	35	C	2023/02/28	Sulfate, total	mg/L	476
UA	35	C	2023/05/31	Sulfate, total	mg/L	670
UA	35	C	2023/08/24	Sulfate, total	mg/L	890
UA	35	C	2023/11/15	Sulfate, total	mg/L	730
UA	35	C	2015/12/09	Temperature (Celsius)	degrees C	14.5
UA	35	C	2016/03/09	Temperature (Celsius)	degrees C	10.1
UA	35	C	2016/06/07	Temperature (Celsius)	degrees C	12.1
UA	35	C	2016/09/15	Temperature (Celsius)	degrees C	16.6
UA	35	C	2016/12/07	Temperature (Celsius)	degrees C	11.9
UA	35	C	2017/02/21	Temperature (Celsius)	degrees C	12.2
UA	35	C	2017/04/25	Temperature (Celsius)	degrees C	15.1
UA	35	C	2017/06/08	Temperature (Celsius)	degrees C	13.3
UA	35	C	2017/11/15	Temperature (Celsius)	degrees C	14.4
UA	35	C	2018/06/13	Temperature (Celsius)	degrees C	14.1
UA	35	C	2018/09/12	Temperature (Celsius)	degrees C	16.0
UA	35	C	2018/12/12	Temperature (Celsius)	degrees C	17.8
UA	35	C	2019/03/13	Temperature (Celsius)	degrees C	9.90
UA	35	C	2019/06/19	Temperature (Celsius)	degrees C	12.6
UA	35	C	2019/09/17	Temperature (Celsius)	degrees C	15.7
UA	35	C	2019/12/11	Temperature (Celsius)	degrees C	12.8
UA	35	C	2020/03/11	Temperature (Celsius)	degrees C	9.80
UA	35	C	2020/06/24	Temperature (Celsius)	degrees C	13.5
UA	35	C	2020/09/02	Temperature (Celsius)	degrees C	16.0
UA	35	C	2020/12/09	Temperature (Celsius)	degrees C	14.5
UA	35	C	2021/03/17	Temperature (Celsius)	degrees C	10.0
UA	35	C	2021/06/23	Temperature (Celsius)	degrees C	13.1
UA	35	C	2021/09/08	Temperature (Celsius)	degrees C	15.9
UA	35	C	2021/12/08	Temperature (Celsius)	degrees C	14.5
UA	35	C	2022/03/22	Temperature (Celsius)	degrees C	10.5
UA	35	C	2022/06/07	Temperature (Celsius)	degrees C	12.6
UA	35	C	2022/09/14	Temperature (Celsius)	degrees C	15.7
UA	35	C	2022/12/27	Temperature (Celsius)	degrees C	13.2

UA	35	C	2023/02/28	Temperature (Celsius)	degrees C	11.1
UA	35	C	2023/05/31	Temperature (Celsius)	degrees C	12.9
UA	35	C	2023/08/24	Temperature (Celsius)	degrees C	16.2
UA	35	C	2023/11/15	Temperature (Celsius)	degrees C	15.6
UA	35	C	2015/12/09	Total Dissolved Solids	mg/L	860
UA	35	C	2016/03/09	Total Dissolved Solids	mg/L	978
UA	35	C	2016/06/07	Total Dissolved Solids	mg/L	802
UA	35	C	2016/09/15	Total Dissolved Solids	mg/L	864
UA	35	C	2016/12/07	Total Dissolved Solids	mg/L	854
UA	35	C	2017/02/21	Total Dissolved Solids	mg/L	868
UA	35	C	2017/04/25	Total Dissolved Solids	mg/L	866
UA	35	C	2017/06/08	Total Dissolved Solids	mg/L	1,010
UA	35	C	2017/11/15	Total Dissolved Solids	mg/L	1,260
UA	35	C	2018/06/13	Total Dissolved Solids	mg/L	972
UA	35	C	2018/09/12	Total Dissolved Solids	mg/L	1,000
UA	35	C	2018/12/12	Total Dissolved Solids	mg/L	872
UA	35	C	2019/03/13	Total Dissolved Solids	mg/L	708
UA	35	C	2019/06/19	Total Dissolved Solids	mg/L	1,130
UA	35	C	2019/09/17	Total Dissolved Solids	mg/L	1,110
UA	35	C	2019/12/11	Total Dissolved Solids	mg/L	1,240
UA	35	C	2020/03/11	Total Dissolved Solids	mg/L	1,520
UA	35	C	2020/06/24	Total Dissolved Solids	mg/L	1,070
UA	35	C	2020/09/02	Total Dissolved Solids	mg/L	1,010
UA	35	C	2020/12/09	Total Dissolved Solids	mg/L	1,470
UA	35	C	2021/03/17	Total Dissolved Solids	mg/L	1,210
UA	35	C	2021/06/23	Total Dissolved Solids	mg/L	1,150
UA	35	C	2021/09/08	Total Dissolved Solids	mg/L	1,140
UA	35	C	2021/12/08	Total Dissolved Solids	mg/L	1,330
UA	35	C	2022/03/22	Total Dissolved Solids	mg/L	1,020
UA	35	C	2022/06/07	Total Dissolved Solids	mg/L	1,840
UA	35	C	2022/09/14	Total Dissolved Solids	mg/L	1,940
UA	35	C	2022/12/27	Total Dissolved Solids	mg/L	1,520
UA	35	C	2023/02/28	Total Dissolved Solids	mg/L	918
UA	35	C	2023/05/31	Total Dissolved Solids	mg/L	1,300
UA	35	C	2023/08/24	Total Dissolved Solids	mg/L	1,600
UA	35	C	2023/11/15	Total Dissolved Solids	mg/L	1,500
UA	49	C	2015/12/10	pH (field)	SU	7.4
UA	49	C	2016/03/09	pH (field)	SU	7.2
UA	49	C	2016/06/07	pH (field)	SU	7.2
UA	49	C	2016/09/15	pH (field)	SU	7.3
UA	49	C	2016/12/07	pH (field)	SU	7.1
UA	49	C	2017/02/21	pH (field)	SU	7.2
UA	49	C	2017/04/25	pH (field)	SU	7.0
UA	49	C	2017/06/08	pH (field)	SU	7.0
UA	49	C	2017/11/16	pH (field)	SU	7.2
UA	49	C	2018/06/13	pH (field)	SU	6.9
UA	49	C	2018/09/12	pH (field)	SU	7.1
UA	49	C	2018/12/12	pH (field)	SU	7.1
UA	49	C	2019/03/13	pH (field)	SU	7.3
UA	49	C	2019/06/19	pH (field)	SU	7.1
UA	49	C	2019/09/18	pH (field)	SU	7.1
UA	49	C	2019/12/11	pH (field)	SU	7.2
UA	49	C	2020/03/11	pH (field)	SU	7.1
UA	49	C	2020/06/03	pH (field)	SU	7.2
UA	49	C	2020/06/25	pH (field)	SU	7.3
UA	49	C	2020/09/02	pH (field)	SU	7.2
UA	49	C	2020/12/09	pH (field)	SU	7.2
UA	49	C	2021/03/19	pH (field)	SU	7.2
UA	49	C	2021/06/23	pH (field)	SU	6.9
UA	49	C	2021/09/08	pH (field)	SU	7.0
UA	49	C	2021/12/08	pH (field)	SU	6.9
UA	49	C	2022/03/22	pH (field)	SU	7.1

UA	49	C	2022/06/07	pH (field)	SU	7.1
UA	49	C	2022/09/13	pH (field)	SU	7.0
UA	49	C	2022/12/27	pH (field)	SU	7.0
UA	49	C	2023/02/28	pH (field)	SU	7.0
UA	49	C	2023/05/31	pH (field)	SU	7.0
UA	49	C	2023/08/25	pH (field)	SU	7.1
UA	49	C	2023/11/15	pH (field)	SU	7.2
UA	49	C	2015/12/10	Oxidation Reduction Potential	mV	-2.00
UA	49	C	2016/03/09	Oxidation Reduction Potential	mV	8.00
UA	49	C	2016/06/07	Oxidation Reduction Potential	mV	65.0
UA	49	C	2016/09/15	Oxidation Reduction Potential	mV	36.0
UA	49	C	2016/12/07	Oxidation Reduction Potential	mV	119
UA	49	C	2017/02/21	Oxidation Reduction Potential	mV	120
UA	49	C	2017/04/25	Oxidation Reduction Potential	mV	37.0
UA	49	C	2017/06/08	Oxidation Reduction Potential	mV	68.0
UA	49	C	2017/11/16	Oxidation Reduction Potential	mV	190
UA	49	C	2018/06/13	Oxidation Reduction Potential	mV	64.0
UA	49	C	2018/09/12	Oxidation Reduction Potential	mV	158
UA	49	C	2018/12/12	Oxidation Reduction Potential	mV	-23.0
UA	49	C	2019/03/13	Oxidation Reduction Potential	mV	13.0
UA	49	C	2019/06/19	Oxidation Reduction Potential	mV	50.0
UA	49	C	2019/09/18	Oxidation Reduction Potential	mV	118
UA	49	C	2019/12/11	Oxidation Reduction Potential	mV	86.0
UA	49	C	2020/03/11	Oxidation Reduction Potential	mV	128
UA	49	C	2020/06/03	Oxidation Reduction Potential	mV	-12.0
UA	49	C	2020/06/25	Oxidation Reduction Potential	mV	152
UA	49	C	2020/09/02	Oxidation Reduction Potential	mV	35.0
UA	49	C	2020/12/09	Oxidation Reduction Potential	mV	24.0
UA	49	C	2021/03/19	Oxidation Reduction Potential	mV	78.0
UA	49	C	2021/06/23	Oxidation Reduction Potential	mV	8.00
UA	49	C	2021/09/08	Oxidation Reduction Potential	mV	20.0
UA	49	C	2021/12/08	Oxidation Reduction Potential	mV	83.0
UA	49	C	2022/03/22	Oxidation Reduction Potential	mV	-50.0
UA	49	C	2022/06/07	Oxidation Reduction Potential	mV	35.0
UA	49	C	2022/09/13	Oxidation Reduction Potential	mV	43.0
UA	49	C	2022/12/27	Oxidation Reduction Potential	mV	-55.0
UA	49	C	2023/02/28	Oxidation Reduction Potential	mV	33.4
UA	49	C	2023/05/31	Oxidation Reduction Potential	mV	-19.0
UA	49	C	2023/08/25	Oxidation Reduction Potential	mV	58.2
UA	49	C	2023/11/15	Oxidation Reduction Potential	mV	11.1
UA	49	C	2015/12/10	Eh	V	0.20
UA	49	C	2016/03/09	Eh	V	0.21
UA	49	C	2016/06/07	Eh	V	0.26
UA	49	C	2016/09/15	Eh	V	0.23
UA	49	C	2016/12/07	Eh	V	0.32
UA	49	C	2017/02/21	Eh	V	0.32
UA	49	C	2017/04/25	Eh	V	0.23
UA	49	C	2017/06/08	Eh	V	0.26
UA	49	C	2017/11/16	Eh	V	0.39
UA	49	C	2018/06/13	Eh	V	0.26
UA	49	C	2018/09/12	Eh	V	0.35
UA	49	C	2018/12/12	Eh	V	0.17
UA	49	C	2019/03/13	Eh	V	0.21
UA	49	C	2019/06/19	Eh	V	0.25
UA	49	C	2019/09/18	Eh	V	0.31
UA	49	C	2019/12/11	Eh	V	0.28
UA	49	C	2020/03/11	Eh	V	0.33
UA	49	C	2020/06/03	Eh	V	0.18
UA	49	C	2020/06/25	Eh	V	0.35
UA	49	C	2020/09/02	Eh	V	0.23
UA	49	C	2020/12/09	Eh	V	0.22
UA	49	C	2021/03/19	Eh	V	0.27

UA	49	C	2021/06/23	Eh	V	0.20
UA	49	C	2021/09/08	Eh	V	0.22
UA	49	C	2021/12/08	Eh	V	0.28
UA	49	C	2022/03/22	Eh	V	0.15
UA	49	C	2022/06/07	Eh	V	0.23
UA	49	C	2022/09/13	Eh	V	0.24
UA	49	C	2022/12/27	Eh	V	0.14
UA	49	C	2023/02/28	Eh	V	0.23
UA	49	C	2023/05/31	Eh	V	0.18
UA	49	C	2023/08/25	Eh	V	0.25
UA	49	C	2023/11/15	Eh	V	0.21
UA	49	C	2019/09/18	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	49	C	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	346
UA	49	C	2021/03/19	Alkalinity, bicarbonate	mg/L CaCO3	326
UA	49	C	2021/09/08	Alkalinity, bicarbonate	mg/L CaCO3	332
UA	49	C	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	322
UA	49	C	2022/09/13	Alkalinity, bicarbonate	mg/L CaCO3	342
UA	49	C	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	347
UA	49	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	339
UA	49	C	2023/08/25	Alkalinity, bicarbonate	mg/L CaCO3	330
UA	49	C	2023/11/15	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	49	C	2015/12/10	Arsenic, total	mg/L	<0.0002
UA	49	C	2016/03/09	Arsenic, total	mg/L	<0.0002
UA	49	C	2016/06/07	Arsenic, total	mg/L	<0.0002
UA	49	C	2016/09/15	Arsenic, total	mg/L	<0.0002
UA	49	C	2016/12/07	Arsenic, total	mg/L	<0.0002
UA	49	C	2017/02/21	Arsenic, total	mg/L	<0.0002
UA	49	C	2017/04/25	Arsenic, total	mg/L	<0.0002
UA	49	C	2017/06/08	Arsenic, total	mg/L	<0.0002
UA	49	C	2018/06/13	Arsenic, total	mg/L	<0.0004
UA	49	C	2018/09/12	Arsenic, total	mg/L	<0.0004
UA	49	C	2018/12/12	Arsenic, total	mg/L	<0.0004
UA	49	C	2019/03/13	Arsenic, total	mg/L	0.00110
UA	49	C	2019/06/19	Arsenic, total	mg/L	<0.0004
UA	49	C	2019/09/18	Arsenic, total	mg/L	<0.0004
UA	49	C	2019/12/11	Arsenic, total	mg/L	<0.0004
UA	49	C	2020/03/11	Arsenic, total	mg/L	<0.0004
UA	49	C	2020/06/03	Arsenic, total	mg/L	<0.0004
UA	49	C	2020/09/02	Arsenic, total	mg/L	<0.0004
UA	49	C	2020/12/09	Arsenic, total	mg/L	<0.0004
UA	49	C	2021/03/19	Arsenic, total	mg/L	<0.0004
UA	49	C	2021/06/23	Arsenic, total	mg/L	<0.0004
UA	49	C	2021/09/08	Arsenic, total	mg/L	<0.0004
UA	49	C	2021/12/08	Arsenic, total	mg/L	<0.0004
UA	49	C	2022/03/22	Arsenic, total	mg/L	<0.0004
UA	49	C	2022/06/07	Arsenic, total	mg/L	<0.0004
UA	49	C	2022/09/13	Arsenic, total	mg/L	<0.0004
UA	49	C	2022/12/27	Arsenic, total	mg/L	<0.0004
UA	49	C	2023/02/28	Arsenic, total	mg/L	0.000600
UA	49	C	2023/05/31	Arsenic, total	mg/L	<0.0087
UA	49	C	2023/08/25	Arsenic, total	mg/L	0.000490
UA	49	C	2023/11/15	Arsenic, total	mg/L	0.000280
UA	49	C	2015/12/10	Barium, total	mg/L	0.0537
UA	49	C	2016/03/09	Barium, total	mg/L	0.0546
UA	49	C	2016/06/07	Barium, total	mg/L	0.0500
UA	49	C	2016/09/15	Barium, total	mg/L	0.0509
UA	49	C	2016/12/07	Barium, total	mg/L	0.0534
UA	49	C	2017/02/21	Barium, total	mg/L	0.0512
UA	49	C	2017/04/25	Barium, total	mg/L	0.0479
UA	49	C	2017/06/08	Barium, total	mg/L	0.0497
UA	49	C	2018/06/13	Barium, total	mg/L	0.0510
UA	49	C	2018/09/12	Barium, total	mg/L	0.0623

UA	49	C	2018/12/12	Barium, total	mg/L	0.0660
UA	49	C	2019/03/13	Barium, total	mg/L	0.0558
UA	49	C	2019/06/19	Barium, total	mg/L	0.0564
UA	49	C	2019/09/18	Barium, total	mg/L	0.0538
UA	49	C	2019/12/11	Barium, total	mg/L	0.0677
UA	49	C	2020/03/11	Barium, total	mg/L	0.0575
UA	49	C	2020/06/03	Barium, total	mg/L	0.0584
UA	49	C	2020/09/02	Barium, total	mg/L	0.0595
UA	49	C	2020/12/09	Barium, total	mg/L	0.0713
UA	49	C	2021/03/19	Barium, total	mg/L	0.0588
UA	49	C	2021/06/23	Barium, total	mg/L	0.0600
UA	49	C	2021/09/08	Barium, total	mg/L	0.0596
UA	49	C	2021/12/08	Barium, total	mg/L	0.0639
UA	49	C	2022/03/22	Barium, total	mg/L	0.0638
UA	49	C	2022/06/07	Barium, total	mg/L	0.0576
UA	49	C	2022/09/13	Barium, total	mg/L	0.0576
UA	49	C	2022/12/27	Barium, total	mg/L	0.0617
UA	49	C	2023/02/28	Barium, total	mg/L	0.0827
UA	49	C	2023/05/31	Barium, total	mg/L	0.0711
UA	49	C	2023/08/25	Barium, total	mg/L	0.0620
UA	49	C	2023/11/15	Barium, total	mg/L	0.0600
UA	49	C	2015/12/10	Boron, total	mg/L	1.64
UA	49	C	2016/03/09	Boron, total	mg/L	1.70
UA	49	C	2016/06/07	Boron, total	mg/L	1.50
UA	49	C	2016/09/15	Boron, total	mg/L	1.52
UA	49	C	2016/12/07	Boron, total	mg/L	1.42
UA	49	C	2017/02/21	Boron, total	mg/L	1.25
UA	49	C	2017/04/25	Boron, total	mg/L	1.21
UA	49	C	2017/06/08	Boron, total	mg/L	1.14
UA	49	C	2017/11/16	Boron, total	mg/L	1.12
UA	49	C	2018/06/13	Boron, total	mg/L	1.19
UA	49	C	2018/09/12	Boron, total	mg/L	1.06
UA	49	C	2018/12/12	Boron, total	mg/L	0.960
UA	49	C	2019/03/13	Boron, total	mg/L	1.07
UA	49	C	2019/06/19	Boron, total	mg/L	0.961
UA	49	C	2019/09/18	Boron, total	mg/L	1.00
UA	49	C	2019/12/11	Boron, total	mg/L	0.966
UA	49	C	2020/03/11	Boron, total	mg/L	0.883
UA	49	C	2020/06/03	Boron, total	mg/L	0.829
UA	49	C	2020/09/02	Boron, total	mg/L	0.764
UA	49	C	2020/12/09	Boron, total	mg/L	0.771
UA	49	C	2021/03/19	Boron, total	mg/L	0.702
UA	49	C	2021/06/23	Boron, total	mg/L	0.806
UA	49	C	2021/09/08	Boron, total	mg/L	0.796
UA	49	C	2021/12/08	Boron, total	mg/L	0.844
UA	49	C	2022/03/22	Boron, total	mg/L	0.858
UA	49	C	2022/06/07	Boron, total	mg/L	0.680
UA	49	C	2022/09/13	Boron, total	mg/L	0.701
UA	49	C	2022/12/27	Boron, total	mg/L	0.689
UA	49	C	2023/02/28	Boron, total	mg/L	0.703
UA	49	C	2023/05/31	Boron, total	mg/L	0.758
UA	49	C	2023/08/25	Boron, total	mg/L	0.690
UA	49	C	2023/11/15	Boron, total	mg/L	0.890
UA	49	C	2015/12/10	Cadmium, total	mg/L	<0.0002
UA	49	C	2016/03/09	Cadmium, total	mg/L	<0.0002
UA	49	C	2016/06/07	Cadmium, total	mg/L	<0.0002
UA	49	C	2016/09/15	Cadmium, total	mg/L	<0.0002
UA	49	C	2016/12/07	Cadmium, total	mg/L	<0.0002
UA	49	C	2017/02/21	Cadmium, total	mg/L	<0.0002
UA	49	C	2017/04/25	Cadmium, total	mg/L	<0.0002
UA	49	C	2017/06/08	Cadmium, total	mg/L	<0.0002
UA	49	C	2018/06/13	Cadmium, total	mg/L	0.00110

UA	49	C	2018/09/12	Cadmium, total	mg/L	0.00130
UA	49	C	2018/12/12	Cadmium, total	mg/L	0.00160
UA	49	C	2019/03/13	Cadmium, total	mg/L	0.00140
UA	49	C	2019/06/19	Cadmium, total	mg/L	0.00130
UA	49	C	2019/09/18	Cadmium, total	mg/L	0.00150
UA	49	C	2019/12/11	Cadmium, total	mg/L	0.00180
UA	49	C	2020/03/11	Cadmium, total	mg/L	0.00150
UA	49	C	2020/06/03	Cadmium, total	mg/L	0.00170
UA	49	C	2020/09/02	Cadmium, total	mg/L	0.00170
UA	49	C	2020/12/09	Cadmium, total	mg/L	0.00230
UA	49	C	2021/03/19	Cadmium, total	mg/L	0.00160
UA	49	C	2021/06/23	Cadmium, total	mg/L	0.00170
UA	49	C	2021/09/08	Cadmium, total	mg/L	0.00160
UA	49	C	2021/12/08	Cadmium, total	mg/L	0.00180
UA	49	C	2022/03/22	Cadmium, total	mg/L	0.00160
UA	49	C	2022/06/07	Cadmium, total	mg/L	0.00140
UA	49	C	2022/09/13	Cadmium, total	mg/L	0.00120
UA	49	C	2022/12/27	Cadmium, total	mg/L	0.00140
UA	49	C	2023/02/28	Cadmium, total	mg/L	0.00250
UA	49	C	2023/05/31	Cadmium, total	mg/L	0.00110
UA	49	C	2023/08/25	Cadmium, total	mg/L	0.00130
UA	49	C	2023/11/15	Cadmium, total	mg/L	0.00120
UA	49	C	2015/12/10	Calcium, total	mg/L	133
UA	49	C	2016/03/09	Calcium, total	mg/L	144
UA	49	C	2016/06/07	Calcium, total	mg/L	134
UA	49	C	2016/09/15	Calcium, total	mg/L	130
UA	49	C	2016/12/07	Calcium, total	mg/L	131
UA	49	C	2017/02/21	Calcium, total	mg/L	133
UA	49	C	2017/04/25	Calcium, total	mg/L	113
UA	49	C	2017/06/08	Calcium, total	mg/L	126
UA	49	C	2017/11/16	Calcium, total	mg/L	134
UA	49	C	2018/06/13	Calcium, total	mg/L	125
UA	49	C	2018/09/12	Calcium, total	mg/L	139
UA	49	C	2018/12/12	Calcium, total	mg/L	151
UA	49	C	2019/03/13	Calcium, total	mg/L	123
UA	49	C	2019/06/19	Calcium, total	mg/L	120
UA	49	C	2019/09/18	Calcium, total	mg/L	121
UA	49	C	2019/12/11	Calcium, total	mg/L	118
UA	49	C	2020/03/11	Calcium, total	mg/L	117
UA	49	C	2020/06/03	Calcium, total	mg/L	122
UA	49	C	2020/09/02	Calcium, total	mg/L	113
UA	49	C	2020/12/09	Calcium, total	mg/L	140
UA	49	C	2021/03/19	Calcium, total	mg/L	117
UA	49	C	2021/06/23	Calcium, total	mg/L	118
UA	49	C	2021/09/08	Calcium, total	mg/L	113
UA	49	C	2021/12/08	Calcium, total	mg/L	110
UA	49	C	2022/03/22	Calcium, total	mg/L	114
UA	49	C	2022/06/07	Calcium, total	mg/L	113
UA	49	C	2022/09/13	Calcium, total	mg/L	113
UA	49	C	2022/12/27	Calcium, total	mg/L	116
UA	49	C	2023/02/28	Calcium, total	mg/L	127
UA	49	C	2023/05/31	Calcium, total	mg/L	115
UA	49	C	2023/08/25	Calcium, total	mg/L	99.0
UA	49	C	2023/11/15	Calcium, total	mg/L	100
UA	49	C	2015/12/10	Chloride, total	mg/L	73.0
UA	49	C	2016/03/09	Chloride, total	mg/L	96.0
UA	49	C	2016/06/07	Chloride, total	mg/L	98.0
UA	49	C	2016/09/15	Chloride, total	mg/L	91.0
UA	49	C	2016/12/07	Chloride, total	mg/L	105
UA	49	C	2017/02/21	Chloride, total	mg/L	103
UA	49	C	2017/04/25	Chloride, total	mg/L	111
UA	49	C	2017/06/08	Chloride, total	mg/L	110

UA	49	C	2017/11/16	Chloride, total	mg/L	100
UA	49	C	2018/06/13	Chloride, total	mg/L	106
UA	49	C	2018/09/12	Chloride, total	mg/L	114
UA	49	C	2018/12/12	Chloride, total	mg/L	105
UA	49	C	2019/03/13	Chloride, total	mg/L	104
UA	49	C	2019/06/19	Chloride, total	mg/L	100
UA	49	C	2019/09/18	Chloride, total	mg/L	97.0
UA	49	C	2019/12/11	Chloride, total	mg/L	100
UA	49	C	2020/03/11	Chloride, total	mg/L	97.0
UA	49	C	2020/06/03	Chloride, total	mg/L	108
UA	49	C	2020/09/02	Chloride, total	mg/L	115
UA	49	C	2020/12/09	Chloride, total	mg/L	101
UA	49	C	2021/03/19	Chloride, total	mg/L	94.0
UA	49	C	2021/06/23	Chloride, total	mg/L	102
UA	49	C	2021/09/08	Chloride, total	mg/L	100
UA	49	C	2021/12/08	Chloride, total	mg/L	106
UA	49	C	2022/03/22	Chloride, total	mg/L	103
UA	49	C	2022/06/07	Chloride, total	mg/L	108
UA	49	C	2022/09/13	Chloride, total	mg/L	103
UA	49	C	2022/12/27	Chloride, total	mg/L	110
UA	49	C	2023/02/28	Chloride, total	mg/L	104
UA	49	C	2023/05/31	Chloride, total	mg/L	102
UA	49	C	2023/08/25	Chloride, total	mg/L	95.0
UA	49	C	2023/11/15	Chloride, total	mg/L	95.0
UA	49	C	2023/05/31	Iron, dissolved	mg/L	<0.02
UA	49	C	2023/08/25	Iron, dissolved	mg/L	<0.047
UA	49	C	2015/12/10	Lithium, total	mg/L	0.0243
UA	49	C	2016/03/09	Lithium, total	mg/L	0.0257
UA	49	C	2016/06/07	Lithium, total	mg/L	0.0233
UA	49	C	2016/09/15	Lithium, total	mg/L	0.0270
UA	49	C	2016/12/07	Lithium, total	mg/L	0.0256
UA	49	C	2017/02/21	Lithium, total	mg/L	0.0238
UA	49	C	2017/04/25	Lithium, total	mg/L	0.0279
UA	49	C	2017/06/08	Lithium, total	mg/L	0.0236
UA	49	C	2018/06/13	Lithium, total	mg/L	0.0273
UA	49	C	2018/09/12	Lithium, total	mg/L	0.0260
UA	49	C	2018/12/12	Lithium, total	mg/L	0.0245
UA	49	C	2019/03/13	Lithium, total	mg/L	0.0297
UA	49	C	2019/06/19	Lithium, total	mg/L	0.0263
UA	49	C	2019/09/18	Lithium, total	mg/L	0.0268
UA	49	C	2019/12/11	Lithium, total	mg/L	0.0272
UA	49	C	2020/03/11	Lithium, total	mg/L	0.0262
UA	49	C	2020/06/03	Lithium, total	mg/L	0.0263
UA	49	C	2020/09/02	Lithium, total	mg/L	0.0229
UA	49	C	2020/12/09	Lithium, total	mg/L	0.0231
UA	49	C	2021/03/19	Lithium, total	mg/L	0.0254
UA	49	C	2021/06/23	Lithium, total	mg/L	0.0245
UA	49	C	2021/09/08	Lithium, total	mg/L	0.0229
UA	49	C	2021/12/08	Lithium, total	mg/L	0.0250
UA	49	C	2022/03/22	Lithium, total	mg/L	0.0274
UA	49	C	2022/06/07	Lithium, total	mg/L	0.0218
UA	49	C	2022/09/13	Lithium, total	mg/L	0.0245
UA	49	C	2022/12/27	Lithium, total	mg/L	0.0249
UA	49	C	2023/02/28	Lithium, total	mg/L	0.0207
UA	49	C	2023/05/31	Lithium, total	mg/L	0.0202
UA	49	C	2023/08/25	Lithium, total	mg/L	0.0230
UA	49	C	2023/11/15	Lithium, total	mg/L	0.0240
UA	49	C	2019/09/18	Magnesium, total	mg/L	33.9
UA	49	C	2020/03/11	Magnesium, total	mg/L	36.2
UA	49	C	2020/06/03	Magnesium, total	mg/L	34.7
UA	49	C	2021/03/19	Magnesium, total	mg/L	35.1
UA	49	C	2021/09/08	Magnesium, total	mg/L	33.6

UA	49	C	2022/03/22	Magnesium, total	mg/L	33.5
UA	49	C	2022/09/13	Magnesium, total	mg/L	34.9
UA	49	C	2023/02/28	Magnesium, total	mg/L	36.3
UA	49	C	2023/05/31	Magnesium, total	mg/L	35.9
UA	49	C	2023/08/25	Magnesium, total	mg/L	32.0
UA	49	C	2023/11/15	Magnesium, total	mg/L	34.0
UA	49	C	2023/05/31	Manganese, dissolved	mg/L	0.00450
UA	49	C	2023/08/25	Manganese, dissolved	mg/L	0.00440
UA	49	C	2023/05/31	Phosphate, dissolved	mg/L	0.0340
UA	49	C	2023/08/25	Phosphate, dissolved	mg/L	0.170
UA	49	C	2019/09/18	Potassium, total	mg/L	11.9
UA	49	C	2020/03/11	Potassium, total	mg/L	13.1
UA	49	C	2020/06/03	Potassium, total	mg/L	12.8
UA	49	C	2021/03/19	Potassium, total	mg/L	15.4
UA	49	C	2021/09/08	Potassium, total	mg/L	12.3
UA	49	C	2022/03/22	Potassium, total	mg/L	13.0
UA	49	C	2022/09/13	Potassium, total	mg/L	12.7
UA	49	C	2023/02/28	Potassium, total	mg/L	14.7
UA	49	C	2023/05/31	Potassium, total	mg/L	12.3
UA	49	C	2023/08/25	Potassium, total	mg/L	11.0
UA	49	C	2023/11/15	Potassium, total	mg/L	11.0
UA	49	C	2023/05/31	Silicon, dissolved	mg/L	7.59
UA	49	C	2023/08/25	Silicon, dissolved	mg/L	9.30
UA	49	C	2019/09/18	Sodium, total	mg/L	60.2
UA	49	C	2020/03/11	Sodium, total	mg/L	65.6
UA	49	C	2020/06/03	Sodium, total	mg/L	64.0
UA	49	C	2021/03/19	Sodium, total	mg/L	65.0
UA	49	C	2021/09/08	Sodium, total	mg/L	60.2
UA	49	C	2022/03/22	Sodium, total	mg/L	60.1
UA	49	C	2022/09/13	Sodium, total	mg/L	60.8
UA	49	C	2023/02/28	Sodium, total	mg/L	62.8
UA	49	C	2023/05/31	Sodium, total	mg/L	57.9
UA	49	C	2023/08/25	Sodium, total	mg/L	56.0
UA	49	C	2023/11/15	Sodium, total	mg/L	56.0
UA	49	C	2015/12/10	Sulfate, total	mg/L	114
UA	49	C	2016/03/09	Sulfate, total	mg/L	107
UA	49	C	2016/06/07	Sulfate, total	mg/L	109
UA	49	C	2016/09/15	Sulfate, total	mg/L	105
UA	49	C	2016/12/07	Sulfate, total	mg/L	101
UA	49	C	2017/02/21	Sulfate, total	mg/L	96.0
UA	49	C	2017/04/25	Sulfate, total	mg/L	105
UA	49	C	2017/06/08	Sulfate, total	mg/L	104
UA	49	C	2017/11/16	Sulfate, total	mg/L	89.0
UA	49	C	2018/06/13	Sulfate, total	mg/L	97.0
UA	49	C	2018/09/12	Sulfate, total	mg/L	100
UA	49	C	2018/12/12	Sulfate, total	mg/L	84.0
UA	49	C	2019/03/13	Sulfate, total	mg/L	82.0
UA	49	C	2019/06/19	Sulfate, total	mg/L	88.0
UA	49	C	2019/09/18	Sulfate, total	mg/L	71.0
UA	49	C	2019/12/11	Sulfate, total	mg/L	79.0
UA	49	C	2020/03/11	Sulfate, total	mg/L	75.0
UA	49	C	2020/06/03	Sulfate, total	mg/L	85.0
UA	49	C	2020/09/02	Sulfate, total	mg/L	81.0
UA	49	C	2020/12/09	Sulfate, total	mg/L	96.0
UA	49	C	2021/03/19	Sulfate, total	mg/L	84.0
UA	49	C	2021/06/23	Sulfate, total	mg/L	83.0
UA	49	C	2021/09/08	Sulfate, total	mg/L	79.0
UA	49	C	2021/12/08	Sulfate, total	mg/L	95.0
UA	49	C	2022/03/22	Sulfate, total	mg/L	82.0
UA	49	C	2022/06/07	Sulfate, total	mg/L	83.0
UA	49	C	2022/09/13	Sulfate, total	mg/L	75.0
UA	49	C	2022/12/27	Sulfate, total	mg/L	84.0

UA	49	C	2023/02/28	Sulfate, total	mg/L	108
UA	49	C	2023/05/31	Sulfate, total	mg/L	84.0
UA	49	C	2023/08/25	Sulfate, total	mg/L	78.0
UA	49	C	2023/11/15	Sulfate, total	mg/L	77.0
UA	49	C	2015/12/10	Temperature (Celsius)	degrees C	12.8
UA	49	C	2016/03/09	Temperature (Celsius)	degrees C	11.6
UA	49	C	2016/06/07	Temperature (Celsius)	degrees C	12.0
UA	49	C	2016/09/15	Temperature (Celsius)	degrees C	13.4
UA	49	C	2016/12/07	Temperature (Celsius)	degrees C	9.41
UA	49	C	2017/02/21	Temperature (Celsius)	degrees C	13.2
UA	49	C	2017/04/25	Temperature (Celsius)	degrees C	20.2
UA	49	C	2017/06/08	Temperature (Celsius)	degrees C	20.1
UA	49	C	2017/11/16	Temperature (Celsius)	degrees C	12
UA	49	C	2018/06/13	Temperature (Celsius)	degrees C	14.3
UA	49	C	2018/09/12	Temperature (Celsius)	degrees C	13.4
UA	49	C	2018/12/12	Temperature (Celsius)	degrees C	12.0
UA	49	C	2019/03/13	Temperature (Celsius)	degrees C	12.6
UA	49	C	2019/06/19	Temperature (Celsius)	degrees C	13.0
UA	49	C	2019/09/18	Temperature (Celsius)	degrees C	13.3
UA	49	C	2019/12/11	Temperature (Celsius)	degrees C	12.5
UA	49	C	2020/03/11	Temperature (Celsius)	degrees C	12.5
UA	49	C	2020/06/03	Temperature (Celsius)	degrees C	13.7
UA	49	C	2020/06/25	Temperature (Celsius)	degrees C	13.8
UA	49	C	2020/09/02	Temperature (Celsius)	degrees C	14.1
UA	49	C	2020/12/09	Temperature (Celsius)	degrees C	13.4
UA	49	C	2021/03/19	Temperature (Celsius)	degrees C	13.5
UA	49	C	2021/06/23	Temperature (Celsius)	degrees C	14.0
UA	49	C	2021/09/08	Temperature (Celsius)	degrees C	14.4
UA	49	C	2021/12/08	Temperature (Celsius)	degrees C	13.6
UA	49	C	2022/03/22	Temperature (Celsius)	degrees C	14.1
UA	49	C	2022/06/07	Temperature (Celsius)	degrees C	14.5
UA	49	C	2022/09/13	Temperature (Celsius)	degrees C	14.5
UA	49	C	2022/12/27	Temperature (Celsius)	degrees C	13.7
UA	49	C	2023/02/28	Temperature (Celsius)	degrees C	13.9
UA	49	C	2023/05/31	Temperature (Celsius)	degrees C	14.9
UA	49	C	2023/08/25	Temperature (Celsius)	degrees C	15.3
UA	49	C	2023/11/15	Temperature (Celsius)	degrees C	14.9
UA	49	C	2015/12/10	Total Dissolved Solids	mg/L	662
UA	49	C	2016/03/09	Total Dissolved Solids	mg/L	640
UA	49	C	2016/06/07	Total Dissolved Solids	mg/L	684
UA	49	C	2016/09/15	Total Dissolved Solids	mg/L	706
UA	49	C	2016/12/07	Total Dissolved Solids	mg/L	676
UA	49	C	2017/02/21	Total Dissolved Solids	mg/L	630
UA	49	C	2017/04/25	Total Dissolved Solids	mg/L	678
UA	49	C	2017/06/08	Total Dissolved Solids	mg/L	662
UA	49	C	2017/11/16	Total Dissolved Solids	mg/L	686
UA	49	C	2018/06/13	Total Dissolved Solids	mg/L	692
UA	49	C	2018/09/12	Total Dissolved Solids	mg/L	710
UA	49	C	2018/12/12	Total Dissolved Solids	mg/L	670
UA	49	C	2019/03/13	Total Dissolved Solids	mg/L	656
UA	49	C	2019/06/19	Total Dissolved Solids	mg/L	642
UA	49	C	2019/09/18	Total Dissolved Solids	mg/L	654
UA	49	C	2019/12/11	Total Dissolved Solids	mg/L	612
UA	49	C	2020/03/11	Total Dissolved Solids	mg/L	630
UA	49	C	2020/06/03	Total Dissolved Solids	mg/L	606
UA	49	C	2020/09/02	Total Dissolved Solids	mg/L	604
UA	49	C	2020/12/09	Total Dissolved Solids	mg/L	602
UA	49	C	2021/03/19	Total Dissolved Solids	mg/L	600
UA	49	C	2021/06/23	Total Dissolved Solids	mg/L	628
UA	49	C	2021/09/08	Total Dissolved Solids	mg/L	596
UA	49	C	2021/12/08	Total Dissolved Solids	mg/L	566
UA	49	C	2022/03/22	Total Dissolved Solids	mg/L	594

UA	49	C	2022/06/07	Total Dissolved Solids	mg/L	658
UA	49	C	2022/09/13	Total Dissolved Solids	mg/L	658
UA	49	C	2022/12/27	Total Dissolved Solids	mg/L	620
UA	49	C	2023/02/28	Total Dissolved Solids	mg/L	618
UA	49	C	2023/05/31	Total Dissolved Solids	mg/L	602
UA	49	C	2023/08/25	Total Dissolved Solids	mg/L	620
UA	49	C	2023/11/15	Total Dissolved Solids	mg/L	580
UA	50	C	2019/09/17	pH (field)	SU	6.9
UA	50	C	2019/12/11	pH (field)	SU	7.2
UA	50	C	2020/03/11	pH (field)	SU	7.3
UA	50	C	2020/06/03	pH (field)	SU	7.3
UA	50	C	2020/06/25	pH (field)	SU	7.3
UA	50	C	2020/09/02	pH (field)	SU	7.2
UA	50	C	2020/12/09	pH (field)	SU	7.3
UA	50	C	2021/03/19	pH (field)	SU	7.4
UA	50	C	2021/06/23	pH (field)	SU	7.1
UA	50	C	2021/09/08	pH (field)	SU	7.0
UA	50	C	2021/12/08	pH (field)	SU	7.3
UA	50	C	2022/03/22	pH (field)	SU	7.4
UA	50	C	2022/06/07	pH (field)	SU	7.3
UA	50	C	2022/09/13	pH (field)	SU	7.3
UA	50	C	2022/12/27	pH (field)	SU	7.4
UA	50	C	2023/02/28	pH (field)	SU	7.4
UA	50	C	2023/05/31	pH (field)	SU	7.3
UA	50	C	2023/08/25	pH (field)	SU	7.5
UA	50	C	2023/11/14	pH (field)	SU	7.5
UA	50	C	2019/09/17	Oxidation Reduction Potential	mV	153
UA	50	C	2019/12/11	Oxidation Reduction Potential	mV	43.0
UA	50	C	2020/03/11	Oxidation Reduction Potential	mV	49.0
UA	50	C	2020/06/03	Oxidation Reduction Potential	mV	108
UA	50	C	2020/06/25	Oxidation Reduction Potential	mV	120
UA	50	C	2020/09/02	Oxidation Reduction Potential	mV	117
UA	50	C	2020/12/09	Oxidation Reduction Potential	mV	56.0
UA	50	C	2021/03/19	Oxidation Reduction Potential	mV	200
UA	50	C	2021/06/23	Oxidation Reduction Potential	mV	137
UA	50	C	2021/09/08	Oxidation Reduction Potential	mV	64.0
UA	50	C	2021/12/08	Oxidation Reduction Potential	mV	-65.0
UA	50	C	2022/03/22	Oxidation Reduction Potential	mV	-71.0
UA	50	C	2022/06/07	Oxidation Reduction Potential	mV	47.0
UA	50	C	2022/09/13	Oxidation Reduction Potential	mV	55.0
UA	50	C	2022/12/27	Oxidation Reduction Potential	mV	-67.0
UA	50	C	2023/02/28	Oxidation Reduction Potential	mV	24.1
UA	50	C	2023/05/31	Oxidation Reduction Potential	mV	34.0
UA	50	C	2023/08/25	Oxidation Reduction Potential	mV	88.0
UA	50	C	2023/11/14	Oxidation Reduction Potential	mV	206
UA	50	C	2019/09/17	Eh	V	0.35
UA	50	C	2019/12/11	Eh	V	0.24
UA	50	C	2020/03/11	Eh	V	0.24
UA	50	C	2020/06/03	Eh	V	0.30
UA	50	C	2020/06/25	Eh	V	0.31
UA	50	C	2020/09/02	Eh	V	0.31
UA	50	C	2020/12/09	Eh	V	0.25
UA	50	C	2021/03/19	Eh	V	0.40
UA	50	C	2021/06/23	Eh	V	0.33
UA	50	C	2021/09/08	Eh	V	0.26
UA	50	C	2021/12/08	Eh	V	0.13
UA	50	C	2022/03/22	Eh	V	0.12
UA	50	C	2022/06/07	Eh	V	0.24
UA	50	C	2022/09/13	Eh	V	0.25
UA	50	C	2022/12/27	Eh	V	0.13
UA	50	C	2023/02/28	Eh	V	0.22
UA	50	C	2023/05/31	Eh	V	0.23

UA	50	C	2023/08/25	Eh	V	0.28
UA	50	C	2023/11/14	Eh	V	0.40
UA	50	C	2019/09/17	Alkalinity, bicarbonate	mg/L CaCO3	356
UA	50	C	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	370
UA	50	C	2021/03/19	Alkalinity, bicarbonate	mg/L CaCO3	270
UA	50	C	2021/09/08	Alkalinity, bicarbonate	mg/L CaCO3	335
UA	50	C	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	281
UA	50	C	2022/09/13	Alkalinity, bicarbonate	mg/L CaCO3	326
UA	50	C	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	251
UA	50	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	324
UA	50	C	2023/08/25	Alkalinity, bicarbonate	mg/L CaCO3	280
UA	50	C	2023/11/14	Alkalinity, bicarbonate	mg/L CaCO3	290
UA	50	C	2019/09/17	Arsenic, total	mg/L	<0.0004
UA	50	C	2019/12/11	Arsenic, total	mg/L	<0.0004
UA	50	C	2020/03/11	Arsenic, total	mg/L	<0.0004
UA	50	C	2020/06/03	Arsenic, total	mg/L	<0.0004
UA	50	C	2020/09/02	Arsenic, total	mg/L	<0.0004
UA	50	C	2020/12/09	Arsenic, total	mg/L	<0.0004
UA	50	C	2021/03/19	Arsenic, total	mg/L	<0.0004
UA	50	C	2021/06/23	Arsenic, total	mg/L	<0.0004
UA	50	C	2021/09/08	Arsenic, total	mg/L	<0.0004
UA	50	C	2021/12/08	Arsenic, total	mg/L	<0.0004
UA	50	C	2022/03/22	Arsenic, total	mg/L	<0.0004
UA	50	C	2022/09/13	Arsenic, total	mg/L	0.000800
UA	50	C	2023/02/28	Arsenic, total	mg/L	0.00100
UA	50	C	2023/05/31	Arsenic, total	mg/L	<0.0087
UA	50	C	2023/08/25	Arsenic, total	mg/L	<0.00023
UA	50	C	2023/11/14	Arsenic, total	mg/L	0.000760
UA	50	C	2019/09/17	Barium, total	mg/L	0.0969
UA	50	C	2019/12/11	Barium, total	mg/L	0.112
UA	50	C	2020/03/11	Barium, total	mg/L	0.0983
UA	50	C	2020/06/03	Barium, total	mg/L	0.0980
UA	50	C	2020/09/02	Barium, total	mg/L	0.0954
UA	50	C	2020/12/09	Barium, total	mg/L	0.0821
UA	50	C	2021/03/19	Barium, total	mg/L	0.0862
UA	50	C	2021/06/23	Barium, total	mg/L	0.0901
UA	50	C	2021/09/08	Barium, total	mg/L	0.0977
UA	50	C	2021/12/08	Barium, total	mg/L	0.0912
UA	50	C	2022/03/22	Barium, total	mg/L	0.0925
UA	50	C	2022/09/13	Barium, total	mg/L	0.105
UA	50	C	2023/02/28	Barium, total	mg/L	0.103
UA	50	C	2023/05/31	Barium, total	mg/L	0.0888
UA	50	C	2023/08/25	Barium, total	mg/L	0.0640
UA	50	C	2023/11/14	Barium, total	mg/L	0.0870
UA	50	C	2019/09/17	Boron, total	mg/L	0.815
UA	50	C	2019/12/11	Boron, total	mg/L	0.820
UA	50	C	2020/03/11	Boron, total	mg/L	0.732
UA	50	C	2020/06/03	Boron, total	mg/L	0.816
UA	50	C	2020/09/02	Boron, total	mg/L	0.681
UA	50	C	2020/12/09	Boron, total	mg/L	0.777
UA	50	C	2021/03/19	Boron, total	mg/L	0.862
UA	50	C	2021/06/23	Boron, total	mg/L	0.790
UA	50	C	2021/09/08	Boron, total	mg/L	0.696
UA	50	C	2021/12/08	Boron, total	mg/L	0.690
UA	50	C	2022/03/22	Boron, total	mg/L	1.24
UA	50	C	2022/09/13	Boron, total	mg/L	0.618
UA	50	C	2023/02/28	Boron, total	mg/L	1.43
UA	50	C	2023/05/31	Boron, total	mg/L	0.784
UA	50	C	2023/08/25	Boron, total	mg/L	0.590
UA	50	C	2023/11/14	Boron, total	mg/L	1.00
UA	50	C	2019/09/17	Cadmium, total	mg/L	0.00120
UA	50	C	2019/12/11	Cadmium, total	mg/L	0.00140

UA	50	C	2020/03/11	Cadmium, total	mg/L	0.00140
UA	50	C	2020/06/03	Cadmium, total	mg/L	0.00140
UA	50	C	2020/09/02	Cadmium, total	mg/L	0.00130
UA	50	C	2020/12/09	Cadmium, total	mg/L	0.00150
UA	50	C	2021/03/19	Cadmium, total	mg/L	0.00140
UA	50	C	2021/06/23	Cadmium, total	mg/L	0.00110
UA	50	C	2021/09/08	Cadmium, total	mg/L	0.00150
UA	50	C	2021/12/08	Cadmium, total	mg/L	0.00130
UA	50	C	2022/03/22	Cadmium, total	mg/L	0.00100
UA	50	C	2022/09/13	Cadmium, total	mg/L	0.00140
UA	50	C	2023/02/28	Cadmium, total	mg/L	0.00370
UA	50	C	2023/05/31	Cadmium, total	mg/L	<0.0005
UA	50	C	2023/08/25	Cadmium, total	mg/L	0.00140
UA	50	C	2023/11/14	Cadmium, total	mg/L	0.00150
UA	50	C	2019/09/17	Calcium, total	mg/L	128
UA	50	C	2019/12/11	Calcium, total	mg/L	128
UA	50	C	2020/03/11	Calcium, total	mg/L	125
UA	50	C	2020/06/03	Calcium, total	mg/L	124
UA	50	C	2020/09/02	Calcium, total	mg/L	111
UA	50	C	2020/12/09	Calcium, total	mg/L	110
UA	50	C	2021/03/19	Calcium, total	mg/L	113
UA	50	C	2021/06/23	Calcium, total	mg/L	123
UA	50	C	2021/09/08	Calcium, total	mg/L	119
UA	50	C	2021/12/08	Calcium, total	mg/L	111
UA	50	C	2022/03/22	Calcium, total	mg/L	114
UA	50	C	2022/09/13	Calcium, total	mg/L	110
UA	50	C	2023/02/28	Calcium, total	mg/L	121
UA	50	C	2023/05/31	Calcium, total	mg/L	122
UA	50	C	2023/08/25	Calcium, total	mg/L	100
UA	50	C	2023/11/14	Calcium, total	mg/L	110
UA	50	C	2019/09/17	Chloride, total	mg/L	91.0
UA	50	C	2019/12/11	Chloride, total	mg/L	95.0
UA	50	C	2020/03/11	Chloride, total	mg/L	86.0
UA	50	C	2020/06/03	Chloride, total	mg/L	94.0
UA	50	C	2020/09/02	Chloride, total	mg/L	93.0
UA	50	C	2020/12/09	Chloride, total	mg/L	88.0
UA	50	C	2021/03/19	Chloride, total	mg/L	87.0
UA	50	C	2021/06/23	Chloride, total	mg/L	94.0
UA	50	C	2021/09/08	Chloride, total	mg/L	95.0
UA	50	C	2021/12/08	Chloride, total	mg/L	97.0
UA	50	C	2022/03/22	Chloride, total	mg/L	102
UA	50	C	2022/09/13	Chloride, total	mg/L	96.0
UA	50	C	2023/02/28	Chloride, total	mg/L	101
UA	50	C	2023/05/31	Chloride, total	mg/L	90.0
UA	50	C	2023/08/25	Chloride, total	mg/L	87.0
UA	50	C	2023/11/14	Chloride, total	mg/L	83.0
UA	50	C	2023/05/31	Iron, dissolved	mg/L	<0.02
UA	50	C	2023/08/25	Iron, dissolved	mg/L	<0.047
UA	50	C	2019/09/17	Lithium, total	mg/L	0.0231
UA	50	C	2019/12/11	Lithium, total	mg/L	0.0239
UA	50	C	2020/03/11	Lithium, total	mg/L	0.0221
UA	50	C	2020/06/03	Lithium, total	mg/L	0.0229
UA	50	C	2020/09/02	Lithium, total	mg/L	0.0180
UA	50	C	2020/12/09	Lithium, total	mg/L	0.0232
UA	50	C	2021/03/19	Lithium, total	mg/L	0.0238
UA	50	C	2021/06/23	Lithium, total	mg/L	0.0245
UA	50	C	2021/09/08	Lithium, total	mg/L	0.0197
UA	50	C	2021/12/08	Lithium, total	mg/L	0.0206
UA	50	C	2022/03/22	Lithium, total	mg/L	0.0225
UA	50	C	2022/09/13	Lithium, total	mg/L	0.0201
UA	50	C	2023/02/28	Lithium, total	mg/L	0.0242
UA	50	C	2023/05/31	Lithium, total	mg/L	0.00710

UA	50	C	2023/08/25	Lithium, total	mg/L	0.0250
UA	50	C	2023/11/14	Lithium, total	mg/L	0.0300
UA	50	C	2019/09/17	Magnesium, total	mg/L	35.7
UA	50	C	2020/03/11	Magnesium, total	mg/L	37.4
UA	50	C	2020/06/03	Magnesium, total	mg/L	36.6
UA	50	C	2021/03/19	Magnesium, total	mg/L	30.2
UA	50	C	2021/09/08	Magnesium, total	mg/L	33.4
UA	50	C	2022/03/22	Magnesium, total	mg/L	29.4
UA	50	C	2022/09/13	Magnesium, total	mg/L	32.9
UA	50	C	2023/02/28	Magnesium, total	mg/L	27.4
UA	50	C	2023/05/31	Magnesium, total	mg/L	30.1
UA	50	C	2023/08/25	Magnesium, total	mg/L	31.0
UA	50	C	2023/11/14	Magnesium, total	mg/L	23.0
UA	50	C	2023/05/31	Manganese, dissolved	mg/L	0.176
UA	50	C	2023/08/25	Manganese, dissolved	mg/L	0.270
UA	50	C	2023/05/31	Phosphate, dissolved	mg/L	0.0310
UA	50	C	2023/08/25	Phosphate, dissolved	mg/L	0.180
UA	50	C	2019/09/17	Potassium, total	mg/L	9.07
UA	50	C	2020/03/11	Potassium, total	mg/L	8.72
UA	50	C	2020/06/03	Potassium, total	mg/L	8.02
UA	50	C	2021/03/19	Potassium, total	mg/L	9.71
UA	50	C	2021/09/08	Potassium, total	mg/L	9.69
UA	50	C	2022/03/22	Potassium, total	mg/L	9.08
UA	50	C	2022/09/13	Potassium, total	mg/L	9.32
UA	50	C	2023/02/28	Potassium, total	mg/L	9.20
UA	50	C	2023/05/31	Potassium, total	mg/L	9.45
UA	50	C	2023/08/25	Potassium, total	mg/L	11.0
UA	50	C	2023/11/14	Potassium, total	mg/L	8.30
UA	50	C	2023/05/31	Silicon, dissolved	mg/L	14.5
UA	50	C	2023/08/25	Silicon, dissolved	mg/L	17.0
UA	50	C	2019/09/17	Sodium, total	mg/L	65.7
UA	50	C	2020/03/11	Sodium, total	mg/L	70.2
UA	50	C	2020/06/03	Sodium, total	mg/L	70.5
UA	50	C	2021/03/19	Sodium, total	mg/L	57.5
UA	50	C	2021/09/08	Sodium, total	mg/L	58.6
UA	50	C	2022/03/22	Sodium, total	mg/L	59.5
UA	50	C	2022/09/13	Sodium, total	mg/L	61.0
UA	50	C	2023/02/28	Sodium, total	mg/L	56.5
UA	50	C	2023/05/31	Sodium, total	mg/L	59.7
UA	50	C	2023/08/25	Sodium, total	mg/L	54.0
UA	50	C	2023/11/14	Sodium, total	mg/L	51.0
UA	50	C	2019/09/17	Sulfate, total	mg/L	83.0
UA	50	C	2019/12/11	Sulfate, total	mg/L	113
UA	50	C	2020/03/11	Sulfate, total	mg/L	98.0
UA	50	C	2020/06/03	Sulfate, total	mg/L	107
UA	50	C	2020/09/02	Sulfate, total	mg/L	81.0
UA	50	C	2020/12/09	Sulfate, total	mg/L	89.0
UA	50	C	2021/03/19	Sulfate, total	mg/L	96.0
UA	50	C	2021/06/23	Sulfate, total	mg/L	90.0
UA	50	C	2021/09/08	Sulfate, total	mg/L	85.0
UA	50	C	2021/12/08	Sulfate, total	mg/L	104
UA	50	C	2022/03/22	Sulfate, total	mg/L	90.0
UA	50	C	2022/09/13	Sulfate, total	mg/L	81.0
UA	50	C	2023/02/28	Sulfate, total	mg/L	136
UA	50	C	2023/05/31	Sulfate, total	mg/L	88.0
UA	50	C	2023/08/25	Sulfate, total	mg/L	93.0
UA	50	C	2023/11/14	Sulfate, total	mg/L	91.0
UA	50	C	2019/09/17	Temperature (Celsius)	degrees C	16.5
UA	50	C	2019/12/11	Temperature (Celsius)	degrees C	16.4
UA	50	C	2020/03/11	Temperature (Celsius)	degrees C	15.5
UA	50	C	2020/06/03	Temperature (Celsius)	degrees C	15.9
UA	50	C	2020/06/25	Temperature (Celsius)	degrees C	16.4

UA	50	C	2020/09/02	Temperature (Celsius)	degrees C	17.8
UA	50	C	2020/12/09	Temperature (Celsius)	degrees C	16.7
UA	50	C	2021/03/19	Temperature (Celsius)	degrees C	15.5
UA	50	C	2021/06/23	Temperature (Celsius)	degrees C	15.5
UA	50	C	2021/09/08	Temperature (Celsius)	degrees C	15.9
UA	50	C	2021/12/08	Temperature (Celsius)	degrees C	16.7
UA	50	C	2022/03/22	Temperature (Celsius)	degrees C	15.2
UA	50	C	2022/06/07	Temperature (Celsius)	degrees C	14.1
UA	50	C	2022/09/13	Temperature (Celsius)	degrees C	15.9
UA	50	C	2022/12/27	Temperature (Celsius)	degrees C	13.1
UA	50	C	2023/02/28	Temperature (Celsius)	degrees C	14.7
UA	50	C	2023/05/31	Temperature (Celsius)	degrees C	15.5
UA	50	C	2023/08/25	Temperature (Celsius)	degrees C	16.7
UA	50	C	2023/11/14	Temperature (Celsius)	degrees C	15.8
UA	50	C	2019/09/17	Total Dissolved Solids	mg/L	700
UA	50	C	2019/12/11	Total Dissolved Solids	mg/L	672
UA	50	C	2020/03/11	Total Dissolved Solids	mg/L	690
UA	50	C	2020/06/03	Total Dissolved Solids	mg/L	662
UA	50	C	2020/09/02	Total Dissolved Solids	mg/L	622
UA	50	C	2020/12/09	Total Dissolved Solids	mg/L	604
UA	50	C	2021/03/19	Total Dissolved Solids	mg/L	606
UA	50	C	2021/06/23	Total Dissolved Solids	mg/L	692
UA	50	C	2021/09/08	Total Dissolved Solids	mg/L	588
UA	50	C	2021/12/08	Total Dissolved Solids	mg/L	598
UA	50	C	2022/03/22	Total Dissolved Solids	mg/L	598
UA	50	C	2022/09/13	Total Dissolved Solids	mg/L	668
UA	50	C	2023/02/28	Total Dissolved Solids	mg/L	580
UA	50	C	2023/05/31	Total Dissolved Solids	mg/L	632
UA	50	C	2023/08/25	Total Dissolved Solids	mg/L	610
UA	50	C	2023/11/14	Total Dissolved Solids	mg/L	610
UA	51	C	2020/03/11	pH (field)	SU	7.5
UA	51	C	2020/06/24	pH (field)	SU	7.5
UA	51	C	2020/09/02	pH (field)	SU	7.5
UA	51	C	2020/12/10	pH (field)	SU	7.6
UA	51	C	2021/03/17	pH (field)	SU	7.3
UA	51	C	2021/06/23	pH (field)	SU	7.3
UA	51	C	2021/09/09	pH (field)	SU	7.4
UA	51	C	2021/12/09	pH (field)	SU	7.3
UA	51	C	2022/03/22	pH (field)	SU	7.4
UA	51	C	2022/06/07	pH (field)	SU	7.3
UA	51	C	2022/09/13	pH (field)	SU	7.2
UA	51	C	2022/12/27	pH (field)	SU	7.2
UA	51	C	2023/02/28	pH (field)	SU	7.2
UA	51	C	2023/05/31	pH (field)	SU	7.2
UA	51	C	2023/08/22	pH (field)	SU	7.4
UA	51	C	2023/11/15	pH (field)	SU	7.4
UA	51	C	2020/03/11	Oxidation Reduction Potential	mV	-132
UA	51	C	2020/06/24	Oxidation Reduction Potential	mV	-139
UA	51	C	2020/09/02	Oxidation Reduction Potential	mV	-150
UA	51	C	2020/12/10	Oxidation Reduction Potential	mV	-152
UA	51	C	2021/03/17	Oxidation Reduction Potential	mV	-125
UA	51	C	2021/06/23	Oxidation Reduction Potential	mV	-194
UA	51	C	2021/09/09	Oxidation Reduction Potential	mV	-152
UA	51	C	2021/12/09	Oxidation Reduction Potential	mV	-142
UA	51	C	2022/03/22	Oxidation Reduction Potential	mV	-163
UA	51	C	2022/06/07	Oxidation Reduction Potential	mV	15.0
UA	51	C	2022/09/13	Oxidation Reduction Potential	mV	68.0
UA	51	C	2022/12/27	Oxidation Reduction Potential	mV	-141
UA	51	C	2023/02/28	Oxidation Reduction Potential	mV	-119
UA	51	C	2023/05/31	Oxidation Reduction Potential	mV	-135
UA	51	C	2023/08/22	Oxidation Reduction Potential	mV	-129
UA	51	C	2023/11/15	Oxidation Reduction Potential	mV	-125

UA	51	C	2020/03/11	Eh	V	0.066
UA	51	C	2020/06/24	Eh	V	0.058
UA	51	C	2020/09/02	Eh	V	0.046
UA	51	C	2020/12/10	Eh	V	0.046
UA	51	C	2021/03/17	Eh	V	0.074
UA	51	C	2021/06/23	Eh	V	0.0034
UA	51	C	2021/09/09	Eh	V	0.045
UA	51	C	2021/12/09	Eh	V	0.056
UA	51	C	2022/03/22	Eh	V	0.035
UA	51	C	2022/06/07	Eh	V	0.21
UA	51	C	2022/09/13	Eh	V	0.26
UA	51	C	2022/12/27	Eh	V	0.057
UA	51	C	2023/02/28	Eh	V	0.079
UA	51	C	2023/05/31	Eh	V	0.062
UA	51	C	2023/08/22	Eh	V	0.065
UA	51	C	2023/11/15	Eh	V	0.072
UA	51	C	2020/03/11	Alkalinity, bicarbonate	mg/L CaCO3	332
UA	51	C	2021/02/25	Alkalinity, bicarbonate	mg/L CaCO3	344
UA	51	C	2021/03/04	Alkalinity, bicarbonate	mg/L CaCO3	347
UA	51	C	2021/03/09	Alkalinity, bicarbonate	mg/L CaCO3	335
UA	51	C	2021/03/17	Alkalinity, bicarbonate	mg/L CaCO3	349
UA	51	C	2021/03/18	Alkalinity, bicarbonate	mg/L CaCO3	339
UA	51	C	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	355
UA	51	C	2021/09/09	Alkalinity, bicarbonate	mg/L CaCO3	356
UA	51	C	2022/03/22	Alkalinity, bicarbonate	mg/L CaCO3	346
UA	51	C	2022/09/13	Alkalinity, bicarbonate	mg/L CaCO3	347
UA	51	C	2023/02/28	Alkalinity, bicarbonate	mg/L CaCO3	357
UA	51	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	356
UA	51	C	2023/08/22	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	51	C	2023/11/15	Alkalinity, bicarbonate	mg/L CaCO3	360
UA	51	C	2020/03/11	Arsenic, total	mg/L	0.0102
UA	51	C	2020/06/24	Arsenic, total	mg/L	0.0105
UA	51	C	2020/09/02	Arsenic, total	mg/L	0.0132
UA	51	C	2020/12/10	Arsenic, total	mg/L	0.0237
UA	51	C	2021/02/25	Arsenic, total	mg/L	0.0171
UA	51	C	2021/03/04	Arsenic, total	mg/L	0.0168
UA	51	C	2021/03/09	Arsenic, total	mg/L	0.0190
UA	51	C	2021/03/17	Arsenic, total	mg/L	0.0176
UA	51	C	2021/03/18	Arsenic, total	mg/L	0.0180
UA	51	C	2021/03/30	Arsenic, total	mg/L	0.0165
UA	51	C	2021/06/23	Arsenic, total	mg/L	0.0192
UA	51	C	2021/09/09	Arsenic, total	mg/L	0.0174
UA	51	C	2021/12/09	Arsenic, total	mg/L	0.0197
UA	51	C	2022/03/22	Arsenic, total	mg/L	0.0195
UA	51	C	2022/06/07	Arsenic, total	mg/L	0.0192
UA	51	C	2022/09/13	Arsenic, total	mg/L	0.0206
UA	51	C	2022/12/27	Arsenic, total	mg/L	0.0264
UA	51	C	2023/02/28	Arsenic, total	mg/L	0.0308
UA	51	C	2023/05/31	Arsenic, total	mg/L	0.0182
UA	51	C	2023/08/22	Arsenic, total	mg/L	0.0190
UA	51	C	2023/11/15	Arsenic, total	mg/L	0.0190
UA	51	C	2020/03/11	Barium, total	mg/L	0.145
UA	51	C	2020/06/24	Barium, total	mg/L	0.106
UA	51	C	2020/09/02	Barium, total	mg/L	0.112
UA	51	C	2020/12/10	Barium, total	mg/L	0.144
UA	51	C	2021/02/25	Barium, total	mg/L	0.118
UA	51	C	2021/03/17	Barium, total	mg/L	0.126
UA	51	C	2021/06/23	Barium, total	mg/L	0.122
UA	51	C	2021/09/09	Barium, total	mg/L	0.115
UA	51	C	2021/12/09	Barium, total	mg/L	0.112
UA	51	C	2022/03/22	Barium, total	mg/L	0.102
UA	51	C	2022/06/07	Barium, total	mg/L	0.0968

UA	51	C	2022/09/13	Barium, total	mg/L	0.0917
UA	51	C	2022/12/27	Barium, total	mg/L	0.120
UA	51	C	2023/02/28	Barium, total	mg/L	0.134
UA	51	C	2023/05/31	Barium, total	mg/L	0.109
UA	51	C	2023/08/22	Barium, total	mg/L	0.100
UA	51	C	2023/11/15	Barium, total	mg/L	0.100
UA	51	C	2020/03/11	Boron, total	mg/L	3.14
UA	51	C	2020/06/24	Boron, total	mg/L	2.83
UA	51	C	2020/09/02	Boron, total	mg/L	2.40
UA	51	C	2020/12/10	Boron, total	mg/L	2.63
UA	51	C	2021/02/25	Boron, total	mg/L	2.41
UA	51	C	2021/03/04	Boron, total	mg/L	2.32
UA	51	C	2021/03/09	Boron, total	mg/L	2.10
UA	51	C	2021/03/17	Boron, total	mg/L	2.24
UA	51	C	2021/03/18	Boron, total	mg/L	2.37
UA	51	C	2021/03/30	Boron, total	mg/L	2.51
UA	51	C	2021/06/23	Boron, total	mg/L	2.11
UA	51	C	2021/09/09	Boron, total	mg/L	1.96
UA	51	C	2021/12/09	Boron, total	mg/L	1.90
UA	51	C	2022/03/22	Boron, total	mg/L	2.55
UA	51	C	2022/06/07	Boron, total	mg/L	1.72
UA	51	C	2022/09/13	Boron, total	mg/L	1.57
UA	51	C	2022/12/27	Boron, total	mg/L	2.01
UA	51	C	2023/02/28	Boron, total	mg/L	1.54
UA	51	C	2023/05/31	Boron, total	mg/L	1.63
UA	51	C	2023/08/22	Boron, total	mg/L	1.30
UA	51	C	2023/11/15	Boron, total	mg/L	1.60
UA	51	C	2020/03/11	Cadmium, total	mg/L	<0.0002
UA	51	C	2020/06/24	Cadmium, total	mg/L	<0.0002
UA	51	C	2020/09/02	Cadmium, total	mg/L	<0.0002
UA	51	C	2020/12/10	Cadmium, total	mg/L	<0.0002
UA	51	C	2021/02/25	Cadmium, total	mg/L	<0.0000002
UA	51	C	2021/03/17	Cadmium, total	mg/L	<0.0002
UA	51	C	2021/06/23	Cadmium, total	mg/L	<0.0002
UA	51	C	2021/09/09	Cadmium, total	mg/L	<0.0002
UA	51	C	2021/12/09	Cadmium, total	mg/L	<0.0002
UA	51	C	2022/03/22	Cadmium, total	mg/L	<0.0002
UA	51	C	2022/06/07	Cadmium, total	mg/L	<0.0002
UA	51	C	2022/09/13	Cadmium, total	mg/L	<0.0002
UA	51	C	2022/12/27	Cadmium, total	mg/L	<0.0002
UA	51	C	2023/02/28	Cadmium, total	mg/L	<0.0002
UA	51	C	2023/05/31	Cadmium, total	mg/L	<0.0005
UA	51	C	2023/08/22	Cadmium, total	mg/L	<0.00017
UA	51	C	2023/11/15	Cadmium, total	mg/L	<0.00017
UA	51	C	2020/03/11	Calcium, total	mg/L	126
UA	51	C	2020/06/24	Calcium, total	mg/L	116
UA	51	C	2020/09/02	Calcium, total	mg/L	120
UA	51	C	2020/12/10	Calcium, total	mg/L	168
UA	51	C	2021/02/25	Calcium, total	mg/L	129
UA	51	C	2021/03/04	Calcium, total	mg/L	119
UA	51	C	2021/03/09	Calcium, total	mg/L	120
UA	51	C	2021/03/17	Calcium, total	mg/L	127
UA	51	C	2021/03/18	Calcium, total	mg/L	128
UA	51	C	2021/03/30	Calcium, total	mg/L	123
UA	51	C	2021/06/23	Calcium, total	mg/L	128
UA	51	C	2021/09/09	Calcium, total	mg/L	132
UA	51	C	2021/12/09	Calcium, total	mg/L	132
UA	51	C	2022/03/22	Calcium, total	mg/L	121
UA	51	C	2022/06/07	Calcium, total	mg/L	120
UA	51	C	2022/09/13	Calcium, total	mg/L	124
UA	51	C	2022/12/27	Calcium, total	mg/L	128
UA	51	C	2023/02/28	Calcium, total	mg/L	132

UA	51	C	2023/05/31	Calcium, total	mg/L	127
UA	51	C	2023/08/22	Calcium, total	mg/L	110
UA	51	C	2023/11/15	Calcium, total	mg/L	110
UA	51	C	2020/03/11	Chloride, total	mg/L	94.0
UA	51	C	2020/06/24	Chloride, total	mg/L	93.0
UA	51	C	2020/09/02	Chloride, total	mg/L	103
UA	51	C	2020/12/10	Chloride, total	mg/L	99.0
UA	51	C	2021/02/25	Chloride, total	mg/L	97.0
UA	51	C	2021/03/04	Chloride, total	mg/L	100
UA	51	C	2021/03/09	Chloride, total	mg/L	105
UA	51	C	2021/03/17	Chloride, total	mg/L	90.0
UA	51	C	2021/03/18	Chloride, total	mg/L	97.0
UA	51	C	2021/03/30	Chloride, total	mg/L	99.0
UA	51	C	2021/06/23	Chloride, total	mg/L	105
UA	51	C	2021/09/09	Chloride, total	mg/L	101
UA	51	C	2021/12/09	Chloride, total	mg/L	107
UA	51	C	2022/03/22	Chloride, total	mg/L	103
UA	51	C	2022/06/07	Chloride, total	mg/L	111
UA	51	C	2022/09/13	Chloride, total	mg/L	112
UA	51	C	2022/12/27	Chloride, total	mg/L	109
UA	51	C	2023/02/28	Chloride, total	mg/L	110
UA	51	C	2023/05/31	Chloride, total	mg/L	109
UA	51	C	2023/08/22	Chloride, total	mg/L	94.0
UA	51	C	2023/11/15	Chloride, total	mg/L	92.0
UA	51	C	2023/08/22	Ferrous Iron, dissolved	mg/L	1.74
UA	51	C	2021/02/25	Iron, dissolved	mg/L	4.60
UA	51	C	2021/03/04	Iron, dissolved	mg/L	4.39
UA	51	C	2021/03/09	Iron, dissolved	mg/L	5.00
UA	51	C	2021/03/18	Iron, dissolved	mg/L	5.17
UA	51	C	2021/03/30	Iron, dissolved	mg/L	4.72
UA	51	C	2023/05/31	Iron, dissolved	mg/L	6.53
UA	51	C	2023/08/22	Iron, dissolved	mg/L	6.10
UA	51	C	2020/03/11	Lithium, total	mg/L	0.0245
UA	51	C	2020/06/24	Lithium, total	mg/L	0.0232
UA	51	C	2020/09/02	Lithium, total	mg/L	0.0214
UA	51	C	2020/12/10	Lithium, total	mg/L	0.0224
UA	51	C	2021/02/25	Lithium, total	mg/L	0.0230
UA	51	C	2021/03/04	Lithium, total	mg/L	0.0244
UA	51	C	2021/03/09	Lithium, total	mg/L	0.0240
UA	51	C	2021/03/17	Lithium, total	mg/L	0.0242
UA	51	C	2021/03/18	Lithium, total	mg/L	0.0214
UA	51	C	2021/03/30	Lithium, total	mg/L	0.0238
UA	51	C	2021/06/23	Lithium, total	mg/L	0.0241
UA	51	C	2021/09/09	Lithium, total	mg/L	0.0248
UA	51	C	2021/12/09	Lithium, total	mg/L	0.0251
UA	51	C	2022/03/22	Lithium, total	mg/L	0.0250
UA	51	C	2022/06/07	Lithium, total	mg/L	0.0258
UA	51	C	2022/09/13	Lithium, total	mg/L	0.0213
UA	51	C	2022/12/27	Lithium, total	mg/L	0.0302
UA	51	C	2023/02/28	Lithium, total	mg/L	0.0210
UA	51	C	2023/05/31	Lithium, total	mg/L	0.0714
UA	51	C	2023/08/22	Lithium, total	mg/L	0.0250
UA	51	C	2023/11/15	Lithium, total	mg/L	0.0260
UA	51	C	2020/03/11	Magnesium, total	mg/L	41.5
UA	51	C	2020/06/24	Magnesium, total	mg/L	40.8
UA	51	C	2021/02/25	Magnesium, total	mg/L	47.5
UA	51	C	2021/03/04	Magnesium, total	mg/L	42.1
UA	51	C	2021/03/09	Magnesium, total	mg/L	44.0
UA	51	C	2021/03/17	Magnesium, total	mg/L	44.5
UA	51	C	2021/03/18	Magnesium, total	mg/L	45.5
UA	51	C	2021/03/30	Magnesium, total	mg/L	45.1
UA	51	C	2021/09/09	Magnesium, total	mg/L	42.9

UA	51	C	2022/03/22	Magnesium, total	mg/L	37.3
UA	51	C	2022/09/13	Magnesium, total	mg/L	36.7
UA	51	C	2023/02/28	Magnesium, total	mg/L	39.8
UA	51	C	2023/05/31	Magnesium, total	mg/L	40.2
UA	51	C	2023/08/22	Magnesium, total	mg/L	37.0
UA	51	C	2023/11/15	Magnesium, total	mg/L	37.0
UA	51	C	2021/02/25	Manganese, dissolved	mg/L	0.0965
UA	51	C	2021/03/04	Manganese, dissolved	mg/L	0.117
UA	51	C	2021/03/09	Manganese, dissolved	mg/L	0.110
UA	51	C	2021/03/18	Manganese, dissolved	mg/L	0.109
UA	51	C	2021/03/30	Manganese, dissolved	mg/L	0.0991
UA	51	C	2023/05/31	Manganese, dissolved	mg/L	0.169
UA	51	C	2023/08/22	Manganese, dissolved	mg/L	0.150
UA	51	C	2023/05/31	Phosphate, dissolved	mg/L	0.0710
UA	51	C	2023/08/22	Phosphate, dissolved	mg/L	<0.073
UA	51	C	2020/03/11	Potassium, total	mg/L	5.16
UA	51	C	2020/06/24	Potassium, total	mg/L	4.56
UA	51	C	2021/02/25	Potassium, total	mg/L	4.05
UA	51	C	2021/03/04	Potassium, total	mg/L	4.55
UA	51	C	2021/03/09	Potassium, total	mg/L	4.20
UA	51	C	2021/03/17	Potassium, total	mg/L	4.89
UA	51	C	2021/03/18	Potassium, total	mg/L	4.78
UA	51	C	2021/03/30	Potassium, total	mg/L	4.32
UA	51	C	2021/09/09	Potassium, total	mg/L	4.98
UA	51	C	2022/03/22	Potassium, total	mg/L	5.36
UA	51	C	2022/09/13	Potassium, total	mg/L	6.49
UA	51	C	2023/02/28	Potassium, total	mg/L	6.55
UA	51	C	2023/05/31	Potassium, total	mg/L	6.65
UA	51	C	2023/08/22	Potassium, total	mg/L	5.60
UA	51	C	2023/11/15	Potassium, total	mg/L	6.10
UA	51	C	2023/05/31	Silicon, dissolved	mg/L	7.53
UA	51	C	2023/08/22	Silicon, dissolved	mg/L	8.70
UA	51	C	2020/03/11	Sodium, total	mg/L	46.5
UA	51	C	2020/06/24	Sodium, total	mg/L	50.7
UA	51	C	2021/02/25	Sodium, total	mg/L	57.2
UA	51	C	2021/03/04	Sodium, total	mg/L	59.2
UA	51	C	2021/03/09	Sodium, total	mg/L	53.0
UA	51	C	2021/03/17	Sodium, total	mg/L	55.9
UA	51	C	2021/03/18	Sodium, total	mg/L	55.6
UA	51	C	2021/03/30	Sodium, total	mg/L	54.5
UA	51	C	2021/09/09	Sodium, total	mg/L	57.2
UA	51	C	2022/03/22	Sodium, total	mg/L	57.6
UA	51	C	2022/09/13	Sodium, total	mg/L	55.5
UA	51	C	2023/02/28	Sodium, total	mg/L	59.3
UA	51	C	2023/05/31	Sodium, total	mg/L	58.9
UA	51	C	2023/08/22	Sodium, total	mg/L	52.0
UA	51	C	2023/11/15	Sodium, total	mg/L	56.0
UA	51	C	2020/03/11	Sulfate, total	mg/L	120
UA	51	C	2020/06/24	Sulfate, total	mg/L	113
UA	51	C	2020/09/02	Sulfate, total	mg/L	106
UA	51	C	2020/12/10	Sulfate, total	mg/L	124
UA	51	C	2021/02/25	Sulfate, total	mg/L	105
UA	51	C	2021/03/04	Sulfate, total	mg/L	106
UA	51	C	2021/03/09	Sulfate, total	mg/L	127
UA	51	C	2021/03/17	Sulfate, total	mg/L	95.0
UA	51	C	2021/03/18	Sulfate, total	mg/L	106
UA	51	C	2021/03/30	Sulfate, total	mg/L	116
UA	51	C	2021/06/23	Sulfate, total	mg/L	103
UA	51	C	2021/09/09	Sulfate, total	mg/L	101
UA	51	C	2021/12/09	Sulfate, total	mg/L	108
UA	51	C	2022/03/22	Sulfate, total	mg/L	94.0
UA	51	C	2022/06/07	Sulfate, total	mg/L	95.0

UA	51	C	2022/09/13	Sulfate, total	mg/L	105
UA	51	C	2022/12/27	Sulfate, total	mg/L	100
UA	51	C	2023/02/28	Sulfate, total	mg/L	105
UA	51	C	2023/05/31	Sulfate, total	mg/L	97.0
UA	51	C	2023/08/22	Sulfate, total	mg/L	90.0
UA	51	C	2023/11/15	Sulfate, total	mg/L	87.0
UA	51	C	2020/03/11	Temperature (Celsius)	degrees C	11.3
UA	51	C	2020/06/24	Temperature (Celsius)	degrees C	13.1
UA	51	C	2020/09/02	Temperature (Celsius)	degrees C	14.3
UA	51	C	2020/12/10	Temperature (Celsius)	degrees C	11.6
UA	51	C	2021/03/17	Temperature (Celsius)	degrees C	10.1
UA	51	C	2021/06/23	Temperature (Celsius)	degrees C	12.3
UA	51	C	2021/09/09	Temperature (Celsius)	degrees C	12.6
UA	51	C	2021/12/09	Temperature (Celsius)	degrees C	11.9
UA	51	C	2022/03/22	Temperature (Celsius)	degrees C	11.8
UA	51	C	2022/06/07	Temperature (Celsius)	degrees C	12.8
UA	51	C	2022/09/13	Temperature (Celsius)	degrees C	13.1
UA	51	C	2022/12/27	Temperature (Celsius)	degrees C	11.6
UA	51	C	2023/02/28	Temperature (Celsius)	degrees C	11.2
UA	51	C	2023/05/31	Temperature (Celsius)	degrees C	12.9
UA	51	C	2023/08/22	Temperature (Celsius)	degrees C	17.3
UA	51	C	2023/11/15	Temperature (Celsius)	degrees C	13.0
UA	51	C	2020/03/11	Total Dissolved Solids	mg/L	644
UA	51	C	2020/06/24	Total Dissolved Solids	mg/L	652
UA	51	C	2020/09/02	Total Dissolved Solids	mg/L	605
UA	51	C	2020/12/10	Total Dissolved Solids	mg/L	634
UA	51	C	2021/02/25	Total Dissolved Solids	mg/L	628
UA	51	C	2021/03/04	Total Dissolved Solids	mg/L	630
UA	51	C	2021/03/09	Total Dissolved Solids	mg/L	632
UA	51	C	2021/03/17	Total Dissolved Solids	mg/L	676
UA	51	C	2021/03/18	Total Dissolved Solids	mg/L	624
UA	51	C	2021/03/30	Total Dissolved Solids	mg/L	644
UA	51	C	2021/06/23	Total Dissolved Solids	mg/L	702
UA	51	C	2021/09/09	Total Dissolved Solids	mg/L	628
UA	51	C	2021/12/09	Total Dissolved Solids	mg/L	584
UA	51	C	2022/03/22	Total Dissolved Solids	mg/L	622
UA	51	C	2022/06/07	Total Dissolved Solids	mg/L	684
UA	51	C	2022/09/13	Total Dissolved Solids	mg/L	615
UA	51	C	2022/12/27	Total Dissolved Solids	mg/L	624
UA	51	C	2023/02/28	Total Dissolved Solids	mg/L	630
UA	51	C	2023/05/31	Total Dissolved Solids	mg/L	630
UA	51	C	2023/08/22	Total Dissolved Solids	mg/L	680
UA	51	C	2023/11/15	Total Dissolved Solids	mg/L	650
UA	21	C	2013/03/08	pH (field)	SU	7.2
UA	21	C	2013/06/07	pH (field)	SU	8.0
UA	21	C	2013/09/03	pH (field)	SU	7.1
UA	21	C	2013/12/10	pH (field)	SU	7.2
UA	21	C	2014/03/25	pH (field)	SU	7.6
UA	21	C	2014/08/19	pH (field)	SU	7.7
UA	21	C	2014/09/30	pH (field)	SU	7.5
UA	21	C	2015/03/18	pH (field)	SU	7.5
UA	21	C	2015/09/16	pH (field)	SU	7.5
UA	21	C	2015/12/10	pH (field)	SU	7.6
UA	21	C	2016/03/09	pH (field)	SU	7.3
UA	21	C	2016/06/07	pH (field)	SU	7.4
UA	21	C	2016/09/15	pH (field)	SU	7.4
UA	21	C	2016/12/07	pH (field)	SU	7.6
UA	21	C	2017/02/21	pH (field)	SU	7.4
UA	21	C	2017/04/25	pH (field)	SU	7.4
UA	21	C	2017/06/08	pH (field)	SU	7.4
UA	21	C	2017/09/06	pH (field)	SU	7.4
UA	21	C	2017/11/15	pH (field)	SU	7.5

UA	21	C	2018/03/26	pH (field)	SU	7.7
UA	21	C	2018/06/13	pH (field)	SU	6.8
UA	21	C	2018/09/12	pH (field)	SU	7.5
UA	21	C	2018/12/12	pH (field)	SU	7.4
UA	21	C	2019/03/13	pH (field)	SU	7.5
UA	21	C	2019/06/19	pH (field)	SU	7.4
UA	21	C	2015/12/10	Oxidation Reduction Potential	mV	-88.0
UA	21	C	2016/03/09	Oxidation Reduction Potential	mV	-110
UA	21	C	2016/06/07	Oxidation Reduction Potential	mV	-129
UA	21	C	2016/09/15	Oxidation Reduction Potential	mV	-124
UA	21	C	2016/12/07	Oxidation Reduction Potential	mV	-113
UA	21	C	2017/02/21	Oxidation Reduction Potential	mV	-88.0
UA	21	C	2017/04/25	Oxidation Reduction Potential	mV	-139
UA	21	C	2017/06/08	Oxidation Reduction Potential	mV	-187
UA	21	C	2017/11/15	Oxidation Reduction Potential	mV	10.0
UA	21	C	2018/06/13	Oxidation Reduction Potential	mV	-120
UA	21	C	2018/09/12	Oxidation Reduction Potential	mV	-183
UA	21	C	2018/12/12	Oxidation Reduction Potential	mV	-166
UA	21	C	2019/03/13	Oxidation Reduction Potential	mV	32.0
UA	21	C	2019/06/19	Oxidation Reduction Potential	mV	-168
UA	21	C	2015/12/10	Eh	V	0.11
UA	21	C	2016/03/09	Eh	V	0.087
UA	21	C	2016/06/07	Eh	V	0.068
UA	21	C	2016/09/15	Eh	V	0.071
UA	21	C	2016/12/07	Eh	V	0.085
UA	21	C	2017/02/21	Eh	V	0.11
UA	21	C	2017/04/25	Eh	V	0.051
UA	21	C	2017/06/08	Eh	V	0.0087
UA	21	C	2017/11/15	Eh	V	0.21
UA	21	C	2018/06/13	Eh	V	0.075
UA	21	C	2018/09/12	Eh	V	0.012
UA	21	C	2018/12/12	Eh	V	0.031
UA	21	C	2019/03/13	Eh	V	0.23
UA	21	C	2019/06/19	Eh	V	0.029
UA	21	C	2013/06/07	Arsenic, total	mg/L	0.00740
UA	21	C	2013/09/03	Arsenic, total	mg/L	0.00890
UA	21	C	2015/12/10	Arsenic, total	mg/L	0.00980
UA	21	C	2016/03/09	Arsenic, total	mg/L	0.00860
UA	21	C	2016/06/07	Arsenic, total	mg/L	0.00910
UA	21	C	2016/09/15	Arsenic, total	mg/L	0.00940
UA	21	C	2016/12/07	Arsenic, total	mg/L	0.00890
UA	21	C	2017/02/21	Arsenic, total	mg/L	0.00910
UA	21	C	2017/04/25	Arsenic, total	mg/L	0.00920
UA	21	C	2017/06/08	Arsenic, total	mg/L	0.00870
UA	21	C	2018/06/13	Arsenic, total	mg/L	0.0105
UA	21	C	2018/09/12	Arsenic, total	mg/L	0.0128
UA	21	C	2018/12/12	Arsenic, total	mg/L	0.00240
UA	21	C	2019/03/13	Arsenic, total	mg/L	0.00460
UA	21	C	2019/06/19	Arsenic, total	mg/L	0.00530
UA	21	C	2013/06/07	Barium, total	mg/L	0.203
UA	21	C	2013/09/03	Barium, total	mg/L	0.182
UA	21	C	2015/12/10	Barium, total	mg/L	0.179
UA	21	C	2016/03/09	Barium, total	mg/L	0.180
UA	21	C	2016/06/07	Barium, total	mg/L	0.179
UA	21	C	2016/09/15	Barium, total	mg/L	0.183
UA	21	C	2016/12/07	Barium, total	mg/L	0.187
UA	21	C	2017/02/21	Barium, total	mg/L	0.177
UA	21	C	2017/04/25	Barium, total	mg/L	0.175
UA	21	C	2017/06/08	Barium, total	mg/L	0.176
UA	21	C	2018/06/13	Barium, total	mg/L	0.173
UA	21	C	2018/09/12	Barium, total	mg/L	0.237
UA	21	C	2018/12/12	Barium, total	mg/L	0.199

UA	21	C	2019/03/13	Barium, total	mg/L	0.129
UA	21	C	2019/06/19	Barium, total	mg/L	0.221
UA	21	C	2013/06/07	Boron, total	mg/L	5.18
UA	21	C	2013/09/03	Boron, total	mg/L	5.09
UA	21	C	2015/12/10	Boron, total	mg/L	4.20
UA	21	C	2016/03/09	Boron, total	mg/L	4.30
UA	21	C	2016/06/07	Boron, total	mg/L	4.31
UA	21	C	2016/09/15	Boron, total	mg/L	4.60
UA	21	C	2016/12/07	Boron, total	mg/L	4.35
UA	21	C	2017/02/21	Boron, total	mg/L	3.95
UA	21	C	2017/04/25	Boron, total	mg/L	4.17
UA	21	C	2017/06/08	Boron, total	mg/L	4.01
UA	21	C	2017/11/15	Boron, total	mg/L	4.12
UA	21	C	2018/06/13	Boron, total	mg/L	3.89
UA	21	C	2018/09/12	Boron, total	mg/L	3.64
UA	21	C	2018/12/12	Boron, total	mg/L	4.12
UA	21	C	2019/03/13	Boron, total	mg/L	1.25
UA	21	C	2019/06/19	Boron, total	mg/L	3.73
UA	21	C	2013/06/07	Cadmium, total	mg/L	<0.0003
UA	21	C	2013/09/03	Cadmium, total	mg/L	<0.0003
UA	21	C	2015/12/10	Cadmium, total	mg/L	<0.0002
UA	21	C	2016/03/09	Cadmium, total	mg/L	<0.0002
UA	21	C	2016/06/07	Cadmium, total	mg/L	<0.0002
UA	21	C	2016/09/15	Cadmium, total	mg/L	<0.0002
UA	21	C	2016/12/07	Cadmium, total	mg/L	<0.0002
UA	21	C	2017/02/21	Cadmium, total	mg/L	<0.0002
UA	21	C	2017/04/25	Cadmium, total	mg/L	<0.0002
UA	21	C	2017/06/08	Cadmium, total	mg/L	<0.0002
UA	21	C	2018/06/13	Cadmium, total	mg/L	<0.0002
UA	21	C	2018/09/12	Cadmium, total	mg/L	<0.0002
UA	21	C	2018/12/12	Cadmium, total	mg/L	<0.0002
UA	21	C	2019/03/13	Cadmium, total	mg/L	<0.0002
UA	21	C	2019/06/19	Cadmium, total	mg/L	<0.0002
UA	21	C	2015/12/10	Calcium, total	mg/L	97.2
UA	21	C	2016/03/09	Calcium, total	mg/L	99.8
UA	21	C	2016/06/07	Calcium, total	mg/L	99.4
UA	21	C	2016/09/15	Calcium, total	mg/L	100
UA	21	C	2016/12/07	Calcium, total	mg/L	106
UA	21	C	2017/02/21	Calcium, total	mg/L	98.6
UA	21	C	2017/04/25	Calcium, total	mg/L	91.5
UA	21	C	2017/06/08	Calcium, total	mg/L	103
UA	21	C	2017/11/15	Calcium, total	mg/L	104
UA	21	C	2018/06/13	Calcium, total	mg/L	99.5
UA	21	C	2018/09/12	Calcium, total	mg/L	131
UA	21	C	2018/12/12	Calcium, total	mg/L	114
UA	21	C	2019/03/13	Calcium, total	mg/L	75.4
UA	21	C	2019/06/19	Calcium, total	mg/L	108
UA	21	C	2013/03/08	Chloride, total	mg/L	41.0
UA	21	C	2013/06/07	Chloride, total	mg/L	43.0
UA	21	C	2013/09/03	Chloride, total	mg/L	40.0
UA	21	C	2013/12/10	Chloride, total	mg/L	43.0
UA	21	C	2014/03/25	Chloride, total	mg/L	38.0
UA	21	C	2014/09/30	Chloride, total	mg/L	46.0
UA	21	C	2015/03/18	Chloride, total	mg/L	41.0
UA	21	C	2015/09/16	Chloride, total	mg/L	38.0
UA	21	C	2015/12/10	Chloride, total	mg/L	49.0
UA	21	C	2016/03/09	Chloride, total	mg/L	48.0
UA	21	C	2016/06/07	Chloride, total	mg/L	48.0
UA	21	C	2016/09/15	Chloride, total	mg/L	43.0
UA	21	C	2016/12/07	Chloride, total	mg/L	44.0
UA	21	C	2017/02/21	Chloride, total	mg/L	38.0
UA	21	C	2017/04/25	Chloride, total	mg/L	40.0

UA	21	C	2017/06/08	Chloride, total	mg/L	41.0
UA	21	C	2017/09/06	Chloride, total	mg/L	44.0
UA	21	C	2017/11/15	Chloride, total	mg/L	41.0
UA	21	C	2018/03/26	Chloride, total	mg/L	45.0
UA	21	C	2018/06/13	Chloride, total	mg/L	50.0
UA	21	C	2018/09/12	Chloride, total	mg/L	59.0
UA	21	C	2018/12/12	Chloride, total	mg/L	56.0
UA	21	C	2019/03/13	Chloride, total	mg/L	33.0
UA	21	C	2019/06/19	Chloride, total	mg/L	54.0
UA	21	C	2013/03/08	Iron, dissolved	mg/L	0.880
UA	21	C	2013/12/10	Iron, dissolved	mg/L	4.13
UA	21	C	2014/03/25	Iron, dissolved	mg/L	3.47
UA	21	C	2014/08/19	Iron, dissolved	mg/L	<0.007
UA	21	C	2014/09/30	Iron, dissolved	mg/L	3.53
UA	21	C	2015/03/18	Iron, dissolved	mg/L	2.49
UA	21	C	2015/09/16	Iron, dissolved	mg/L	2.77
UA	21	C	2016/03/09	Iron, dissolved	mg/L	3.65
UA	21	C	2016/09/15	Iron, dissolved	mg/L	3.64
UA	21	C	2017/02/21	Iron, dissolved	mg/L	3.06
UA	21	C	2017/09/06	Iron, dissolved	mg/L	1.93
UA	21	C	2018/03/26	Iron, dissolved	mg/L	4.20
UA	21	C	2015/12/10	Lithium, total	mg/L	0.0126
UA	21	C	2016/03/09	Lithium, total	mg/L	0.0136
UA	21	C	2016/06/07	Lithium, total	mg/L	0.0137
UA	21	C	2016/09/15	Lithium, total	mg/L	0.0136
UA	21	C	2016/12/07	Lithium, total	mg/L	0.0138
UA	21	C	2017/02/21	Lithium, total	mg/L	0.0124
UA	21	C	2017/04/25	Lithium, total	mg/L	0.0126
UA	21	C	2017/06/08	Lithium, total	mg/L	0.0138
UA	21	C	2018/06/13	Lithium, total	mg/L	0.0160
UA	21	C	2018/09/12	Lithium, total	mg/L	0.0208
UA	21	C	2018/12/12	Lithium, total	mg/L	0.0158
UA	21	C	2019/03/13	Lithium, total	mg/L	0.00640
UA	21	C	2019/06/19	Lithium, total	mg/L	0.0145
UA	21	C	2013/03/08	Manganese, dissolved	mg/L	0.0800
UA	21	C	2013/12/10	Manganese, dissolved	mg/L	0.121
UA	21	C	2014/03/25	Manganese, dissolved	mg/L	0.0977
UA	21	C	2014/08/19	Manganese, dissolved	mg/L	0.0956
UA	21	C	2014/09/30	Manganese, dissolved	mg/L	0.102
UA	21	C	2015/03/18	Manganese, dissolved	mg/L	0.0918
UA	21	C	2015/09/16	Manganese, dissolved	mg/L	0.0971
UA	21	C	2016/03/09	Manganese, dissolved	mg/L	0.103
UA	21	C	2016/09/15	Manganese, dissolved	mg/L	0.112
UA	21	C	2017/02/21	Manganese, dissolved	mg/L	0.114
UA	21	C	2017/09/06	Manganese, dissolved	mg/L	0.110
UA	21	C	2018/03/26	Manganese, dissolved	mg/L	0.109
UA	21	C	2013/03/08	Sulfate, total	mg/L	144
UA	21	C	2013/06/07	Sulfate, total	mg/L	161
UA	21	C	2013/09/03	Sulfate, total	mg/L	149
UA	21	C	2013/12/10	Sulfate, total	mg/L	119
UA	21	C	2014/03/25	Sulfate, total	mg/L	120
UA	21	C	2014/09/30	Sulfate, total	mg/L	159
UA	21	C	2015/03/18	Sulfate, total	mg/L	123
UA	21	C	2015/09/16	Sulfate, total	mg/L	124
UA	21	C	2015/12/10	Sulfate, total	mg/L	146
UA	21	C	2016/03/09	Sulfate, total	mg/L	146
UA	21	C	2016/06/07	Sulfate, total	mg/L	169
UA	21	C	2016/09/15	Sulfate, total	mg/L	167
UA	21	C	2016/12/07	Sulfate, total	mg/L	149
UA	21	C	2017/02/21	Sulfate, total	mg/L	142
UA	21	C	2017/04/25	Sulfate, total	mg/L	142
UA	21	C	2017/06/08	Sulfate, total	mg/L	163

UA	21	C	2017/09/06	Sulfate, total	mg/L	143
UA	21	C	2017/11/15	Sulfate, total	mg/L	110
UA	21	C	2018/03/26	Sulfate, total	mg/L	130
UA	21	C	2018/06/13	Sulfate, total	mg/L	135
UA	21	C	2018/09/12	Sulfate, total	mg/L	140
UA	21	C	2018/12/12	Sulfate, total	mg/L	91.0
UA	21	C	2019/03/13	Sulfate, total	mg/L	51.0
UA	21	C	2019/06/19	Sulfate, total	mg/L	77.0
UA	21	C	2013/03/08	Temperature (Celsius)	degrees C	10.9
UA	21	C	2013/06/07	Temperature (Celsius)	degrees C	15.1
UA	21	C	2013/09/03	Temperature (Celsius)	degrees C	16.8
UA	21	C	2013/12/10	Temperature (Celsius)	degrees C	10.3
UA	21	C	2014/03/25	Temperature (Celsius)	degrees C	10.3
UA	21	C	2014/08/19	Temperature (Celsius)	degrees C	14.3
UA	21	C	2014/09/30	Temperature (Celsius)	degrees C	13.4
UA	21	C	2015/03/18	Temperature (Celsius)	degrees C	13.2
UA	21	C	2015/09/16	Temperature (Celsius)	degrees C	14.2
UA	21	C	2015/12/10	Temperature (Celsius)	degrees C	14.1
UA	21	C	2016/03/09	Temperature (Celsius)	degrees C	12.6
UA	21	C	2016/06/07	Temperature (Celsius)	degrees C	13.3
UA	21	C	2016/09/15	Temperature (Celsius)	degrees C	15.2
UA	21	C	2016/12/07	Temperature (Celsius)	degrees C	11.5
UA	21	C	2017/02/21	Temperature (Celsius)	degrees C	14.2
UA	21	C	2017/04/25	Temperature (Celsius)	degrees C	22.9
UA	21	C	2017/06/08	Temperature (Celsius)	degrees C	14.6
UA	21	C	2017/09/06	Temperature (Celsius)	degrees C	13.3
UA	21	C	2017/11/15	Temperature (Celsius)	degrees C	13.5
UA	21	C	2018/03/26	Temperature (Celsius)	degrees C	13.7
UA	21	C	2018/06/13	Temperature (Celsius)	degrees C	16.3
UA	21	C	2018/09/12	Temperature (Celsius)	degrees C	15.8
UA	21	C	2018/12/12	Temperature (Celsius)	degrees C	12.7
UA	21	C	2019/03/13	Temperature (Celsius)	degrees C	12.2
UA	21	C	2019/06/19	Temperature (Celsius)	degrees C	13.5
UA	21	C	2013/03/08	Total Dissolved Solids	mg/L	518
UA	21	C	2013/06/07	Total Dissolved Solids	mg/L	564
UA	21	C	2013/09/03	Total Dissolved Solids	mg/L	618
UA	21	C	2013/12/10	Total Dissolved Solids	mg/L	540
UA	21	C	2014/03/25	Total Dissolved Solids	mg/L	442
UA	21	C	2014/08/19	Total Dissolved Solids	mg/L	546
UA	21	C	2014/09/30	Total Dissolved Solids	mg/L	546
UA	21	C	2015/03/18	Total Dissolved Solids	mg/L	542
UA	21	C	2015/09/16	Total Dissolved Solids	mg/L	564
UA	21	C	2015/12/10	Total Dissolved Solids	mg/L	532
UA	21	C	2016/03/09	Total Dissolved Solids	mg/L	560
UA	21	C	2016/06/07	Total Dissolved Solids	mg/L	588
UA	21	C	2016/09/15	Total Dissolved Solids	mg/L	582
UA	21	C	2016/12/07	Total Dissolved Solids	mg/L	532
UA	21	C	2017/02/21	Total Dissolved Solids	mg/L	532
UA	21	C	2017/04/25	Total Dissolved Solids	mg/L	564
UA	21	C	2017/06/08	Total Dissolved Solids	mg/L	558
UA	21	C	2017/09/06	Total Dissolved Solids	mg/L	558
UA	21	C	2017/11/15	Total Dissolved Solids	mg/L	572
UA	21	C	2018/03/26	Total Dissolved Solids	mg/L	560
UA	21	C	2018/06/13	Total Dissolved Solids	mg/L	586
UA	21	C	2018/09/12	Total Dissolved Solids	mg/L	644
UA	21	C	2018/12/12	Total Dissolved Solids	mg/L	568
UA	21	C	2019/03/13	Total Dissolved Solids	mg/L	338
UA	21	C	2019/06/19	Total Dissolved Solids	mg/L	508
UA	24	C	2013/03/08	pH (field)	SU	7.3
UA	24	C	2013/06/07	pH (field)	SU	7.8
UA	24	C	2013/09/03	pH (field)	SU	7.8
UA	24	C	2013/12/10	pH (field)	SU	7.6

UA	24	C	2014/03/25	pH (field)	SU	7.5
UA	24	C	2014/08/19	pH (field)	SU	7.8
UA	24	C	2014/09/30	pH (field)	SU	7.6
UA	24	C	2015/03/18	pH (field)	SU	7.6
UA	24	C	2015/09/16	pH (field)	SU	8.0
UA	24	C	2015/12/10	pH (field)	SU	7.6
UA	24	C	2016/03/09	pH (field)	SU	7.8
UA	24	C	2016/06/07	pH (field)	SU	7.6
UA	24	C	2016/09/15	pH (field)	SU	7.6
UA	24	C	2016/12/07	pH (field)	SU	7.4
UA	24	C	2017/02/21	pH (field)	SU	7.5
UA	24	C	2017/04/25	pH (field)	SU	7.3
UA	24	C	2017/06/08	pH (field)	SU	7.4
UA	24	C	2017/09/06	pH (field)	SU	7.4
UA	24	C	2017/11/15	pH (field)	SU	7.7
UA	24	C	2018/03/26	pH (field)	SU	7.6
UA	24	C	2018/06/13	pH (field)	SU	7.0
UA	24	C	2018/09/12	pH (field)	SU	7.4
UA	24	C	2018/12/12	pH (field)	SU	7.4
UA	24	C	2019/03/13	pH (field)	SU	7.5
UA	24	C	2019/06/19	pH (field)	SU	7.5
UA	24	C	2015/12/10	Oxidation Reduction Potential	mV	-78.0
UA	24	C	2016/03/09	Oxidation Reduction Potential	mV	-155
UA	24	C	2016/06/07	Oxidation Reduction Potential	mV	-114
UA	24	C	2016/09/15	Oxidation Reduction Potential	mV	-123
UA	24	C	2016/12/07	Oxidation Reduction Potential	mV	-90.0
UA	24	C	2017/02/21	Oxidation Reduction Potential	mV	-87.0
UA	24	C	2017/04/25	Oxidation Reduction Potential	mV	-142
UA	24	C	2017/06/08	Oxidation Reduction Potential	mV	-160
UA	24	C	2017/11/15	Oxidation Reduction Potential	mV	-102
UA	24	C	2018/06/13	Oxidation Reduction Potential	mV	-138
UA	24	C	2018/09/12	Oxidation Reduction Potential	mV	-153
UA	24	C	2018/12/12	Oxidation Reduction Potential	mV	-135
UA	24	C	2019/03/13	Oxidation Reduction Potential	mV	-119
UA	24	C	2019/06/19	Oxidation Reduction Potential	mV	-112
UA	24	C	2015/12/10	Eh	V	0.12
UA	24	C	2016/03/09	Eh	V	0.043
UA	24	C	2016/06/07	Eh	V	0.083
UA	24	C	2016/09/15	Eh	V	0.074
UA	24	C	2016/12/07	Eh	V	0.11
UA	24	C	2017/02/21	Eh	V	0.11
UA	24	C	2017/04/25	Eh	V	0.050
UA	24	C	2017/06/08	Eh	V	0.034
UA	24	C	2017/11/15	Eh	V	0.095
UA	24	C	2018/06/13	Eh	V	0.058
UA	24	C	2018/09/12	Eh	V	0.044
UA	24	C	2018/12/12	Eh	V	0.063
UA	24	C	2019/03/13	Eh	V	0.078
UA	24	C	2019/06/19	Eh	V	0.085
UA	24	C	2013/06/07	Arsenic, total	mg/L	0.00890
UA	24	C	2013/09/03	Arsenic, total	mg/L	0.00880
UA	24	C	2015/12/10	Arsenic, total	mg/L	0.0279
UA	24	C	2016/03/09	Arsenic, total	mg/L	0.0263
UA	24	C	2016/06/07	Arsenic, total	mg/L	0.0275
UA	24	C	2016/09/15	Arsenic, total	mg/L	0.0328
UA	24	C	2016/12/07	Arsenic, total	mg/L	0.0343
UA	24	C	2017/02/21	Arsenic, total	mg/L	0.0300
UA	24	C	2017/04/25	Arsenic, total	mg/L	0.0319
UA	24	C	2017/06/08	Arsenic, total	mg/L	0.0313
UA	24	C	2018/06/13	Arsenic, total	mg/L	0.0336
UA	24	C	2018/09/12	Arsenic, total	mg/L	0.0332
UA	24	C	2018/12/12	Arsenic, total	mg/L	0.0332

UA	24	C	2019/03/13	Arsenic, total	mg/L	0.0380
UA	24	C	2019/06/19	Arsenic, total	mg/L	0.0254
UA	24	C	2013/06/07	Barium, total	mg/L	0.0424
UA	24	C	2013/09/03	Barium, total	mg/L	0.0397
UA	24	C	2015/12/10	Barium, total	mg/L	0.0499
UA	24	C	2016/03/09	Barium, total	mg/L	0.0451
UA	24	C	2016/06/07	Barium, total	mg/L	0.0538
UA	24	C	2016/09/15	Barium, total	mg/L	0.0536
UA	24	C	2016/12/07	Barium, total	mg/L	0.0588
UA	24	C	2017/02/21	Barium, total	mg/L	0.0550
UA	24	C	2017/04/25	Barium, total	mg/L	0.0535
UA	24	C	2017/06/08	Barium, total	mg/L	0.0575
UA	24	C	2018/06/13	Barium, total	mg/L	0.0634
UA	24	C	2018/09/12	Barium, total	mg/L	0.0653
UA	24	C	2018/12/12	Barium, total	mg/L	0.0705
UA	24	C	2019/03/13	Barium, total	mg/L	0.0699
UA	24	C	2019/06/19	Barium, total	mg/L	0.0555
UA	24	C	2013/06/07	Boron, total	mg/L	3.02
UA	24	C	2013/09/03	Boron, total	mg/L	2.90
UA	24	C	2015/12/10	Boron, total	mg/L	3.39
UA	24	C	2016/03/09	Boron, total	mg/L	3.19
UA	24	C	2016/06/07	Boron, total	mg/L	3.84
UA	24	C	2016/09/15	Boron, total	mg/L	2.80
UA	24	C	2016/12/07	Boron, total	mg/L	2.81
UA	24	C	2017/02/21	Boron, total	mg/L	2.74
UA	24	C	2017/04/25	Boron, total	mg/L	2.54
UA	24	C	2017/06/08	Boron, total	mg/L	2.41
UA	24	C	2017/11/15	Boron, total	mg/L	2.48
UA	24	C	2018/06/13	Boron, total	mg/L	2.36
UA	24	C	2018/09/12	Boron, total	mg/L	2.22
UA	24	C	2018/12/12	Boron, total	mg/L	2.39
UA	24	C	2019/03/13	Boron, total	mg/L	2.44
UA	24	C	2019/06/19	Boron, total	mg/L	2.11
UA	24	C	2013/06/07	Cadmium, total	mg/L	<0.0003
UA	24	C	2013/09/03	Cadmium, total	mg/L	<0.0003
UA	24	C	2015/12/10	Cadmium, total	mg/L	<0.0002
UA	24	C	2016/03/09	Cadmium, total	mg/L	<0.0002
UA	24	C	2016/06/07	Cadmium, total	mg/L	<0.0002
UA	24	C	2016/09/15	Cadmium, total	mg/L	<0.0002
UA	24	C	2016/12/07	Cadmium, total	mg/L	<0.0002
UA	24	C	2017/02/21	Cadmium, total	mg/L	<0.0002
UA	24	C	2017/04/25	Cadmium, total	mg/L	<0.0002
UA	24	C	2017/06/08	Cadmium, total	mg/L	<0.0002
UA	24	C	2018/06/13	Cadmium, total	mg/L	<0.0002
UA	24	C	2018/09/12	Cadmium, total	mg/L	<0.0002
UA	24	C	2018/12/12	Cadmium, total	mg/L	<0.0002
UA	24	C	2019/03/13	Cadmium, total	mg/L	<0.0002
UA	24	C	2019/06/19	Cadmium, total	mg/L	<0.0002
UA	24	C	2015/12/10	Calcium, total	mg/L	125
UA	24	C	2016/03/09	Calcium, total	mg/L	108
UA	24	C	2016/06/07	Calcium, total	mg/L	152
UA	24	C	2016/09/15	Calcium, total	mg/L	139
UA	24	C	2016/12/07	Calcium, total	mg/L	150
UA	24	C	2017/02/21	Calcium, total	mg/L	142
UA	24	C	2017/04/25	Calcium, total	mg/L	127
UA	24	C	2017/06/08	Calcium, total	mg/L	141
UA	24	C	2017/11/15	Calcium, total	mg/L	152
UA	24	C	2018/06/13	Calcium, total	mg/L	145
UA	24	C	2018/09/12	Calcium, total	mg/L	133
UA	24	C	2018/12/12	Calcium, total	mg/L	141
UA	24	C	2019/03/13	Calcium, total	mg/L	143
UA	24	C	2019/06/19	Calcium, total	mg/L	107

UA	24	C	2013/03/08	Chloride, total	mg/L	45.0
UA	24	C	2013/06/07	Chloride, total	mg/L	38.0
UA	24	C	2013/09/03	Chloride, total	mg/L	40.0
UA	24	C	2013/12/10	Chloride, total	mg/L	45.0
UA	24	C	2014/03/25	Chloride, total	mg/L	43.0
UA	24	C	2014/09/30	Chloride, total	mg/L	55.0
UA	24	C	2015/03/18	Chloride, total	mg/L	55.0
UA	24	C	2015/09/16	Chloride, total	mg/L	46.0
UA	24	C	2015/12/10	Chloride, total	mg/L	47.0
UA	24	C	2016/03/09	Chloride, total	mg/L	51.0
UA	24	C	2016/06/07	Chloride, total	mg/L	63.0
UA	24	C	2016/09/15	Chloride, total	mg/L	69.0
UA	24	C	2016/12/07	Chloride, total	mg/L	75.0
UA	24	C	2017/02/21	Chloride, total	mg/L	70.0
UA	24	C	2017/04/25	Chloride, total	mg/L	82.0
UA	24	C	2017/06/08	Chloride, total	mg/L	77.0
UA	24	C	2017/09/06	Chloride, total	mg/L	85.0
UA	24	C	2017/11/15	Chloride, total	mg/L	86.0
UA	24	C	2018/03/26	Chloride, total	mg/L	89.0
UA	24	C	2018/06/13	Chloride, total	mg/L	99.0
UA	24	C	2018/09/12	Chloride, total	mg/L	106
UA	24	C	2018/12/12	Chloride, total	mg/L	96.0
UA	24	C	2019/03/13	Chloride, total	mg/L	95.0
UA	24	C	2019/06/19	Chloride, total	mg/L	88.0
UA	24	C	2013/03/08	Iron, dissolved	mg/L	2.39
UA	24	C	2013/12/10	Iron, dissolved	mg/L	0.679
UA	24	C	2014/03/25	Iron, dissolved	mg/L	3.02
UA	24	C	2014/08/19	Iron, dissolved	mg/L	0.235
UA	24	C	2014/09/30	Iron, dissolved	mg/L	3.75
UA	24	C	2015/03/18	Iron, dissolved	mg/L	3.27
UA	24	C	2015/09/16	Iron, dissolved	mg/L	1.81
UA	24	C	2016/03/09	Iron, dissolved	mg/L	3.68
UA	24	C	2016/09/15	Iron, dissolved	mg/L	4.83
UA	24	C	2017/02/21	Iron, dissolved	mg/L	3.27
UA	24	C	2017/09/06	Iron, dissolved	mg/L	5.57
UA	24	C	2018/03/26	Iron, dissolved	mg/L	4.43
UA	24	C	2015/12/10	Lithium, total	mg/L	0.0202
UA	24	C	2016/03/09	Lithium, total	mg/L	0.0195
UA	24	C	2016/06/07	Lithium, total	mg/L	0.0241
UA	24	C	2016/09/15	Lithium, total	mg/L	0.0220
UA	24	C	2016/12/07	Lithium, total	mg/L	0.0218
UA	24	C	2017/02/21	Lithium, total	mg/L	0.0202
UA	24	C	2017/04/25	Lithium, total	mg/L	0.0220
UA	24	C	2017/06/08	Lithium, total	mg/L	0.0193
UA	24	C	2018/06/13	Lithium, total	mg/L	0.0242
UA	24	C	2018/09/12	Lithium, total	mg/L	0.0257
UA	24	C	2018/12/12	Lithium, total	mg/L	0.0255
UA	24	C	2019/03/13	Lithium, total	mg/L	0.0270
UA	24	C	2019/06/19	Lithium, total	mg/L	0.0236
UA	24	C	2013/03/08	Manganese, dissolved	mg/L	0.0500
UA	24	C	2013/12/10	Manganese, dissolved	mg/L	0.0663
UA	24	C	2014/03/25	Manganese, dissolved	mg/L	0.0735
UA	24	C	2014/08/19	Manganese, dissolved	mg/L	0.0398
UA	24	C	2014/09/30	Manganese, dissolved	mg/L	0.0835
UA	24	C	2015/03/18	Manganese, dissolved	mg/L	0.0733
UA	24	C	2015/09/16	Manganese, dissolved	mg/L	0.0576
UA	24	C	2016/03/09	Manganese, dissolved	mg/L	0.0860
UA	24	C	2016/09/15	Manganese, dissolved	mg/L	0.101
UA	24	C	2017/02/21	Manganese, dissolved	mg/L	0.100
UA	24	C	2017/09/06	Manganese, dissolved	mg/L	0.110
UA	24	C	2018/03/26	Manganese, dissolved	mg/L	0.100
UA	24	C	2013/03/08	Sulfate, total	mg/L	192

UA	24	C	2013/06/07	Sulfate, total	mg/L	108
UA	24	C	2013/09/03	Sulfate, total	mg/L	75.0
UA	24	C	2013/12/10	Sulfate, total	mg/L	139
UA	24	C	2014/03/25	Sulfate, total	mg/L	154
UA	24	C	2014/09/30	Sulfate, total	mg/L	179
UA	24	C	2015/03/18	Sulfate, total	mg/L	162
UA	24	C	2015/09/16	Sulfate, total	mg/L	135
UA	24	C	2015/12/10	Sulfate, total	mg/L	140
UA	24	C	2016/03/09	Sulfate, total	mg/L	133
UA	24	C	2016/06/07	Sulfate, total	mg/L	135
UA	24	C	2016/09/15	Sulfate, total	mg/L	143
UA	24	C	2016/12/07	Sulfate, total	mg/L	149
UA	24	C	2017/02/21	Sulfate, total	mg/L	131
UA	24	C	2017/04/25	Sulfate, total	mg/L	140
UA	24	C	2017/06/08	Sulfate, total	mg/L	148
UA	24	C	2017/09/06	Sulfate, total	mg/L	141
UA	24	C	2017/11/15	Sulfate, total	mg/L	128
UA	24	C	2018/03/26	Sulfate, total	mg/L	139
UA	24	C	2018/06/13	Sulfate, total	mg/L	120
UA	24	C	2018/09/12	Sulfate, total	mg/L	133
UA	24	C	2018/12/12	Sulfate, total	mg/L	119
UA	24	C	2019/03/13	Sulfate, total	mg/L	101
UA	24	C	2019/06/19	Sulfate, total	mg/L	95.0
UA	24	C	2013/03/08	Temperature (Celsius)	degrees C	11.3
UA	24	C	2013/06/07	Temperature (Celsius)	degrees C	13.2
UA	24	C	2013/09/03	Temperature (Celsius)	degrees C	15.3
UA	24	C	2013/12/10	Temperature (Celsius)	degrees C	9.90
UA	24	C	2014/03/25	Temperature (Celsius)	degrees C	10.2
UA	24	C	2014/08/19	Temperature (Celsius)	degrees C	13.3
UA	24	C	2014/09/30	Temperature (Celsius)	degrees C	12.6
UA	24	C	2015/03/18	Temperature (Celsius)	degrees C	12.4
UA	24	C	2015/09/16	Temperature (Celsius)	degrees C	12.8
UA	24	C	2015/12/10	Temperature (Celsius)	degrees C	13.9
UA	24	C	2016/03/09	Temperature (Celsius)	degrees C	11.6
UA	24	C	2016/06/07	Temperature (Celsius)	degrees C	12.2
UA	24	C	2016/09/15	Temperature (Celsius)	degrees C	13.6
UA	24	C	2016/12/07	Temperature (Celsius)	degrees C	10.7
UA	24	C	2017/02/21	Temperature (Celsius)	degrees C	13.1
UA	24	C	2017/04/25	Temperature (Celsius)	degrees C	20.1
UA	24	C	2017/06/08	Temperature (Celsius)	degrees C	17.2
UA	24	C	2017/09/06	Temperature (Celsius)	degrees C	12.4
UA	24	C	2017/11/15	Temperature (Celsius)	degrees C	12.3
UA	24	C	2018/03/26	Temperature (Celsius)	degrees C	12.8
UA	24	C	2018/06/13	Temperature (Celsius)	degrees C	13.7
UA	24	C	2018/09/12	Temperature (Celsius)	degrees C	13.3
UA	24	C	2018/12/12	Temperature (Celsius)	degrees C	11.7
UA	24	C	2019/03/13	Temperature (Celsius)	degrees C	12.4
UA	24	C	2019/06/19	Temperature (Celsius)	degrees C	12.3
UA	24	C	2013/03/08	Total Dissolved Solids	mg/L	578
UA	24	C	2013/06/07	Total Dissolved Solids	mg/L	376
UA	24	C	2013/09/03	Total Dissolved Solids	mg/L	324
UA	24	C	2013/12/10	Total Dissolved Solids	mg/L	522
UA	24	C	2014/03/25	Total Dissolved Solids	mg/L	526
UA	24	C	2014/08/19	Total Dissolved Solids	mg/L	336
UA	24	C	2014/09/30	Total Dissolved Solids	mg/L	622
UA	24	C	2015/03/18	Total Dissolved Solids	mg/L	630
UA	24	C	2015/09/16	Total Dissolved Solids	mg/L	558
UA	24	C	2015/12/10	Total Dissolved Solids	mg/L	568
UA	24	C	2016/03/09	Total Dissolved Solids	mg/L	458
UA	24	C	2016/06/07	Total Dissolved Solids	mg/L	564
UA	24	C	2016/09/15	Total Dissolved Solids	mg/L	648
UA	24	C	2016/12/07	Total Dissolved Solids	mg/L	632

UA	24	C	2017/02/21	Total Dissolved Solids	mg/L	602
UA	24	C	2017/04/25	Total Dissolved Solids	mg/L	676
UA	24	C	2017/06/08	Total Dissolved Solids	mg/L	658
UA	24	C	2017/09/06	Total Dissolved Solids	mg/L	696
UA	24	C	2017/11/15	Total Dissolved Solids	mg/L	702
UA	24	C	2018/03/26	Total Dissolved Solids	mg/L	654
UA	24	C	2018/06/13	Total Dissolved Solids	mg/L	714
UA	24	C	2018/09/12	Total Dissolved Solids	mg/L	822
UA	24	C	2018/12/12	Total Dissolved Solids	mg/L	722
UA	24	C	2019/03/13	Total Dissolved Solids	mg/L	690
UA	24	C	2019/06/19	Total Dissolved Solids	mg/L	540

Notes:

< = results is less than detection limit

B = Background

C = Compliance

HSU = Hydrostratigraphic Unit

CCR = Coal Combustion Residuals

UA = Uppermost Aquifer

mg/L = milligrams per liter

SU = standard units

V = volts

Intended for
Dynegy Midwest Generation, LLC
13498 E 800th St.
Hennepin, Illinois, 61327

Date
May 6, 2025

Project No.
1940110241-006

NATURE AND EXTENT REPORT ADDENDUM

HENNEPIN POWER PLANT, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

RAMBOLL Bright ideas. Sustainable change.

NATURE AND EXTENT REPORT ADDENDUM
HENNEPIN POWER PLANT, WEST ASH POND SYSTEM, IEPA ID NO. W1550100002-01 AND W1550100002-03

Project name	**Hennepin West Ash Pond System**
Project no.	**1940110241-006**
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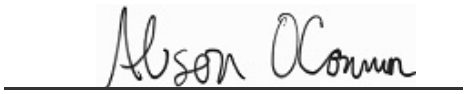

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APPENDICES

Appendix A Packer Test Memorandum
Appendix B Geochemical Conceptual Site Model - Addendum (Geosyntec Consultants, Inc., 2025)

ACRONYMS AND ABBREVIATIONS

%	percent
35 I.A.C.	Title 35 of the Illinois Administrative Code
ASD	Alternative Source Demonstration
CCR	coal combustion residuals
cm/s	centimeters per second
CSM	conceptual site model
ft	feet
GCSM	geochemical conceptual site model
GWPS	groundwater protection standard
HPP	Hennepin Power Plant
ID	identification
IEPA	Illinois Environmental Protection Agency
LOI	loss on ignition
No.	number
SEP	sequential extraction procedure
SI	surface impoundment
TOC	total organic carbon
UA	uppermost aquifer
WAPS	West Ash Pond System
XRD	X-ray diffraction

1. INTRODUCTION

35 Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.650(d)(1) requires the owner or operator of a coal combustion residuals (CCR) surface impoundment (SI) to characterize the nature and extent of a release and relevant site conditions that may affect the remedy ultimately selected for a CCR SI if any constituent regulated under 35 I.A.C. § 845 is found to exceed[1] the groundwater protection standard (GWPS). A report documenting the nature and extent of constituents detected above the GWPS that are attributable to the Hennepin Power Plant (HPP) West Ash Pond System (WAPS) was prepared and submitted to the Illinois Environmental Protection Agency (IEPA) dated May 9, 2024 [1].

Following submittal, additional investigation was completed in October and November 2024 to further characterize the bedrock confining unit and support a permit-level design of a deep cutoff wall as a groundwater corrective action at the WAPS. The additional investigation included the following:

- Advancement of three borings into competent bedrock along the perimeter of the WAPS, including coring of the bedrock
- Continuous logging of the materials including Rock Quality Designation (RQD) of the bedrock
- Collection of aquifer material from the boring nearest to monitoring well 21R for geochemical evaluation
- Packer testing within the bedrock to evaluate ranges in hydraulic conductivity

Documentation of site investigation activities described above is included as **Appendix A.** This report supplements the existing Nature and Extent Report with the results from the additional investigation and initial groundwater monitoring completed in 2024.

[1] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or GWPSs as described in the proposed groundwater monitoring program, which was submitted to the IEPA on October 25, 2021 as part of Dynegy Midwest Generation, LLC's operating permit application for the HPP WAPS. That operating permit application, including the proposed groundwater monitoring program, remains under review by the IEPA and, therefore, Dynegy Midwest Generation, LLC has not identified any actual exceedances.

2. ADDITIONAL INVESTIGATION RESULTS

2.1 Geology

As previously described in the Nature and Extent Report [1] materials at the site have been categorized into two hydrostratigraphic units at the WAPS based on stratigraphic relationships, geologic composition, and common hydrogeologic properties. The units, listed from surface downward, are summarized as follows:

- **Uppermost Aquifer (UA)**: Includes the Cahokia Alluvium which consists of fine-grained river deposits comprised of silts and clays (upper UA), fine-medium sands (middle UA), and highly permeable glacial outwash sands and gravels of the Henry Formation (lower UA). The UA contains variable amounts of cobbles and boulders within a sand and gravel matrix. Both the prevalence and size of the cobbles and boulders increase with depth.

- **Bedrock Confining Unit**: Comprised of interbedded layers of shales with thin limestone, sandstone, and coal beds. Borings along the perimeter of the nearby East Ash Pond System confirm the presence of shale bedrock between elevations ranging from 399.2 to 410.2 feet[2] (ft) [2].

The additional borings installed to further characterize the bedrock confining unit (B100, B101, and B102) indicate consistent geologic materials and stratigraphic relationships (**Appendix A**). Additional details on the hydrostratigraphic units encountered by the borings are summarized as follows:

- **Uppermost Aquifer (UA)**: Consistent with previous borings the UA was encountered at thicknesses up to 85 ft and consisted of sand, gravel, and cobbles south and east of the WAPS (B101 and B102), while materials west of the WAPS (B100) were primarily silty clay with intermittent layers of sand, gravel, and cobbles.

- **Bedrock Confining Unit:** Weathered shale and shaley limestone was observed at depths of 70 to 85 ft, with a thickness of approximately 10 to 20 ft. The weathered bedrock was underlain by competent shale with intermittent beds of shaley limestone. RQD measurements within the bedrock range from 32 percent (%) to 72% with higher measurements generally occurring at greater depths. The elevation of the weathered bedrock ranged from approximately 374 ft in B101 to 385 ft in B102 while competent bedrock was encountered at an elevation between 364 and 365 ft in all three borings.

2.2 Hydraulic Conductivities

Hydraulic conductivity was evaluated in the borings using packer tests as described in **Attachment A**. Results indicate that hydraulic conductivities in the shale bedrock range from 2.2×10^{-6} centimeters per second (cm/s) to 1.1×10^{-5} cm/s, with a geometric mean of 3.4×10^{-6} cm/s. This is significantly lower than measurements in the UA which ranged from 1.2×10^{-2} cm/s in the Henry Formation (deep UA) to 1.3×10^{-4} cm/s in the Cahokia Alluvium silt (shallowest UA). The geometric mean hydraulic conductivity for the sand and gravel portion of the UA is 6×10^{-3} cm/s and 1.7×10^{-2} cm/s for wells finished in the glacial outwash gravels of the Henry Formation [3].

[2] All elevations in this report are referenced to North American Vertical Datum of 1988 unless otherwise noted.

2.3 Hydrogeologic Conceptual Site Model

The overall groundwater flow regime within the unlithified materials is consistent with topographically-controlled flow patterns, where infiltration of precipitation recharges groundwater and flows north and west near the site towards the Illinois River. Flow patterns within the site hydrostratigraphic units are typically horizontal, with components of converging vertical (upward) flow near and underneath the river. Under typical post-closure conditions, groundwater flow directions at the WAPS are north, towards the river. During the operation of the impoundments, high local recharge to groundwater from sluicing of CCR created radial flow conditions near the impoundment; while groundwater flow was still predominantly towards the river, some of the groundwater beneath the impoundment flowed towards the adjacent wetlands located south and west of the WAPS.

Conceptually, source water from the WAPS, if present, migrates downward into the materials of the UA, either sand or silt/clay, and mixes with groundwater. Groundwater continues to migrate vertically in the low permeability silt/clay materials until it encounters the sand and gravel portions of the UA. In the sand and gravel, groundwater migrates horizontally to the north towards the Illinois River. Downward migration of groundwater within the UA is limited by the low permeability shale bedrock underlying the WAPS.

3. GEOCHEMICAL CONCEPTUAL SITE MODEL FOR ARSENIC (NATURE)

A geochemical conceptual site model (GCSM) was developed to describe the conditions of the groundwater in the vicinity of the HPP WAPS and is summarized here (full analysis originally presented in Appendix B of the Nature and Extent Report [1] to which this addendum is attached). The GCSM describes the geochemical processes that contribute to the mobilization, distribution, and attenuation of chemicals in the environment. Additional investigation was conducted to describe arsenic geochemistry in the groundwater west of the WAPS. The effects of the additional data collection on the arsenic GCSM are summarized here and described in detail in **Appendix B**.

Two soil samples were collected from boring B100, located in the vicinity of the wells with arsenic exceedances (21R and 51), at depths in the UA near the well screen intervals. The soil samples were analyzed for total organic carbon (TOC), loss on ignition (LOI), total metals, seven-step sequential extraction procedure (SEP), and X-ray diffraction (XRD). TOC and LOI had lower concentrations in the B100 samples than previous samples and there was high variability between the two samples. These results suggest that the organic matter required to drive reducing conditions in the groundwater is heterogeneous in the UA. Arsenic, iron, and manganese has similar concentrations relative to previous samples. Additionally, SEP results indicated that over 25% of soil associated arsenic was present in the metal oxide phases which sorb arsenic. XRD results were largely consistent with previous analyses.

Aqueous samples from background well 34 and compliance wells 21R and 51 were analyzed for arsenic speciation as well as total and dissolved metals. Arsenic in groundwater primarily exists as two species, depending on pH and redox conditions: reduced arsenic (III) forms the neutral complex $As(OH)_3$ and is more mobile, whereas oxidized arsenic (V) forms the oxyanion $HAsO_4^{2-}$ at neutral pH and is less mobile. At background well 34, arsenic (V) and arsenic (III) were present in the groundwater at approximately equal abundance. At wells 21R and 51, the mobile species arsenic (III) made up the majority (>85%) of the arsenic in the groundwater.

Although exceedances of typical CCR indicator parameters (*i.e.*, boron and sulfate) are observed elsewhere in the WAPS monitoring network, concentrations of both boron and sulfate have been decreasing at wells 21R and 51 since unit closure in 2020 (see Appendix B of the Nature and Extent Report [1] to which this addendum is attached). This suggests that there may have been previous influence of porewater on the UA soils at 21R and 51. Therefore, both the CCR porewater and native geological material are potential sources to the arsenic observed in the UA soils west of the WAPS.

Based on the historical data (described in the Nature and Extent Report [1] to which this document is attached) and the results of this additional investigation, the GCSM concludes that the arsenic exceedances observed at wells 21R and 51 at the western end of the WAPS are due to reducing conditions driving mobilization of arsenic from the soils (derived from either native materials or previous CCR porewater influence). The mobilization of arsenic is likely driven by reduction of less mobile arsenic (V) to arsenic (III). The primary mechanism of arsenic attenuation in the subsurface is sorption to iron oxides and oxyhydroxides under conditions where arsenic (V) is stable.

4. COMBINED GEOCHEMICAL AND HYDROGEOLOGIC CONCEPTUAL SITE MODEL FOR ARSENIC

4.1 Arsenic Conceptual Site Model

The conceptual site model (CSM) describing current conditions at the WAPS combining the hydrogeologic and geochemical CSMs for arsenic is as follows. Water that may come into contact with CCR in the WAPS becomes porewater within the unlined CCR unit. During operations, sluicing of CCR with elevated heads in the unit resulted in radial flow, likely causing porewater, potentially impacted with arsenic, to migrate downward into the UA. Previous influence of porewater on aquifer material west of the unit may have resulted in arsenic attenuation in the solid phase, likely on iron oxides/hydroxides. The arsenic exceedances observed at wells 21R and 51 (which are at the western end of the WAPS in the area with more reducing groundwater) are due to reducing conditions driving mobilization of arsenic from the soils (derived from either native materials or previous CCR porewater influence). In addition to physical attenuation mechanisms of dilution and dispersion, elevated arsenic concentrations may be attenuated via surface complexation reactions with metal (*i.e.,* aluminum, iron, and manganese) oxyhydroxides under more oxidizing conditions.

5. CONCLUSIONS AND FUTURE ACTIVITIES

In accordance with 35 I.A.C. § 845.650(d)(1), the nature and extent of GWPS exceedances of arsenic, boron, lithium, sulfate, and total dissolved solids have been described in sufficient detail in the Nature and Extent Report [1] and this Addendum to support a complete and accurate assessment of the corrective measures necessary to effectively clean up all releases from the WAPS.

Following closure, groundwater monitoring results are generally consistent with the conclusions in the Closure Plan [4] and site conditions are improving as follows:

- Water levels within the CCR are declining. Porewater monitoring wells have gone dry, indicating the level in the unit has declined.
- Trends for boron and sulfate, which are conservative indicators of CCR impacts, indicate concentrations are declining in all wells except wells 23 and 35. Concentrations at these two locations are potentially related to localized flow conditions that originated as a result of closure, but are expected to dissipate as the unit reaches equilibrium (predicted to occur in 2027).

These observations are consistent with the conceptual site models and constituent extents previously provided. Additional evaluation of arsenic concentrations (**Appendix B**) indicates that arsenic concentrations observed at wells 21R and 51 at the western end of the WAPS are due to mobilization of arsenic from the aquifer soils (derived from native material and/or previous CCR porewater influence) due to reducing conditions and not ongoing influence from unit porewater.

6. REFERENCES

[1] Ramboll Americas Engineering Solutions, "Nature and Extent Report. Hennepin West Ash Pond System. Hennepin Power Plant. Hennepin, Illinois," May 9, 2024.

[2] Ramboll Americas Engineering Solutions, Inc. , "Hydrogeologic Site Characterization Report, East Ash Pond, Hennepin Power Plant, Hennepin, Illinois," October 25, 2021.

[3] Natural Resource Technology, an OBG Company, Hydrogeologic Site Characterization Report, West Ash Pond System, Hennepin Power Station, Hennepin, Illinois, December 20, 2017.

[4] Geosyntec Consultants Inc., "Closure and Post Closure Care Plan, Old West Ash Pond, Old West Polishing Pond at Dynegy Midwest Generation, LLC, Hennepin Power Station," 2017.

APPENDICES

APPENDIX A
Packer Test Memorandum

RAMBOLL

ENVIRONMENT
& HEALTH

TECHNICAL MEMORANDUM

To: Dynegy Midwest Generation, LLC

CC: Vistra Corp
Luminant

From: Ramboll Americas Engineering Solutions, Inc. (Ramboll)

Re: Summary of Bedrock Investigation Results
Hennepin Power Plant
West Ash Pond System
Hennepin, Illinois

March 9, 2025

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INTRODUCTION

This Technical Memorandum (Tech Memo) was prepared by Ramboll Americas Engineering Solutions, Inc. (Ramboll) for Luminant to document and summarize the bedrock investigation work performed, including soil boring advancement and packer testing to evaluate the permeability of the bedrock, at Hennepin Power Plant (HPP) West Ash Pond System (WAPS) between October and November 2024.

OBJECTIVES

The objectives of the field event were, for the WAPS specifically, to evaluate the: (1) ranges in depth to bedrock; (2) the type of bedrock; (3) variations in the bedrock weathering profile; and (4) bedrock properties to support the permit-level design of a deep cutoff wall as a groundwater corrective action at the WAPS.

These objectives were met through the following investigatory field tasks: (1) clearing utilities for each boring locations; (2) advancing three borings along the perimeter of the HPP WAPS through unconsolidated materials and into competent bedrock; (3) photographing observed materials observed; (4) characterizing the materials observed through continuous logging, including Rock Quality Designation (RQD) of the bedrock; (5) collecting and storing bedrock core materials onsite, (6) conducting packer testing on select intervals from each boring to evaluate ranges in bedrock hydraulic conductivities; and (7) abandonment of each borehole in accordance with I.A.C. 77 § 920.120.

SITE WORK ACTIVITIES

On-site work activities were conducted between October 28 and November 7, 2024. Boring installation and packer testing were performed by Cascade Drilling, LP (Cascade) with oversight and direction from Ramboll.

The following sections discuss site work methods and documentation of completed work.

UTILITY CLEARANCE

Prior to drilling, the proposed locations for borings B100, B101, and B102 shown on **Figure 1** were evaluated for the presence of underground utilities by Ground Penetrating Radar Systems (GPRS). GPRS utilized a ground penetrating radar antenna to scan a 10-foot

radius around the proposed well locations. No underground utilities were identified around the borings.

BORING INSTALLATION SUMMARY

Cascade used a Boart Longyear LS450 Sonic track mounted drill rig to advance three borings (B100, B101, and B102) through unconsolidated materials and into bedrock. Sonic tooling was utilized for the unconsolidated material (6-inch diameter core barrel), and an HQ coring system was utilized for bedrock material (4 7/8-inch diameter core barrel). The unconsolidated material was logged continuously by a Ramboll representative using the Unified Soil Classification System (USCS), and competent bedrock was logged continuously and characterized using the RQD method specified in the Designation D 6032-02, Standard Test Method for Determining Rock Quality Designation (ASTM, 2002). Bedrock cores were placed in core boxes labeled with the location ID, depth interval, and RQD, and were stored in the warehouse immediately east of the main power plant building. The boring logs are provided in **Attachment A** and described below.

Boring location B100, located in the northwest corner of the WAPS, contained 70 feet (ft) of unconsolidated material, consisting primarily of silty clay with intermittent layers of sand, gravel, and cobbles. The bedrock encountered between 70 and 85 ft below ground surface (bgs) was very weak, moderately fractured, moderately to highly weathered shale with inclusions of residual soil. The bedrock between 85 ft and 100 ft bgs was competent bedrock, slightly weathered, moderately fractured shale containing extremely narrow apertures, with intermittent bands of shaley limestone around 90 ft bgs. RQD decreased with depth, from 72% between 85 and 90 ft bgs, to 32% between 95 and 100 ft bgs. B100 was terminated at a depth of 100 ft bgs after encountering approximately 15 ft of competent bedrock.

Boring location B101, located in the northeast corner of the WAPS, contained 85 ft of unconsolidated material, consisting primarily of sand, gravel, and cobbles. The bedrock encountered between 85 and 95 ft bgs was competent bedrock, very strong, fine grained, moderately to intensely fractured shaley limestone with narrow to very narrow apertures. The bedrock between 95 and 105 ft bgs was competent bedrock, slightly to moderately weathered, intensely fractured shale containing very narrow apertures. In general, RQD's were considered poor, however RQD increased with depth. Within the shaley limestone from 85 to 95 ft bgs the RQD was 32%, and within the shale from 95 to 105 ft the RQD's increased from 39% to 52%. B101 was terminated at a depth of 105 ft bgs after encountering approximately 20 ft of competent bedrock.

Boring location B102, located south of the WAPS, contained 70 ft of unconsolidated material, consisting primarily of sand, gravel, and cobbles. The bedrock encountered between 70 and 90 ft bgs was very weak, extremely weathered shale that had transitioned into a residual soil. The bedrock between 90 and 95 ft bgs was competent bedrock, very strong, intensely fractured shale with very narrow apertures. The bedrock between 95 and 105 ft was competent bedrock, primarily fresh, very strong, slightly fractured to unfractured shaley limestone and shale. RQD's in the competent bedrock increased with depth. Within the shale from 90 to 95 ft bgs the RQD was 29%, and within the shaley limestone and deeper shale from 95 to 105 ft bgs the RQD's increased from 48% to 70%. B102 was terminated at a depth of 105 ft bgs after encountering approximately 15 ft of competent bedrock.

PACKER TESTING

The objective of packer testing was to evaluate the permeability of the bedrock at various depths and compositions to support permit-level design of a deep cutoff wall. Intervals selected for packer testing at each borehole were determined based upon field observations of fracture density and bedrock competency (RQD). The intervals selected and packer test specifications are summarized in **Table A**. The maximum injection pressure (P_{max}) was determined prior to each test to ensure the pressures in the test zone do not

exceed the confinement stress of the bedrock formation at depth. The P_{max} for each boring location interval was selected such that the estimated hydraulic conductivity would be measurable below 1 x 10^{-5} centimeters per second (cm/sec), without hydro-jacking the formation. The packer inflation pressures were calculated prior to testing, using the packer manufacturers specifications outlined in the technical manual (TAM International, 1999). Each borehole interval received a constant head injection test (Lugeon Test), consisting of five stages, with a predetermined water pressure associated with each stage: 1st stage (0.5 x P_{max}), 2nd stage (0.75 x P_{max}), 3rd stage (P_{max}), 4th stage (0.75 x P_{max}), and 5th stage (0.5 x P_{max}).

Table A. Packer Testing Specifications

Borehole ID	Packer Interval (ft bgs)	Test Length (ft)	RQD	P_{max} (pounds per square inch [psi])
B100	86.0 – 90.8	4.8	72%	60
	90.0 – 94.8	4.8	52%	62
	95.0 – 99.8	4.8	32%	65
B101	92.0 – 95.3	3.3	32%	62
	95.0 – 98.3	3.3	39%	64
	98.0 – 101.3	3.3	39 - 52%	66
	100.0 – 103.3	3.3	52%	67
B102	92.0 – 96.8	4.8	29 – 48%	63
	96.0 – 100.8	4.8	48%	66
	100.0 – 104.8	4.8	70%	68

Instrumentation/Quality Control Checks

Attachment C contains a photograph of the packer test skid that was used for the tests, and the magnetic water meter (flow meter). The flow meter registered flow accurately at 0.03 to 6.6 gallons per minute (gpm) and provided a digital display to 0.01 gallons per minute (gpm). The flow rate and total consumed volume outputs were used during the tests. The total consumed volume output registered flow in two directions, which made observation of flow reversal possible. For intervals where no flow was registered, when pressure was applied to the system by restricting the bypass valve, a few seconds of flow downhole could be observed to occur until new pressure equilibrium is reached. Likewise, when pressure was released from the system, flow could be observed to reverse until a new equilibrium was obtained.

The total consumed volume was found to be zero for intervals where no flow occurred. The finding was confirmed with the use of a graduated 300-gallon water tank from which all pumped water was taken and transferred to a separate tank during the injection tests. The drill rig was equipped with a pump system which was used to pump water from the tanks for the packer tests. A grease pen was used to mark the water level in the tank prior to startup of the pump for each test. Upon completion of tests with no flow, the water tank most often indicated the water level had not changed during the test (*e.g.* the test interval did

not consume any water). Where small volumes of water were consumed, the meter reading for total consumed volume was compared to the volume lost from the tank. Where volumes did not match, test data was further evaluated to identify possible sources of system leaks or interferences.

Prior to packer testing, leak tests were performed on the 1-inch diameter steel rod and inflatable packer elements. Several sections of steel rod were connected above ground and water was pumped into the rod under pressure to test the integrity of the threaded pipe joints. Teflon tape was placed on every threaded joint as the packer system was lowered into the hole. Leak tests did not find that threaded joints were a source of leakage.

Inflatable packer elements were leak tested above ground and downhole. Packers were slightly inflated above ground and inspected for cuts and leaks using soapy water. Connections to air supply at the packer and nitrogen gas source tank were also tested. The dual/straddle packer system was then constructed to the 4.8-ft (or 3.3-ft) configuration and lowered downhole where it was inflated against the 4 7/8-inch diameter steel coring casing. Packer elements were inflated to the specifications listed in the manufacturer's technical manual and water was injected through the instrumentation skid against the steel casing. Results of the test confirmed function of the packer elements and water meter (which registered no flow). Water level inside the casing was monitored to double check packer and water meter function.

During packer tests, water levels were also monitored inside of the 4 7/8-inch diameter steel casing to monitor integrity of the packer seal. Slight rise in water level inside the casing during a test can occur when test pressure approaches or exceeds packer inflation pressure. If a rise in water level was observed, the test was stopped. Packer inflation pressures were calculated in the field and adjusted based on maximum test pressures (P_{max}).

Nitrogen tank pressure and packer pressure were monitored above ground during tests at pressure gauges mounted on the nitrogen tank. Loss in either nitrogen tank pressure or packer pressure would be reflected in gauge pressure loss and would indicate a failure of either the supply line or packer element.

Lastly, prior to packer testing (*e.g.* prior to the first packer test), the borehole was flushed with water to clean the borehole of drill cuttings. Water was pumped through the coring rod near the bottom of the borehole, forcing water to rise to the surface. Several hundred gallons of water was pumped until return water was free of suspended material.

Calculations

Table 1 provides a summary of the calculated hydraulic conductivities for the test intervals, including the lowest representative hydraulic conductivity calculated at each boring location (*i.e.,* B100, B101 and B102). Based on current Lugeon interpretation practice described in Camilo Quiñones-Rozo (Quinones-Rozo, C., 2010) and the typical Lugeon patterns that resulted from the series of pressure stages at each testing interval (where the Lugeon values generally decrease as the water pressures increase and the minimum Lugeon value is observed at the stage with the maximum water pressure [P_{max}]), the Lugeon value corresponding to the highest water pressure (P_{max}) was selected as the representative Lugeon value, and hydraulic conductivity, for all testing intervals. These values assumed injection at the lowest recordable flow rate at the highest test pressure (P_{max}) possible without exceeding a downhole pressure greater than maximum packer inflation pressure or exceeding the confinement stress of the bedrock formation.

Hydraulic conductivities are calculated using the following equation (Quinones-Rozo, C., 2010):

Lugeon value = $12.42(Q / L) (P_o / P)$ (cm/s)
Where: Q = flow rate (gpm)
L = length of test interval (ft)
P_o = reference pressure (145 psi [1 MPa])
P = water pressure (psi)
1 Lugeon = 1.3×10^{-5} cm/s

Boring B100

Attachment B contains the field notes for the Lugeon tests that were successfully completed at boring B100. A dual/straddle packer system configured with a 4.8-ft perforated interval was used to complete three tests in the following sequence, beginning with the shallowest interval: 86.0 – 90.8 ft bgs, 90.0 – 94.8 ft bgs, and 95.0 – 99.8 ft bgs (single [top packer] packer test). Water was injected under a maximum pressure (P_{max}) of 60 psi in the shallow interval, 62 psi in the intermediate interval, and 65 psi in the deep interval, none of which accepted flow into the formation. Consistent with Lugeon interpretation practice described in (Quinones-Rozo, C., 2010) when Lugeon values decrease as the water pressures increases the representative Lugeon value (and hydraulic conductivity) corresponds to the highest water pressure (3rd stage [P_{max}]). The results in **Table 1** indicate all but one test exhibited this flow behavior, therefore the general assumption for interpretation of the representative Lugeon values in this Tech Memo is to select the Lugeon value (and hydraulic conductivity) that corresponds to highest water pressure (3rd stage [P_{max}]). The lowest measurable hydraulic conductivity calculated at B100 was <2.3E-06 cm/s recorded from 95.0-99.8 ft bgs, where the lowest measurable hydraulic conductivity is determined by the limits of the equipment (minimum measurable flow rate) and confinement stress of the bedrock formation (P_{max}) (**Table 1**).

Boring B101

Attachment B contains the field notes for the Lugeon tests that were successfully completed at boring B101. A dual/straddle packer system configured with a 3.3-ft perforated interval was used to complete four tests in the following sequence, beginning with the shallowest interval: 92.0 – 95.3 ft bgs, 95.0 – 98.3 ft bgs, 98.0 – 101.3 ft bgs, and 100.0 – 103.3 ft bgs. Water was injected under a maximum pressure (P_{max}) of 62 psi in the shallow interval, which did not accept any water into the formation. Water was injected under a maximum pressure (P_{max}) of 64 psi in the shallow-intermediate interval, which accepted water at a rate of 0.1 gallons per minute (gpm) into the formation. Water was injected under a maximum pressure (P_{max}) of 66 psi in the deep-intermediate interval, which accepted water at a rate of 0.1 gpm. Water was injected under a maximum pressure (P_{max}) of 67 psi in the deep interval, which did not accept any water into the formation. The lowest measurable hydraulic conductivity calculated at B101 was <3.2E-06 cm/s recorded from 100.0-103.3 ft bgs (**Table 1**).

Boring B102

Attachment B contains the field notes for the Lugeon tests that were successfully completed at boring B102. A dual/straddle packer system configured with a 4.8-ft perforated interval was used to complete three tests in the following sequence, beginning with the shallowest interval: 92.0 – 96.8 ft bgs, 96.0 – 100.8 ft bgs, and 100.0 – 104.8 ft bgs. Water was injected under a maximum pressure (P_{max}) of 63 psi in the shallow interval, which did not accept any water into the formation. Water was injected under a maximum pressure (P_{max}) of 66 psi in the intermediate interval, which did not accept any water into the formation. Water was injected under a maximum pressure (P_{max}) of 68 psi in the deep interval, which did not accept any water into the formation. The lowest measurable hydraulic conductivity calculated at B102 was <2.2E-06 cm/s recorded from 96.0-100.8 ft bgs and 100.0 – 104.8 ft bgs (**Table 1**).

SURVEYING

On December 26, 2024 IngenAE, LLC (IngenAE) was contracted to survey boring locations B100, B101, and B102. IngenAE surveyed the coordinates at each location referencing the Illinois West State Plane Coordinate System North American Datum (NAD) 1983. Ground surface elevations were measured at each location using the North American Vertical Datum (NAVD) 1988. The survey report from IngenAE is included in **Attachment D**.

REFERENCES

ASTM, 2002. Designation D 6032-02, Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core. ASTM International, 2002.

Quinones-Rozo, C., 2010. Lugeon Test Interpretation, Revised. URS Corporation.

Ramboll Americas Engineering Solutions, Inc., 2024. *Proposal for Bedrock Investigations to Support Permit-Level Deep Cutoff Wall Design, Hennepin Power Plant, West Ash Pond System*. August 28, 2024.

TAM International, 1999. *Technical Manual For TAM External Inflate Packers, TAM SD Fixed-End Inflatable Packers.* August, 1999.

FIGURES

Figure 1 – Boring Location Map

TABLES

Table 1 – Summary of Calculated Hydraulic Conductivities

ATTACHMENTS

Attachment A Soil Boring Logs
Attachment B Lugeon Test Data Sheets
Attachment C Photographic Log
Attachment D 2024 Well Survey

FIGURES

MONITORING WELL
LEACHATE WELL
SOIL BORING
SITE FEATURE
PROPERTY BOUNDARY

*ALSO KNOWN AS OLD WEST ASH POND (OWAP)

0 200 400
Feet

FIGURE 1 - BORING LOCATION MAP

HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\22285\MXD\Sampling_and_Analysis_Request\SAR_Maps.aprx\HEN West Monitoring Well Location Map

PROJECT: 169000XXXX | DATED: 1/13/2025 | DESIGNER: GALARNMC

TABLES

TABLE 1
SUMMARY OF CALCULATED HYDRAULIC CONDUCTIVITIES - PACKER TEST INTERVALS
TECHNICAL MEMORANDUM - HENNEPIN POWER PLANT

Corehole Location	**Depth** (feet, bgs, elevation NAVD 88)	**Elevation** (feet NAVD88)	**Q Injection Rate** (gal/min)	**Lugeon Test Step**	**P Gauge Pressure** (psi)	**L Test Interval** (feet)	**Q / L** (gal/min/feet)	**Hydraulic Conductivity (K)** (ft/min)	**P_o / P** (psi)	**Hydraulic Conductivity** (Lugeons)	**Hydraulic Conductivity** (cm/s)
B100	86.0 - 90.8	363.73 - 358.93	< 0.03	A	30	4.8	< 0.006	2.0E-06	4.83	< 3.8E-01	< 4.9E-06
			< 0.03	B	45	4.8	< 0.006	2.0E-06	3.22	< 2.5E-01	< 3.3E-06
			< 0.03	**C**	**60**	**4.8**	**< 0.006**	**2.0E-06**	**2.42**	**< 1.9E-01**	**< 2.4E-06**
			< 0.03	Br	45	4.8	< 0.006	2.0E-06	3.22	< 2.5E-01	< 3.3E-06
			< 0.03	Ar	30	4.8	< 0.006	2.0E-06	4.83	< 3.8E-01	< 4.9E-06
B100	90.0 - 94.8	359.73 - 354.93	< 0.03	A	31	4.8	< 0.006	2.0E-06	4.68	< 3.6E-01	< 4.7E-06
			< 0.03	B	47	4.8	< 0.006	2.0E-06	3.12	< 2.4E-01	< 3.1E-06
			< 0.03	**C**	**62**	**4.8**	**< 0.006**	**2.0E-06**	**2.34**	**< 1.8E-01**	**< 2.4E-06**
			< 0.03	Br	47	4.8	< 0.006	2.0E-06	3.12	< 2.4E-01	< 3.1E-06
			< 0.03	Ar	31	4.8	< 0.006	2.0E-06	4.68	< 3.6E-01	< 4.7E-06
B100	95.0 - 99.8	354.73 - 349.93	< 0.03	A	33	4.8	< 0.006	2.0E-06	4.46	< 3.5E-01	< 4.5E-06
			< 0.03	B	49	4.8	< 0.006	2.0E-06	2.97	< 2.3E-01	< 3.0E-06
			< 0.03	**C**	**65**	**4.8**	**< 0.006**	**2.0E-06**	**2.23**	**< 1.7E-01**	**< 2.3E-06**
			< 0.03	Br	49	4.8	< 0.006	2.0E-06	2.97	< 2.3E-01	< 3.0E-06
			< 0.03	Ar	33	4.8	< 0.006	2.0E-06	4.46	< 3.5E-01	< 4.5E-06
B101	92.0 - 95.3	367.29 - 363.99	< 0.03	A	31	3.3	< 0.009	2.0E-06	4.68	< 5.3E-01	< 6.9E-06
			< 0.03	B	47	3.3	< 0.009	2.0E-06	3.12	< 3.5E-01	< 4.6E-06
			< 0.03	**C**	**62**	**3.3**	**< 0.009**	**2.0E-06**	**2.34**	**< 2.6E-01**	**< 3.4E-06**
			< 0.03	Br	47	3.3	< 0.009	2.0E-06	3.12	< 3.5E-01	< 4.6E-06
			< 0.03	Ar	31	3.3	< 0.009	2.0E-06	4.68	< 5.3E-01	< 6.9E-06
B101	95.0 - 98.3	364.29 - 360.99	0.1	A	32	3.3	< 0.03	6.5E-06	4.53	1.71	< 2.2E-05
			0.1	B	48	3.3	< 0.03	6.5E-06	3.02	1.14	< 1.5E-05
			0.1	**C**	**64**	**3.3**	**< 0.03**	**6.5E-06**	**2.27**	**0.85**	**< 1.1E-05**
			0.1	Br	48	3.3	< 0.03	6.5E-06	3.02	1.14	< 1.5E-05
			0.1	Ar	32	3.3	< 0.03	6.5E-06	4.53	1.71	< 2.2E-05
B101	98.0 - 101.3	361.29 - 357.99	0.1	A	33	3.3	< 0.03	6.5E-06	4.39	1.65	< 2.1E-05
			0.1	B	50	3.3	< 0.03	6.5E-06	2.93	1.10	< 1.4E-05
			0.1	**C**	**66**	**3.3**	**< 0.03**	**6.5E-06**	**2.20**	**0.83**	**< 1.1E-05**
			0.1	Br	50	3.3	< 0.03	6.5E-06	2.93	1.10	< 1.4E-05
			< 0.03	Ar	33	3.3	< 0.009	2.0E-06	4.39	< 5.0E-01	< 6.4E-06
B101	100.0 - 103.3	359.29 - 355.99	< 0.03	A	34	3.3	< 0.009	2.0E-06	4.33	< 4.9E-01	< 6.4E-06
			< 0.03	B	50	3.3	< 0.009	2.0E-06	2.90	< 3.3E-01	< 4.3E-06
			< 0.03	**C**	**67**	**3.3**	**< 0.009**	**2.0E-06**	**2.16**	**< 2.4E-01**	**< 3.2E-06**
			< 0.03	Br	50	3.3	< 0.009	2.0E-06	2.90	< 3.3E-01	< 4.3E-06
			< 0.03	Ar	34	3.3	< 0.009	2.0E-06	4.33	< 4.9E-01	< 6.4E-06
B102	92.0 - 96.8	362.97 - 358.17	< 0.03	A	32	4.8	< 0.006	2.0E-06	4.60	< 3.6E-01	< 4.6E-06
			< 0.03	B	47	4.8	< 0.006	2.0E-06	3.07	< 2.4E-01	< 3.1E-06
			< 0.03	**C**	**63**	**4.8**	**< 0.006**	**2.0E-06**	**2.30**	**< 1.8E-01**	**< 2.3E-06**
			< 0.03	Br	47	4.8	< 0.006	2.0E-06	3.07	< 2.4E-01	< 3.1E-06
			< 0.03	Ar	32	4.8	< 0.006	2.0E-06	4.60	< 3.6E-01	< 4.6E-06
B102	96.0 - 100.8	358.97 - 354.17	< 0.03	A	33	4.8	< 0.006	2.0E-06	4.39	< 3.4E-01	< 4.4E-06
			< 0.03	B	50	4.8	< 0.006	2.0E-06	2.93	< 2.3E-01	< 3.0E-06
			< 0.03	**C**	**66**	**4.8**	**< 0.006**	**2.0E-06**	**2.20**	**< 1.7E-01**	**< 2.2E-06**
			< 0.03	Br	50	4.8	< 0.006	2.0E-06	2.93	< 2.3E-01	< 3.0E-06
			< 0.03	Ar	33	4.8	< 0.006	2.0E-06	4.39	< 3.4E-01	< 4.4E-06
B102	100.0 - 104.8	354.97 - 350.17	< 0.03	A	34	4.8	< 0.006	2.0E-06	4.26	< 3.3E-01	< 4.3E-06
			< 0.03	B	51	4.8	< 0.006	2.0E-06	2.84	< 2.2E-01	< 2.9E-06
			< 0.03	**C**	**68**	**4.8**	**< 0.006**	**2.0E-06**	**2.13**	**< 1.7E-01**	**< 2.2E-06**
			< 0.03	Br	51	4.8	< 0.006	2.0E-06	2.84	< 2.2E-01	< 2.9E-06
			< 0.03	Ar	34	4.8	< 0.006	2.0E-06	4.26	< 3.3E-01	< 4.3E-06

Notes: Bold text indicates representative values selected for testing interval
No Flow = meter's total consumed volume and flow rate outputs/display indicated zero flow for the indicated pressure step.
Hydraulic conductivity values for pressure steps where no flow was observed are shown as less than the calculated hydraulic conductivity at the minimum observable flow rate (0.03 gpm).
gal/min = gallons per minute
psi = pounds per square inch
bgs = below ground surface
cm/s = centimeters per second

Corehole Location	**Depth** (feet,bgs)	**Elevation** (feet NAVD88)	**Q Injection Rate** (gal/min)	**Lugeon Test Step**	**P Gauge Pressure** (psi)	**L Test Interval** (feet)	**Q / L** (gal/min/feet)	**Hydraulic Conductivity (K)** (ft/min)	**P_o / P** (psi)	**Hydraulic Conductivity** (Lugeons)	**Hydraulic Conductivity** (cm/s)
Lowest Measurable Hydraulic Conductivity											
B100	95.0 - 99.8	354.73 - 349.93	<0.03	C	65	4.8	<0.006	2.0E-06	2.2	<1.7E-01	<2.3E-06
B101	100.0 - 103.3	359.29 - 355.99	<0.03	C	67	3.3	<0.009	2.0E-06	2.2	<2.4E-01	<3.2E-06
B102	96.0 - 100.8	358.97 - 354.17	<0.03	C	66	4.8	<0.006	2.0E-06	2.2	<1.7E-01	< 2.2E-06

Notes: Lowest measureable hydraulic conductivity was calculated assuming minimum observable flow rate at maximum test pressure; maximum test/gauge pressue depends on test depth and maximum packer inflation pressure.
The 96.0 - 100.8 foot interval from B102 was selected as the lowest measureable hydraulic conductivity because it is the closer interval to the ground surface.

ATTACHMENTS

ATTACHMENT A
Soil Boring Logs

RAMBOLL

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Hennepin Bedrock Investigation		B-100

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Todd Schmalfedt Cascade Drilling LP	10/28/2024	10/29/2024	Sonic/HQ

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
	Feet (NAVD88)	449.73 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐

State Plane 1,688,599.07 N, 2,526,731.50 E E / W

1/4 of 1/4 of Section , T N, R

Lat 41° 18' 0.2268" Long 89° 19' 44.5512"

Local Grid Location ☐ N ☐ S Feet ☐ E ☐ W Feet

Facility ID	County	State	Civil Town/City/ or Village
	Putnam	IL	Hennepin

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	120 70		1	0 - 8.2' **FILL, WELL-GRADED SAND:** SW, very dark grayish brown (10YR 3/2), fine to medium sand, gravel (5-15%), silt (0-10%), roots (0-5%), dry to moist.										
			2	2' dark yellowish brown (10YR 4/4).										
			3											
			4		(FILL) SW									
			5	5' brown (10YR 5/3), gravel (10-20%).										
			6											
			7											
			8											
			9	8.2 - 9.5' **CLAYEY SILT:** ML/CL, very dark gray (10YR 3/1), moist.	ML/CL									PP = 0.25
2 CS	120 117		10	9.5 - 30' **SILTY CLAY:** CL/ML, very dark gray (10YR 3/1), low toughness, medium plasticity, very soft, moist.										PP = 0.5
			11	10' gravel (0-5%), high plasticity.										
			12											
			13		CL/ML									PP = 0.5
			14											
			15											
			16	15.3' brown (10YR 4/3), shells (0-5%), wood (0-5%).										PP = 0.25
			17											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	Tel / Fax
	Ramboll 234 W Florida St, Milwaukee WI 53204	Tel: 262-901-0095 Fax:

Boring Number B-100 Page 2 of 4

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			18	9.5 - 30' **SILTY CLAY:** CL/ML, very dark gray (10YR 3/1), low toughness, medium plasticity, very soft, moist. *(continued)*										PP = 0.25
			19											
3 CS	120 99		20	20' very coarse sand (0-5%), wet.										PP = 0.5
			21											
			22											
			23											
			24		CL/ML									
			25											PP = 0.5
			26	25.2' moist. 25.6' dark gray (5YR 4/1).										
			27											
			28											
			29											
			30											
4 CS	120 120		31	30 - 40' **SILTY CLAY WITH SAND:** (CL/ML)S, dark gray (5YR 4/1), fine sand, shells (0-5%), wood (0-5%), low toughness, medium plasticity, moist.										PP = 0.5
			32											
			33	33.2' - 33.9' sand (25-35%).										
			34											
			35	35' - 36.8' sand (25-35%).	(CL/ML)S									PP = 0.5
			36											
			37											
			38											
			39											
			40											
5 CS	120 120		41	40 - 50' **WELL-GRADED SAND:** SW, gray (10YR 5/1), fine to coarse sand, gravel (0-5%), shells (0-5%), wet.										
			42											
			43		SW									
			44											
			45											

Boring Number B-100 Page 3 of 4

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			46	40 - 50' **WELL-GRADED SAND:** SW, gray (10YR 5/1), fine to coarse sand, gravel (0-5%), shells (0-5%), wet. *(continued)*	SW									
			47											
			48											
			49											
6 CS	120 120		50	50 - 58.7' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), shells (0-5%), low toughness, high plasticity, very soft, moist.										
			51											
			52											
			53											
			54		CL/ML									
			55											
			56											
			57											
			58											
			59	58.7 - 70' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, gray (10YR 6/1), subangular to subrounded gravel, cobbles (0-5%), loose, wet.										
7 CS	120 31		60											
			61											
			62											
			63											
			64		(GW)s									
			65											
			66											
			67											
			68											
			69											
8 CS	24 24		70	70 - 85.4' **SHALE:** BDX (SH), gray (10YR 5/1), moderately fractured, highly weathered to residual soil, thinly laminated, very weak, - 72.0' blocky, loose, dry.										
			71											
9 CS	36 36		72	72' - 72.8' moderately weathered.	BDX (SH)									
			73	72.8' - 73.5' gravel (5-15%).										

Boring Number B-100 Page 4 of 4

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			74	70 - 85.4' **SHALE:** BDX (SH), gray (10YR 5/1), moderately fractured, highly weathered to residual soil, thinly laminated, very weak, - 72.0' blocky, loose, dry. *(continued)*										
10 CS	60 29		75	75' gravel (5-15%).										75' - 80' significant outwash
			76											
			77											
			78											
			79											
			80		BDX (SH)									
11 CS	60 60		81											
			82											
			83											
			84											
			85	84.3' moderately to highly weathered, weak.										
12 CORE	60 54		86	85.4 - 100' **SHALE:** BDX (SH), very dark gray (10YR 3/1), moderately fractured, extremely narrow appetures, slightly weathered, thinly laminated, strong.										Core 1, RQD=72% Packer interval = 86' - 90.8', Lowest K = < 2.4E-06 cm/s
			87											
			88											
			89											
			90											
13 CORE	60 60		91	90' fresh. 90.9' 1.0" band of shaley limestone, lighter in color. 91' - 91.6' 0.5" bands of shaley limestone throughout, lighter in color. 91.7' - 92.5 slightly weathered.	BDX (SH)									Core 2, RQD=52% Packer interval = 90' - 94.8', Lowest K = < 2.4E-06 cm/s
			92											
			93											
			94											
			95	94.3' - 95.0' slightly weathered.										
14 CORE	60 60		96											Core 3, RQD=32% Packer interval = 95' - 99.8', Lowest K = < 2.3E-06 cm/s
			97											
			98											
			99											
			100	100' End of Boring.										

RAMBOLL

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Hennepin Bedrock Investigation		B-101

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Todd Schmalfedt Cascade Drilling LP	11/1/2024	11/1/2024	Sonic/HQ

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
	Feet (NAVD88)	459.29 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐

State Plane 1,689,421.43 N, 2,529,056.11 E E / W

1/4 of 1/4 of Section , T N, R

Lat 41° 18' 8.1288" Long 89° 19' 13.9944"

Local Grid Location Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Putnam	IL	Hennepin

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	120 87		0	0 - 1.7' **FILL, SANDY SILT WITH GRAVEL:** s(ML)g, very dark brown (10YR 2/2), organics (0-5%), moist.	(FILL) s(ML)g									
			2	1.7 - 3.5' **FILL, POORLY-GRADED SAND WITH GRAVEL:** (SP)g, dark yellowish brown (10YR 4/4), medium sand, subangular to subrounded gravel, cobbles (0-5%), moist. 2.7' silt (10-20%).	(FILL) (SP)g									
			4	3.5 - 6' **CLAYEY SAND:** SC, dark yellowish brown (10YR 4/4), fine to medium sand, gravel (10-20%), silt (0-10%), moist.	SC									
			6	6 - 16.2' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g, dark yellowish brown (10YR 4/4), medium sand, subrounded gravel, cobbles (0-5%), moist. 7.3' brownish yellow (10YR 6/6), fine to medium sand.										
2 CS	120 75		10		(SP)g									
			14											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm Ramboll
234 W Florida St, Milwaukee WI 53204

Tel: 262-901-0095
Fax:

Boring Number B-101 Page 2 of 5

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			15	6 - 16.2' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g, dark yellowish brown (10YR 4/4), medium sand, subrounded gravel, cobbles (0-5%), moist. *(continued)* 15' medium to coarse sand.	(SP)g									
			16											
			17	16.2 - 17.8' **WELL-GRADED SAND:** SW, dark yellowish brown (10YR 4/4), medium to coarse sand, gravel (5-15%), moist to wet.	SW									
			18	17.8 - 20' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, dark yellowish brown (10YR 4/4), silt (10-20%), cobbles (5-15%), wet.	(SW)g									
			19											
3 CS	120 86		20	20 - 30.9' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g, brown (10YR 4/3), very coarse sand, wet. 20.3' cobble.										
			21											
			22											
			23											
			24	23.5' medium sand, gravel (0-5%).										
			25											
			26		(SP)g									
			27											
			28	27.2' dark yellowish brown (10YR 4/4), gravel (20-30%).										
			29											
4 CS	120 93		30	29.7' cobbles (5-15%).										
			31	30.9 - 50' **POORLY-GRADED SAND:** SP, dark yellowish brown (10YR 4/4), very fine sand, wet.										
			32											
			33											
			34		SP									
			35											
			36	35.3' - 36.2' clay (20-30%). 36.2' very fine to fine sand.										
			37											

Boring Number B-101 Page 3 of 5

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			38	30.9 - 50' **POORLY-GRADED SAND:** SP, dark yellowish brown (10YR 4/4), very fine sand, wet. *(continued)*										
			39											
5 CS	120 68		40											
			41											
			42											
			43											
			44		SP									
			45											
			46											
			47	46.3' - 46.8' fine sand.										
			48											
			49											
6 CS	120 106		50	50 - 58.6' **POORLY-GRADED SAND:** SP, dark yellowish brown (10YR 4/4), medium sand, wet.										
			51											
			52											
			53											
			54		SP									
			55											
			56											
			57											
			58											
			59	58.6 - 59.4' **SILTY SAND WITH GRAVEL:** (SM)g, black (10YR 2/1), fine to medium sand, subangular to subrounded gravel, organics (5-15%), wet.	(SM)g									
7 CS	120 10		60		(GW)s									

Boring Number B-101 Page 4 of 5

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			61	59.4 - 80' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, dark yellowish brown (10YR 4/4), subangular to subrounded gravel, medium sand, cobbles (0-5%), wet. *(continued)* 61' yellow (10YR 7/6).										
			62											
			63											
			64											
			65											
			66											
			67											
			68											
			69											
8 CS	120 86		70		(GW)s									
			71											
			72											
			73											
			74											
			75											
			76											
			77											
			78											
			79											
9 CS	60 52		80	80 - 85' **WELL-GRADED GRAVEL:** GW, yellow (10YR 7/6), subangular to subrounded gravel, sand (5-15%), wet.										
			81											
			82		GW									
			83											
			84											

Boring Number B-101 Page 5 of 5

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			85	83.9' gravel coarsens, cobbles (0-5%).	GW									
10 CS	60 40		85	85 - 90.6' **SHALEY LIMESTONE:** BDX (LS/SH), gray (10YR 5/1), fine sand, moderately to intensely fractured, narrow apetures, slightly weathered, laminated, very strong.	BDX (LS/SH)									
			86											
			87											
			88											
			89											
			90											
11 CORE	60 47		91	90.6 - 92.7' **LIMESTONE:** BDX (LS), light gray (GLEY 7/N), fine sand, moderately to intensely fractured, narrow apetures, slightly weathered to fresh, very strong.	BDX (LS)									Core 1, RQD=32%
			92											Packer interval = 92' - 95.3', Lowest K = < 3.4E-06 cm/s
			93	92.7 - 95' **SHALEY LIMESTONE:** BDX (LS/SH), light gray (GLEY 7/N), fine sand, moderately to intensely fractured, narrow apetures, moderately weathered, very strong. 93' slightly weathered.	BDX (LS/SH)									
			94											
12 CORE	60 59		95	95 - 105' **SHALE:** BDX (SH), gray (10YR 5/1), intesely fractured, very narrow apetures, moderately weathered, laminated, strong.	BDX (SH)									Core 2, RQD=39%
			96											Packer interval = 95' - 98.3', Lowest K = < 1.1E-05 cm/s
			97											
			98											Packer interval = 98' - 101.3', Lowest K = < 1.1E-05 cm/s
			99											
13 CORE	60 60		100	100' - 101.0' no fractures.										Core 3, RQD=52%
			101											
			102	102.2' - 102.5' slightly weathered. 102.5' - 103.3' slightly fractured, fresh.										Packer interval = 100' - 103.3', Lowest K = < 3.2E-06 cm/s
			103											
			104											
			105	105' End of Boring.										

RAMBOLL

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Hennepin Bedrock Investigation		B-102

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Todd Schmalfedt Cascade Drilling LP	11/6/2024	11/6/2024	Sonic/HQ

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
	Feet (NAVD88)	454.97 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐

State Plane 1,688,214.42 N, 2,528,526.67 E E / W

1/4 of 1/4 of Section , T N, R

Lat 41° 17' 56.2524"

Long 89° 19' 21.0828"

Local Grid Location ☐ N ☐ S Feet ☐ E ☐ W Feet

Facility ID	County	State	Civil Town/City/ or Village
	Putnam	IL	Hennepin

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	120 115		0	0 - 1.9' **FILL, SILTY SAND:** SM, very dark brown (10YR 2/2), fine to medium sand, moist.	(FILL) SM									
			1											
			2	1.7' gravel (20-30%).										
				1.9 - 15.5' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, dark yellowish brown (10YR 4/6), fine to medium sand, angular to subrounded gravel, moist.									
			3	3.1' gravel (10-20%).										
			4											
			5											
			6											
			7	6.8' gravel (20-30%).										
			8		(SW)g									
			9											
2 CS	120 112		10											
			11											
			12											
			13											
			14											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm Ramboll
234 W Florida St, Milwaukee WI 53204

Tel: 262-901-0095
Fax:

Boring Number B-102 Page 2 of 5

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			15	13.9' fine sand. 1.9 - 15.5' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, dark yellowish brown (10YR 4/6), fine to medium sand, angular to subrounded gravel, moist. *(continued)*	(SW)g									
			16	15.5 - 34' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, brown (10YR 5/3), subangular to subrounded gravel, cobbles (0-5%), wet.										
			17											
			18											
			19											
3 CS	240 30		20											20' - 40' poor recovery
			21											
			22											
			23											
			24											
			25		(GW)s									
			26											
			27											
			28											
			29											
			30											
			31											
			32											
			33											
			34	34 - 40' **WELL-GRADED SAND:** SW, yellowish brown (10YR 5/4), medium to coarse sand, gravel (0-5%), wet.										
			35											
			36		SW									
			37											

Boring Number B-102 Page 3 of 5

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			38	34 - 40' **WELL-GRADED SAND:** SW, yellowish brown (10YR 5/4), medium to coarse sand, gravel (0-5%), wet. *(continued)*	SW									
			39											
4 CS	120 24		40	40 - 50' **POORLY-GRADED SAND:** SP, yellowish brown (10YR 5/4), very fine sand, wet.										
			41											
			42											
			43											
			44											
			45		SP									
			46											
			47											
			48											
			49											
5 CS	120 14		50	50 - 70' **WELL-GRADED GRAVEL:** GW, yellowish brown (10YR 5/4), subangular to subrounded gravel, sand (5-15%), loose, wet.										
			51											
			52											
			53											
			54											
			55		GW									
			56											
			57											
			58											
			59											
6 CS	120 11		60											

Boring Number B-102 Page 4 of 5

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			61	50 - 70' **WELL-GRADED GRAVEL:** GW, yellowish brown (10YR 5/4), subangular to subrounded gravel, sand (5-15%), loose, wet. *(continued)*										
			62											
			63											
			64											
			65		GW									
			66											
			67											
			68											
			69											
7 CS	180 96		70	70 - 90' **SHALE:** BDX (SH), gray (GLEY 1 5/N), extremely weathered, laminated, very weak to weak, dry.											
			71											
			72											
			73											
			74											
			75											
			76	75.5' - 85.0' extremely weathered to residual soil, blocky, platy.										
			77		BDX (SH)									
			78											
			79											
			80											
			81											
			82											
			83											
			84											

Boring Number B-102 Page 5 of 5

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			85	70 - 90' **SHALE:** BDX (SH), gray (GLEY 1 5/N), extremely weathered, laminated, very weak to weak, dry. *(continued)*										
8 CS	60 60		86											
			87	87' - 90.0' blocky, platy.	BDX (SH)									
			88											
			89											
			90	90 - 97.9' **SHALE:** BDX (SH), dark gray (10YR 4/1), slightly fractured, very narrow apetures, fresh, laminated, very strong.										
9 CORE	60 51		91											Core 1, RQD=29%
			92	91.6' - 95.0' intensely fractured.										Packer interval = 92' - 96.8', Lowest K = < 2.3E-06 cm/s
			93											
			94	93.3' - 95.0' moderately weathered.	BDX (SH)									
			95											
10 CORE	60 54		96											Core 2, RQD=48%
			97											Packer interval = 96' - 100.8', Lowest K = < 2.2E-06 cm/s
			98	97.9 - 100' **SHALEY LIMESTONE:** BDX (LS/SH), dark gray (10YR 4/1), no fractures, fresh, laminated, very strong.										
			99		BDX (LS/SH)									
			100	100 - 105' **SHALE:** BDX (SH), dark gray (10YR 4/1), slightly fractured, very narrow apetures, fresh, laminated, very strong.										
11 CORE	60 60		101											Core 3, RQD=70%
			102	101.8' - 102.4' moderately weathered.										Packer interval = 101' - 104.8', Lowest K = < 2.2E-06 cm/s
			103	103.2' no fractures.	BDX (SH)									
			104											
			105	105' End of Boring.										

ATTACHMENT B
Lugeon Test Data Sheets

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant	Project Number:	1940110419	Page 1 of 2
Field Personnel: EGP, LCA	Weather Conditions: 63 deg F/ Cloudy Windy		
Drilling Subcontractor: Cascade	LS450 - Sonic		
Lead Driller: Todd Schmalfeldt	Driller's Helper: Paul, Jeff		
Borehole ID: B100	**Depth/Packer Interval: 86-90.8'**		
Static Water Level: 4.20	**Packer Inflation (psi): 200**		

Packer Specs**:** TAM International packer elements: 3.5"-dia at rest; 6" max inflated dia; unconfined pressure rating: 65 psi; max inflation pressure: 350 psi

Site-specific construction: total length of dual/straddle assembly: 10' 1/4"; length of perforated interval - 4'10"; depth to top of bottom packer: 90.8'; depth to bottom of upper packer: 86.0; borehole dia: 4 7/8" (HQ barrel)

Packer Inflation = [(0.43 x Depth to Packer, ft) + unconfined pressure rating, psi + injection pump pressure, psi] x 1.1
(i.e. at 150 ft depth and 100 psi injection pressure: inflation pressure = [(0.43 x 150) + 65 + 100] x 1.1 = 200 psi

Date: 10/31/24 Start Time: 9:46

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
0	0	0	209.6	0.00	4.2	Tank Level: ~300 gal.
0	30	30		0.00	4.2	closed bypass valve to get to A
1	0	30		0.00	4.2	step psi
2	0	30	210.0	0.00	4.2	
3	0	30		0.00	4.2	
4	0	30		0.00	4.2	
5	0	30	210.1	0.00	4.2	closed bypass valve to get to B
5	30	45		0.00	4.2	step psi
6	0	45		0.00	4.2	
6	30	45		0.00	4.2	
7	0	45	210.2	0.00	4.2	
8	0	45		0.00	4.2	
9	0	45		0.00	4.2	
10	0	45		0.00	4.2	closed bypass valve to get to C
10	30	60		0.00	4.2	step psi
11	0	60		0.00	4.2	
11	30	60		0.00	4.2	
12	0	60		0.00	4.2	
13	0	60		0.00	4.2	
14	0	60	210.2	0.00	4.2	Tank Level: ~295 gal.
15	0	60		0.00	4.2	opened bypass valve to get to
15	30	45		0.00	4.2	Br step psi
16	0	45		0.00	4.2	
17	0	45		0.00	4.2	
18	0	45	210.2	0.00	4.2	
19	0	45		0.00	4.2	
20	0	45		0.00	4.2	opened bypass valve to get to
20	30	30		0.00	4.2	Ar step psi

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant		Project Number:	1940110419	Page 2 of 2
Borehole ID: B100		**Depth / Packer Interval: 90-94.8'**		
Date: 10/31/24 Start Time: 09:46				

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
21	0	30		0.00	4.2	
22	0	30	210.2	0.00	4.2	
23	0	30		0.00	4.2	
24	0	30		0.00	4.2	
25	0	30	210	0.00	4.2	Tank Level: ~295 gal.
TEST ENDED @ 10:11						

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant	Project Number:	1940110419	Page 1 of 2
Field Personnel: EGP, LCA	Weather Conditions: 60 deg F/ Rainy		
Drilling Subcontractor: Cascade	LS450 - Sonic		
Lead Driller: Todd Schmalfeldt	Driller's Helper: Paul, Jeff		
Borehole ID: B100	**Depth/Packer Interval: 90-94.8'**		
Static Water Level: 4.18	**Packer Inflation (psi): 200**		

Packer Specs**:** TAM International packer elements: 3.5"-dia at rest; 6" max inflated dia; unconfined pressure rating: 65 psi; max inflation pressure: 350 psi

Site-specific construction: total length of dual/straddle assembly: 10' 1/4"; length of perforated interval - 4'10"; depth to top of bottom packer: 94.8'; depth to bottom of upper packer: 90.0; borehole dia: 4 7/8" (HQ barrel)

Packer Inflation = [(0.43 x Depth to Packer, ft) + unconfined pressure rating, psi + injection pump pressure, psi] x 1.1
(i.e. at 150 ft depth and 100 psi injection pressure: inflation pressure = [(0.43 x 150) + 65 + 100] x 1.1 = 200 psi

Date: 10/31/24 Start Time: 10:38

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
0	0	0	210.2	0.00	4.18	Tank Level: ~295 gal.
0	30	31		0.00	4.18	closed bypass valve to get to A
1	0	31		0.00	4.18	step psi
1	30	31		0.00	4.18	
2	0	31		0.00	4.18	
2	30	31		0.00	4.18	
3	0	31	210.3	0.00	4.18	
4	0	31		0.00	4.18	
5	0	31		0.00	4.18	closed bypass valve to get to B
5	30	46.5		0.00	4.18	step psi
6	0	46.5		0.00	4.18	
6	30	46.5		0.00	4.18	
7	0	46.5		0.00	4.18	
7	30	46.5	210.4	0.00	4.18	
8	0	46.5		0.00	4.18	
9	0	46.5		0.00	4.18	
10	0	46.5		0.00	4.18	closed bypass valve to get to C
10	30	62		0.00	4.18	step psi
11	0	62		0.00	4.18	
11	30	62		0.00	4.18	
12	0	62		0.00	4.18	
12	30	62		0.00	4.18	
13	0	62		0.00	4.18	
14	0	62		0.00	4.18	
15	0	62		0.00	4.18	opened bypass valve to get to
15	30	46.5		0.00	4.18	Br step psi
16	0	46.5		0.00	4.18	
16	30	46.5		0.00	4.18	

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant				Project Number:	1940110419	Page 2 of 2
Borehole ID: B100				**Depth / Packer Interval: 90-94.8'**		
Date: 10/31/24 Start Time: 10:38						
Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
17	0	46.5	210.3	0.00	4.18	
17	30	46.5		0.00	4.18	
18	0	46.5		0.00	4.18	
19	0	46.5		0.00	4.18	
20	0	46.5		0.00	4.18	opened bypass valve to get to
20	30	32		0.00	4.18	Ar step psi
21	0	32		0.00	4.18	
21	30	32		0.00	4.18	
22	0	32		0.00	4.18	
22	30	32		0.00	4.18	
23	0	32		0.00	4.18	
24	0	32		0.00	4.18	
25	0	32	210.3	0.00	4.18	Tank Level: ~290 gal.
TEST ENDED @ 11:03						

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant	Project Number:	1940110419	Page 1 of 2
Field Personnel: EGP, LCA	Weather Conditions: 58 deg F/ Cloudy/ Windy		
Drilling Subcontractor: Cascade	LS450 - Sonic		
Lead Driller: Todd Schmalfeldt	Driller's Helper: Paul, Jeff		
Borehole ID: B100	**Depth/Packer Interval: 95-99.8'**		
Static Water Level: 4.18	**Packer Inflation (psi): 200**		

Packer Specs**:** TAM International packer elements: 3.5"-dia at rest; 6" max inflated dia; unconfined pressure rating: 65 psi; max inflation pressure: 350 psi

Site-specific construction: total length of dual/straddle assembly: 10' 1/4"; length of perforated interval - 4'10"; (single packer) depth to bottom of hole: 99.8'; depth to bottom of upper packer: 95.0; borehole dia: 4 7/8" (HQ barrel)

Packer Inflation = [(0.43 x Depth to Packer, ft) + unconfined pressure rating, psi + injection pump pressure, psi] x 1.1
(i.e. at 150 ft depth and 100 psi injection pressure: inflation pressure = [(0.43 x 150) + 65 + 100] x 1.1 = 200 psi

Date: 10/31/24 Start Time: 12:54

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
0	0	0	210.2	0.00	4.18	Tank Level: ~290 gal.
0	30	32.5		0.00	4.18	closed bypass valve to get to A
1	0	32.5		0.00	4.18	step psi
1	30	32.5		0.00	4.18	
2	0	32.5	211.2	0.00	4.18	
3	0	32.5		0.00	4.18	
4	0	32.5		0.00	4.18	
5	0	32.5	211.2	0.00	4.18	closed bypass valve to get to B
5	30	48.75		0.00	4.18	step psi
6	0	48.75		0.00	4.18	
7	0	48.75		0.00	4.18	
8	0	48.75		0.00	4.18	
9	0	48.75	211.2	0.00	4.18	
10	0	48.75		0.00	4.18	closed bypass valve to get to C
10	30	65		0.00	4.18	step psi
11	0	65		0.00	4.18	
12	0	65		0.00	4.18	
13	0	65		0.00	4.18	
14	0	65		0.00	4.18	
15	0	65		0.00	4.18	opened bypass valve to get to
15	30	48.75		0.00	4.18	Br step psi
16	0	48.75	211.2	0.00	4.18	
17	0	48.75		0.00	4.18	
18	0	48.75		0.00	4.18	
19	0	48.75		0.00	4.18	
20	0	48.75		0.00	4.18	opened bypass valve to get to
20	30	32.5		0.00	4.18	Ar step psi
21	0	32.5		0.00	4.18	

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant			Project Number:	1940110419	Page 2 of 2
Borehole ID: B100			**Depth / Packer Interval: 95-99.8'**		
Date: 10/31/24 Start Time: 12:54					

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
22	0	32.5	211.2	0.00	4.18	
23	0	32.5		0.00	4.18	
24	0	32.5		0.00	4.18	
25	0	32.5	211.2	0.00	4.18	
END OF TEST (13:19)						

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant	Project Number:	1940110419	Page 1 of 2
Field Personnel: LCA	Weather Conditions: 65 deg F / Windy		
Drilling Subcontractor: Cascade	LS450 - Sonic		
Lead Driller: Todd Schmalfeldt	Driller's Helper: Paul, Jeff		
Borehole ID: B101	**Depth/Packer Interval: 92'-95'**		
Static Water Level: 13.82	**Packer Inflation (psi): 200**		

Packer Specs**:** TAM International packer elements: 3.5"-dia at rest; 6" max inflated dia;
unconfined pressure rating: 65 psi; max inflation pressure: 350 psi

Site-specific construction: total length of dual/straddle assembly: 10' 1/4"; length of perforated interval - 4'10";
depth to top of bottom packer: 90.8'; depth to bottom of upper packer: 86.0; borehole dia: 4 7/8" (HQ barrel)

Packer Inflation = [(0.43 x Depth to Packer, ft) + unconfined pressure rating, psi + injection pump pressure, psi] x 1.1
(i.e. at 150 ft depth and 100 psi injection pressure: inflation pressure = [(0.43 x 150) + 65 + 100] x 1.1 = 200 psi

Date: 11/4/24 Start Time: 0708

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
0	0	0	-	0.00	13.82	
0	30	31	-	0.00	13.82	closed bypass valve to get to A
1	0	31	-	0.00	13.82	step psi
2	0	31	-	0.00	13.82	
3	0	31	-	0.00	13.82	
4	0	31	-	0.00	13.82	
5	0	31	-	0.00	13.82	closed bypass valve to get to B
5	30	46.5	-	0.00	13.82	step psi
6	0	46.5	-	0.00	13.82	
6	30	46.5	-	0.00	13.82	
7	0	46.5	-	0.00	13.82	
8	0	46.5	-	0.00	13.82	
9	0	46.5	-	0.00	13.82	
10	0	46.5	-	0.00	13.82	closed bypass valve to get to C
10	30	62	-	0.00	13.82	step psi
11	0	62	-	0.00	13.82	
11	30	62	-	0.00	13.82	
12	0	62	-	0.00	13.82	
13	0	62	-	0.00	13.82	
14	0	62	-	0.00	13.82	
15	0	62	-	0.00	13.82	opened bypass valve to get to
15	30	46.5	-	0.00	13.82	Br step psi
16	0	46.5	-	0.00	13.82	
17	0	46.5	-	0.00	13.82	
18	0	46.5	-	0.00	13.82	
19	0	46.5	-	0.00	13.82	
20	0	46.5	-	0.00	13.82	opened bypass valve to get to
20	30	31	-	0.00	13.82	Ar step psi

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant				Project Number:	1940110419	Page 2 of 2
Borehole ID: B101				**Depth/Packer Interval: 92'-95'**		
Date: 11/4/24 Start Time: 0708						
Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
21	0	31	-	0.00	13.82	
22	0	31	-	0.00	13.82	
23	0	31	-	0.00	13.82	
24	0	31	-	0.00	13.82	
25	0	31	-	0.00	13.82	~ 5 gal. water used throughout packer test
TEST ENDED @ 0733						

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant	Project Number:	1940110419	Page 1 of 2
Field Personnel: LCA	Weather Conditions: 65 deg F / Windy		
Drilling Subcontractor: Cascade	LS450 - Sonic		
Lead Driller: Todd Schmalfeldt	Driller's Helper: Paul, Jeff		
Borehole ID: B101	**Depth/Packer Interval: 95'-98'**		
Static Water Level: 13.82	**Packer Inflation (psi): 200**		

Packer Specs**:** TAM International packer elements: 3.5"-dia at rest; 6" max inflated dia;
unconfined pressure rating: 65 psi; max inflation pressure: 350 psi

Site-specific construction: total length of dual/straddle assembly: 10' 1/4"; length of perforated interval - 4'10";
depth to top of bottom packer: 90.8'; depth to bottom of upper packer: 86.0; borehole dia: 4 7/8" (HQ barrel)

Packer Inflation = [(0.43 x Depth to Packer, ft) + unconfined pressure rating, psi + injection pump pressure, psi] x 1.1
(i.e. at 150 ft depth and 100 psi injection pressure: inflation pressure = [(0.43 x 150) + 65 + 100] x 1.1 = 200 psi

Date: 11/4/24 Start Time: 0736

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
0	0	0	-	0.10	13.82	
0	30	32	-	0.10	13.82	closed bypass valve to get to A
1	0	32	-	0.10	13.82	step psi
2	0	32	-	0.10	13.82	
3	0	32	-	0.10	13.82	
4	0	32	-	0.10	13.82	
5	0	32	-	0.10	13.82	closed bypass valve to get to B
5	30	48	-	0.10	13.82	step psi
6	0	48	-	0.10	13.82	
6	30	48	-	0.10	13.82	
7	0	48	-	0.10	13.82	
8	0	48	-	0.10	13.82	
9	0	48	-	0.10	13.82	
10	0	48	-	0.10	13.82	closed bypass valve to get to C
10	30	64	-	0.10	13.82	step psi
11	0	64	-	0.10	13.82	
11	30	64	-	0.10	13.82	
12	0	64	-	0.10	13.82	
13	0	64	-	0.10	13.82	
14	0	64	-	0.10	13.82	
15	0	64	-	0.10	13.82	opened bypass valve to get to
15	30	48	-	0.10	13.82	Br step psi
16	0	48	-	0.10	13.82	
17	0	48	-	0.10	13.82	
18	0	48	-	0.10	13.82	
19	0	48	-	0.10	13.82	
20	0	48	-	0.10	13.82	opened bypass valve to get to
20	30	32	-	0.10	13.82	Ar step psi

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant				Project Number:	1940110419	Page 2 of 2
Borehole ID: B101				**Depth/Packer Interval: 95'-98'**		
Date: 11/4/24 Start Time: 0736						
Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
21	0	32	-	0.10	13.82	
22	0	32	-	0.10	13.82	
23	0	32	-	0.10	13.82	
24	0	32	-	0.10	13.82	
25	0	32	-	0.10	13.82	~ 5 gal. water used throughout packer test
TEST ENDED @ 0801						

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant	Project Number:	1940110419	Page 1 of 2
Field Personnel: EGP, LCA	Weather Conditions: 65 deg F / Windy		
Drilling Subcontractor: Cascade	LS450 - Sonic		
Lead Driller: Todd Schmalfeldt	Driller's Helper: Paul, Jeff		
Borehole ID: B101	**Depth/Packer Interval: 98'-101'**		
Static Water Level: 13.82	**Packer Inflation (psi): 200**		

Packer Specs**:** TAM International packer elements: 3.5"-dia at rest; 6" max inflated dia;
unconfined pressure rating: 65 psi; max inflation pressure: 350 psi

Site-specific construction: total length of dual/straddle assembly: 10' 1/4"; length of perforated interval - 4'10";
depth to top of bottom packer: 90.8'; depth to bottom of upper packer: 86.0; borehole dia: 4 7/8" (HQ barrel)

Packer Inflation = [(0.43 x Depth to Packer, ft) + unconfined pressure rating, psi + injection pump pressure, psi] x 1.1
(i.e. at 150 ft depth and 100 psi injection pressure: inflation pressure = [(0.43 x 150) + 65 + 100] x 1.1 = 200 psi

Date: 11/4/24 Start Time: 0807

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
0	0	0	-	0.00	13.82	
0	30	33	-	0.00	13.82	closed bypass valve to get to A
1	0	33	-	0.10	13.82	step psi
2	0	33	-	0.10	13.82	
3	0	33	-	0.10	13.82	
4	0	33	-	0.10	13.82	
5	0	33	-	0.10	13.82	closed bypass valve to get to B
5	30	49.5	-	0.10	13.82	step psi
6	0	49.5	-	0.10	13.82	
6	30	49.5	-	0.10	13.82	
7	0	49.5	-	0.10	13.82	
8	0	49.5	-	0.10	13.82	
9	0	49.5	-	0.10	13.82	
10	0	49.5	-	0.10	13.82	closed bypass valve to get to C
10	30	66	-	0.10	13.82	step psi
11	0	66	-	0.10	13.82	
11	30	66	-	0.10	13.82	
12	0	66	-	0.10	13.82	
13	0	66	-	0.10	13.82	
14	0	66	-	0.10	13.82	
15	0	66	-	0.10	13.82	opened bypass valve to get to
15	30	49.5	-	0.10	13.82	Br step psi
16	0	49.5	-	0.10	13.82	
17	0	49.5	-	0.10	13.82	
18	0	49.5	-	0.10	13.82	
19	0	49.5	-	0.00	13.82	
20	0	49.5	-	0.00	13.82	opened bypass valve to get to
20	30	33	-	0.10	13.82	Ar step psi

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant				Project Number:	1940110419	Page 2 of 2
Borehole ID: B101				**Depth/Packer Interval: 98'-101'**		
Date: 11/4/24 Start Time: 0807						
Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
21	0	33	-	0.00	13.82	
22	0	33	-	0.00	13.82	
23	0	33	-	0.00	13.82	
24	0	33	-	0.00	13.82	
25	0	33	-	0.00	13.82	~ 5 gal. water used throughout packer test
TEST ENDED @ 0832						

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant	Project Number:	1940110419	Page 1 of 2
Field Personnel: EGP, LCA	Weather Conditions: 65 deg F / Windy		
Drilling Subcontractor: Cascade	LS450 - Sonic		
Lead Driller: Todd Schmalfeldt	Driller's Helper: Paul, Jeff		
Borehole ID: B101	**Depth/Packer Interval: 100'-103'**		
Static Water Level: 13.82	**Packer Inflation (psi): 200**		

Packer Specs**:** TAM International packer elements: 3.5"-dia at rest; 6" max inflated dia; unconfined pressure rating: 65 psi; max inflation pressure: 350 psi

Site-specific construction: total length of dual/straddle assembly: 10' 1/4"; length of perforated interval - 4'10"; depth to top of bottom packer: 90.8'; depth to bottom of upper packer: 86.0; borehole dia: 4 7/8" (HQ barrel)

Packer Inflation = [(0.43 x Depth to Packer, ft) + unconfined pressure rating, psi + injection pump pressure, psi] x 1.1
(i.e. at 150 ft depth and 100 psi injection pressure: inflation pressure = [(0.43 x 150) + 65 + 100] x 1.1 = 200 psi

Date: 11/4/24 Start Time: 0841

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
0	0	0	-	0.00	13.82	
0	30	33.5	-	0.00	13.82	closed bypass valve to get to A
1	0	33.5	-	0.00	13.82	step psi
2	0	33.5	-	0.00	13.82	
3	0	33.5	-	0.00	13.82	
4	0	33.5	-	0.00	13.82	
5	0	33.5	-	0.00	13.82	closed bypass valve to get to B
5	30	50	-	0.00	13.82	step psi
6	0	50	-	0.00	13.82	
6	30	50	-	0.00	13.82	
7	0	50	-	0.00	13.82	
8	0	50	-	0.00	13.82	
9	0	50	-	0.00	13.82	
10	0	50	-	0.00	13.82	closed bypass valve to get to C
10	30	67	-	0.00	13.82	step psi
11	0	67	-	0.00	13.82	
11	30	67	-	0.00	13.82	
12	0	67	-	0.00	13.82	
13	0	67	-	0.00	13.82	
14	0	67	-	0.00	13.82	
15	0	67	-	0.00	13.82	opened bypass valve to get to
15	30	50	-	0.00	13.82	Br step psi
16	0	50	-	0.00	13.82	
17	0	50	-	0.00	13.82	
18	0	50	-	0.00	13.82	
19	0	50	-	0.00	13.82	
20	0	50	-	0.00	13.82	opened bypass valve to get to
20	30	33.5	-	0.00	13.82	Ar step psi

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant				Project Number:	1940110419	Page 2 of 2
Borehole ID: B101				**Depth/Packer Interval: 100'-103'**		
Date: 11/4/24 Start Time: 0841						
Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
21	0	33.5	-	0.00	13.82	
22	0	33.5	-	0.00	13.82	
23	0	33.5	-	0.00	13.82	
24	0	33.5	-	0.00	13.82	
25	0	33.5	-	0.00	13.82	~ 5 gal. water used throughout packer test
TEST ENDED @ 0906						

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant	Project Number:	1940110419	Page 1 of 2
Field Personnel: LCA	Weather Conditions: ~ 45 deg F/ Partly Cloudy		
Drilling Subcontractor: Cascade	LS450 - Sonic		
Lead Driller: Todd Schmalfeldt	Driller's Helper: Paul, Jeff		
Borehole ID: B102	**Depth/Packer Interval: 92'-97'**		
Static Water Level: 9.30	**Packer Inflation (psi): 200**		

Packer Specs**:** TAM International packer elements: 3.5"-dia at rest; 6" max inflated dia;
unconfined pressure rating: 65 psi; max inflation pressure: 350 psi

Site-specific construction: total length of dual/straddle assembly: 10' 1/4"; length of perforated interval - 4'10";
depth to top of bottom packer: 90.8'; depth to bottom of upper packer: 86.0; borehole dia: 4 7/8" (HQ barrel)

Packer Inflation = [(0.43 x Depth to Packer, ft) + unconfined pressure rating, psi + injection pump pressure, psi] x 1.1
(i.e. at 150 ft depth and 100 psi injection pressure: inflation pressure = [(0.43 x 150) + 65 + 100] x 1.1 = 200 psi

Date: 11/7/24 Start Time: 0837

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
0	0	33	-	0.00	9.3	
0	30	33	-	0.00	9.3	closed bypass valve to get to A
1	0	33	-	0.00	9.3	step psi
2	0	33	-	0.00	9.3	
3	0	33	-	0.00	9.3	
4	0	33	-	0.00	9.3	
5	0	33	-	0.00	9.3	closed bypass valve to get to B
5	30	49.5	-	0.00	9.3	step psi
6	0	49.5	-	0.00	9.3	
6	30	49.5	-	0.00	9.3	
7	0	49.5	-	0.00	9.3	
8	0	49.5	-	0.00	9.3	
9	0	49.5	-	0.00	9.3	
10	0	49.5	-	0.00	9.3	closed bypass valve to get to C
10	30	66	-	0.00	9.3	step psi
11	0	66	-	0.00	9.3	
11	30	66	-	0.00	9.3	
12	0	66	-	0.00	9.3	
13	0	66	-	0.00	9.3	
14	0	66	-	0.00	9.3	
15	0	66	-	0.00	9.3	opened bypass valve to get to
15	30	49.5	-	0.00	9.3	Br step psi
16	0	49.5	-	0.00	9.3	
17	0	49.5	-	0.00	9.3	
18	0	49.5	-	0.00	9.3	
19	0	49.5	-	0.00	9.3	
20	0	49.5	-	0.00	9.3	opened bypass valve to get to
20	30	33	-	0.00	9.3	Ar step psi

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant				Project Number:	1940110419	Page 2 of 2
Borehole ID: B102				**Depth/Packer Interval: 92'-97'**		
Date: 11/7/24 Start Time: 0837						
Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
21	0	33	-	0.00	9.3	
22	0	33	-	0.00	9.3	
23	0	33	-	0.00	9.3	
24	0	33	-	0.00	9.3	
25	0	33	-	0.00	9.3	~ 5 gal. water used throughout packer test
TEST ENDED @ 0902						

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant	Project Number:	1940110419	Page 1 of 2
Field Personnel: LCA	Weather Conditions: ~ 45 deg F/ Partly Cloudy		
Drilling Subcontractor: Cascade	LS450 - Sonic		
Lead Driller: Todd Schmalfeldt	Driller's Helper: Paul, Jeff		
Borehole ID: B101	**Depth/Packer Interval: 96'-101'**		
Static Water Level: 9.30	**Packer Inflation (psi): 200**		

Packer Specs**:** TAM International packer elements: 3.5"-dia at rest; 6" max inflated dia;
unconfined pressure rating: 65 psi; max inflation pressure: 350 psi

Site-specific construction: total length of dual/straddle assembly: 10' 1/4"; length of perforated interval - 4'10";
depth to top of bottom packer: 90.8'; depth to bottom of upper packer: 86.0; borehole dia: 4 7/8" (HQ barrel)

Packer Inflation = [(0.43 x Depth to Packer, ft) + unconfined pressure rating, psi + injection pump pressure, psi] x 1.1
(i.e. at 150 ft depth and 100 psi injection pressure: inflation pressure = [(0.43 x 150) + 65 + 100] x 1.1 = 200 psi

Date: 11/7/24 Start Time: 0929

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
0	0	33	-	0.00	9.3	
0	30	33	-	0.00	9.3	closed bypass valve to get to A
1	0	33	-	0.00	9.3	step psi
2	0	33	-	0.00	9.3	
3	0	33	-	0.00	9.3	
4	0	33	-	0.00	9.3	
5	0	33	-	0.00	9.3	closed bypass valve to get to B
5	30	49.5	-	0.00	9.3	step psi
6	0	49.5	-	0.00	9.3	
6	30	49.5	-	0.00	9.3	
7	0	49.5	-	0.00	9.3	
8	0	49.5	-	0.00	9.3	
9	0	49.5	-	0.00	9.3	
10	0	49.5	-	0.00	9.3	closed bypass valve to get to C
10	30	66	-	0.00	9.3	step psi
11	0	66	-	0.00	9.3	
11	30	66	-	0.00	9.3	
12	0	66	-	0.00	9.3	
13	0	66	-	0.00	9.3	
14	0	66	-	0.00	9.3	
15	0	66	-	0.00	9.3	opened bypass valve to get to
15	30	49.5	-	0.00	9.3	Br step psi
16	0	49.5	-	0.00	9.3	
17	0	49.5	-	0.00	9.3	
18	0	49.5	-	0.00	9.3	
19	0	49.5	-	0.00	9.3	
20	0	49.5	-	0.00	9.3	opened bypass valve to get to
20	30	33	-	0.00	9.3	Ar step psi

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant				Project Number:	1940110419	Page 2 of 2
Borehole ID: B101				**Depth/Packer Interval: 96'-101'**		
Date: 11/7/24 Start Time: 0929						
Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
21	0	33	-	0.00	9.3	
22	0	33	-	0.00	9.3	
23	0	33	-	0.00	9.3	
24	0	33	-	0.00	9.3	
25	0	33	-	0.00	9.3	~ 5 gal. water used throughout packer test
TEST ENDED @ 0954						

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant	Project Number:	1940110419	Page 1 of 2
Field Personnel: LCA	Weather Conditions: ~ 45 deg F/ Partly Cloudy		
Drilling Subcontractor: Cascade	LS450 - Sonic		
Lead Driller: Todd Schmalfeldt	Driller's Helper: Paul, Jeff		
Borehole ID: B102	**Depth/Packer Interval: 100'-105'**		
Static Water Level: 9.30	**Packer Inflation (psi): 200**		

Packer Specs**:** TAM International packer elements: 3.5"-dia at rest; 6" max inflated dia;
unconfined pressure rating: 65 psi; max inflation pressure: 350 psi

Site-specific construction: total length of dual/straddle assembly: 10' 1/4"; length of perforated interval - 4'10";
depth to top of bottom packer: 90.8'; depth to bottom of upper packer: 86.0; borehole dia: 4 7/8" (HQ barrel)

Packer Inflation = [(0.43 x Depth to Packer, ft) + unconfined pressure rating, psi + injection pump pressure, psi] x 1.1
(i.e. at 150 ft depth and 100 psi injection pressure: inflation pressure = [(0.43 x 150) + 65 + 100] x 1.1 = 200 psi

Date: 11/7/24 Start Time: 1024

Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
0	0	34	-	0.00	9.3	
0	30	34	-	0.00	9.3	closed bypass valve to get to A
1	0	34	-	0.00	9.3	step psi
2	0	34	-	0.00	9.3	
3	0	34	-	0.00	9.3	
4	0	34	-	0.00	9.3	
5	0	34	-	0.00	9.3	closed bypass valve to get to B
5	30	51	-	0.00	9.3	step psi
6	0	51	-	0.00	9.3	
6	30	51	-	0.00	9.3	
7	0	51	-	0.00	9.3	
8	0	51	-	0.00	9.3	
9	0	51	-	0.00	9.3	
10	0	51	-	0.00	9.3	closed bypass valve to get to C
10	30	68	-	0.00	9.3	step psi
11	0	68	-	0.00	9.3	
11	30	68	-	0.00	9.3	
12	0	68	-	0.00	9.3	
13	0	68	-	0.00	9.3	
14	0	68	-	0.00	9.3	
15	0	68	-	0.00	9.3	opened bypass valve to get to
15	30	51	-	0.00	9.3	Br step psi
16	0	51	-	0.00	9.3	
17	0	51	-	0.00	9.3	
18	0	51	-	0.00	9.3	
19	0	51	-	0.00	9.3	
20	0	51	-	0.00	9.3	opened bypass valve to get to
20	30	34	-	0.00	9.3	Ar step psi

Packer / Injection Test Field Data Form

Site: Hennepin Power Plant				Project Number:	1940110419	Page 2 of 2
Borehole ID: B102				**Depth/Packer Interval: 100'-105'**		
Date: 11/7/24 Start Time: 1024						
Elapsed Time		Gauge Pressue	Totalizer Reading	Meter Flow Rate	Borehole Water Level	Notes
(min)	(sec)	(psi)	(gal)	(gpm)	(ft)	
21	0	34	-	0.00	9.3	
22	0	34	-	0.00	9.3	
23	0	34	-	0.00	9.3	
24	0	34	-	0.00	9.3	
25	0	34	-	0.00	9.3	~ 5 gal. water used throughout packer test
TEST ENDED @ 1049						

ATTACHMENT C
Photographic Log

PHOTOGRAPHIC LOG

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
1	10/29/24		
DESCRIPTION: Bedrock from 70-72 ft bgs at boring location B100.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
2	10/29/24		
DESCRIPTION: Bedrock from 72-25 ft bgs at boring location B100.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
3	10/29/24		
DESCRIPTION:			
Bedrock from 75-80 ft bgs at boring location B100.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
4	10/29/24		
DESCRIPTION: Bedrock from 80-85 ft bgs at boring location B100.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
5	10/29/24		
DESCRIPTION: Bedrock from 85-90 ft bgs at boring location B100.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
6	10/29/24		
DESCRIPTION: Bedrock from 90-95 ft bgs at boring location B100.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
7	10/29/24		
DESCRIPTION: Bedrock from 95-100 ft bgs at boring location B100.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
8	11/1/24		
DESCRIPTION: Bedrock from 85-90 ft bgs at boring location B101.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
9	11/1/24		
DESCRIPTION: Bedrock from 90-95 ft bgs at boring location B101.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
10	11/1/24		
DESCRIPTION:			
Bedrock from 95-100 ft bgs at boring location B101.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
11	11/1/24		
DESCRIPTION: Bedrock from 100-105 ft bgs at boring location B101.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
12	11/6/24		
DESCRIPTION: Bedrock from 70-85 ft bgs at boring location B102.			

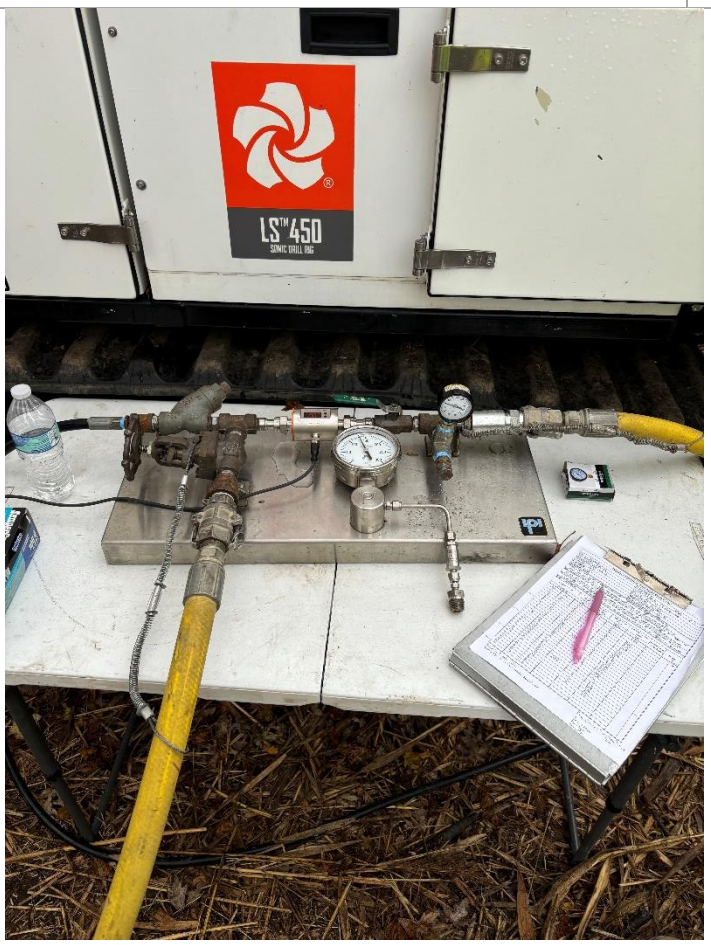
CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
13	11/6/24		
DESCRIPTION: Bedrock from 85-90 ft bgs at boring location B102.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
14	11/6/24		
DESCRIPTION: Bedrock from 90-95 ft bgs at boring location B102.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
15	11/6/24		
DESCRIPTION: Bedrock from 95-100 ft bgs at boring location B102.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
16	11/6/24		
DESCRIPTION: Bedrock from 100-105 ft bgs at boring location B102.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
17	10/29/24		
DESCRIPTION: Preparing the packers for packer testing.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
18	10/29/24		
DESCRIPTION:			
Flow meter and controls for packer testing.			

CLIENT NAME:		SITE LOCATION:	PROJECT NO.
Luminant		Hennepin Power Plant	1940108210
PHOTO NO.	**DATE:**		
19	10/29/24		
DESCRIPTION:			
Packer constructed for packer testing.			

ATTACHMENT D
2024 Well Survey

WELL LOCATION POINT TABLE

NORTHING	EASTING	GROUND ELEVATION	TOP METAL CASING ELEVATION	TOP OF PVC ELEVATION	DESCRIPTION
1689081.33	2532171.95	489.58	492.90	492.60	02
1690298.87	2532306.85	479.99	482.85	482.49	03R
1690078.44	2534368.05	484.47	487.35	486.90	04R
1690519.65	2533189.70	486.10	488.98	488.69	05-DR
1690521.00	2533195.70	486.17	489.02	488.73	05-R
1690112.27	2531832.77	468.23	470.25	470.04	06
1687889.54	2533137.17	515.91	518.80	518.79	07
1688880.11	2533476.52	499.13	502.11	501.51	08
1688936.59	2533465.30	499.57	502.10	501.77	08D
1689862.66	2532597.89	495.59	498.64	498.28	10
1689861.44	2532594.43	495.59	498.75	498.43	11
1689976.85	2533515.56	495.75	499.16	498.94	12
1689975.37	2533512.48	495.71	499.22	498.94	13
1690248.12	2534146.59	495.11	497.98	497.79	15
1689254.48	2533893.39	500.99	502.43	501.95	16
1689458.70	2534509.63	505.42	508.12	507.83	17
1690433.17	2532744.23	485.25	488.21	488.04	18D
1690432.44	2532742.13	485.29	488.28	487.98	18S
1690635.51	2533813.81	484.53	487.97	487.61	19D
1690635.08	2533811.94	484.57	488.03	487.76	19S
1690627.91	2533815.82	***	485.45	485.10	19SR
1688527.50	2526767.51	450.08	452.60	452.43	21-R
1689336.79	2528793.35	461.99	464.98	464.93	22
1689328.45	2528778.59	462.64	466.24	465.91	22D
1688907.32	2527735.69	462.50	464.16	463.91	23
1687728.33	2528267.74	460.55	463.40	463.00	25
1687731.63	2528261.29	459.80	463.33	463.38	26
1687451.34	2526782.20	448.71	451.14	451.03	27
1687464.20	2527578.61	451.32	453.68	453.29	30
1687459.80	2527577.34	451.32	453.76	453.34	31
1685710.08	2526891.16	449.00	451.67	452.02	32
1687001.83	2525897.78	448.23	450.22	450.13	33
1688398.02	2525785.52	448.87	450.75	450.01	34
1688283.09	2528080.24	451.97	455.49	455.23	35
1688332.41	2529057.14	460.09	462.73	462.38	36
1690571.10	2533493.60	485.45	488.37	488.04	40S
1689993.50	2531898.74	465.83	467.94	467.69	45S
1690085.26	2533743.46	496.91	499.41	499.19	46
1689838.06	2533052.60	499.96	503.58	503.37	47
1690544.77	2533342.01	485.51	488.83	488.34	48R
1689022.30	2528296.84	466.21	468.78	468.57	49
1689413.45	2529032.25	460.98	464.77	464.40	50
1688814.32	2527303.49	462.22	465.14	465.04	51
1689532.66	2532952.80	498.48	501.60	501.50	52
1689253.32	2533171.29	500.83	503.49	503.10	53
1689860.33	2533264.80	497.75	500.94	500.78	54
1689972.71	2533502.24	496.09	499.11	499.00	55
1688722.24	2527341.17	466.29	469.76	469.70	LPZ-01
1688843.37	2527961.47	464.97	468.44	468.41	LPZ-03
1688955.34	2528526.96	465.98	469.29	469.13	LPZ-17
1689929.28	2531957.80	494.75	497.06	496.76	P-004
1690017.10	2533589.92	495.91	498.84	498.23	P-006
1689584.13	2533096.85	498.94	498.91	501.41	XPW-01
1689325.53	2533681.67	502.43	505.31	505.08	XPW-02
1689835.41	2533658.38	492.85	495.91	495.62	XPW-03
1689590.05	2534084.62			497.64	XSG-01

*** FLUSH WITH GROUND

BORING LOCATION POINT TABLE (SURVEYED DECEMBER 26, 2024)

NORTHING	EASTING	GROUND ELEVATION	TOP METAL CASING ELEVATION	TOP OF PVC ELEVATION	DESCRIPTION
1688599.07	2526731.50	449.73			B-100
1688214.42	2528526.67	454.97			B-102
1689421.43	2529056.11	459.29			B-101

N

0' 300' 600'

LEGEND

WELL

BORING LOCATION (SURVEYED 12/26/2024)

SURVEY NOTES

1. THIS DRAWING AND THE INFORMATION SHOWN HEREON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC. SURVEY COORDINATES ARE REFERENCED TO ILLINOIS WEST STATE PLANE COORDINATE SYSTEM NAD 1983. ELEVATIONS SHOWN HEREON ARE BASED ON NAVD 1988 DATUM.
2. THE WELL LOCATIONS AND ELEVATIONS SURVEY DONE BY INGENAE DATED APRIL 24, 2024.

IngenAE
502 Earth City Plaza, Suite 120
Earth City, MO 63045
www.ingenae.com

Submissions / Revisions: Date:

1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		

Luminant

Project Name & Location:

HENNEPIN
POWER STATION

13498 E. 800TH ST.
HENNEPIN, ILLINOIS 61327

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Drawing Name:

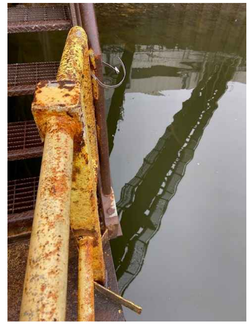
2024 WELL SURVEY

Date: 12/30/2024	Project No.
Type: SITE	Drawing No. 1
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

B-100

B-101

B-102



SG-03
(NOT THERE)

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502 Earth City Plaza, Suite 120
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Submissions / Revisions:		Date:
1		
2		
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13		

Luminant

Project Name & Location:

HENNEPIN
POWER STATION

13498 E. 800TH ST.
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Drawing Name:

PHOTOS

Date: 12/30/2024	Project No.
Type: SITE	Drawing No. 2
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

APPENDIX B
Geochemical Conceptual Site Model - Addendum (Geosyntec Consultants, Inc., 2025)

Geosyntec consultants

engineers | scientists | innovators

Geochemical Conceptual Site Model - Addendum

Hennepin Power Plant – West Ash Pond System

(CCR Unit #804)

Prepared for

Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Prepared by

Geosyntec Consultants, Inc.
134 N. Lasalle Street, Suite 300
Chicago, Illinois 60602

Project Number: GLP8079

May 2025

Geosyntec consultants

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ACRONYMS AND ABBREVIATIONS

CCR	coal combustion residuals
HPP	Hennepin Power Plant
GCSM	geochemical conceptual site model
GWPS	groundwater protection standards
HSU	hydrostratigraphic unit
I.A.C.	Illinois Administrative Code
IEPA	Illinois Environmental Protection Agency
LOI	loss on ignition
meq/100 g	milliequivalents per 100 grams
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
N&E	nature and extent
redox	oxidation-reduction
SEP	sequential extraction procedure
SU	standard units
TOC	total organic carbon
UAU	upper aquifer unit
µg/g	micrograms per gram
WAPS	West Ash Pond System
XRD	X-Ray diffraction

1. INTRODUCTION

This report is an addendum to the geochemical conceptual site model (GCSM) for the Hennepin Power Plant (HPP) West Ash Pond System (WAPS) coal combustion residuals (CCR) unit (Unit #804) with the results of an additional investigation to further characterize the site. The initial GCSM described the geochemical processes that contribute to the mobilization, distribution, and attenuation of chemicals in the environment at the WAPS (Geosyntec 2024). The initial GCSM was prepared as an appendix to the HPP WAPS Nature and Extent (N&E) Report prepared by Ramboll Americas Engineering Solutions. Inc. (Ramboll) and submitted to the Illinois Environmental Protection Agency (IEPA) on 8 May 2024 (Ramboll 2024). Subsequent to the N&E report submittal, an additional investigation was conducted to further characterize the site, including the following:

- Collection of solids samples from two intervals at boring B100, which was advanced immediately adjacent to well 21R in October 2024, and
- Collection of groundwater samples from wells 21R, 34, and 51 in September 2024.

The additional groundwater samples were collected to further characterize aqueous arsenic speciation at locations with arsenic concentrations above the groundwater protection standard (GWPS) (wells 21R and 51) and background well 34. Similarly, solids samples were collected adjacent to 21R to better characterize the aquifer solids at relevant WAPS compliance monitoring locations.

Parameters with exceedances[1] above the GWPS at the Hennepin WAPS for the second, third, and fourth quarters of 2024 sampling events completed under Illinois Administrative Code (I.A.C.) Title 35 § 845.630 are arsenic, boron, lithium, total dissolved solids (TDS) and sulfate. Exceedances of arsenic and boron were reported at compliance monitoring well 21R and for arsenic at well 51. Therefore, arsenic and boron are the constituents of concern in the western portion of the site; however, only arsenic is considered in this addendum due to the targeted nature of the additional sampling completed in 2024 and because boron concentrations have continued to decrease at well 21R. Both well 21R and well 51 are screened within the Uppermost Aquifer Unit (UAU) hydrostratigraphic unit (HSU).

[1] Throughout this document, “exceedance” or “exceedances” is intended to refer only to potential exceedances of proposed applicable background statistics or groundwater protection standards (GWPSs) as described in the proposed groundwater monitoring program which was submitted to the IEPA on October 25, 2021 as part of Dynegy Midwest Generation, LLC’s operating permit application for the WAPS. That operating permit application, including the proposed groundwater monitoring program, remains under review by the IEPA and therefore Dynegy Midwest Generation, LLC has not identified any actual exceedances.

2. UPDATES TO THE GEOCHEMICAL CONCEPTUAL SITE MODEL

The HPP WAPS GCSM (Geosyntec 2024), which was submitted as Appendix B to the N&E Report (Ramboll 2024) provided an overview of the geochemical conditions at the HPP WAPS. This addendum provides details on the additional investigation samples collected in 2024 and an interpretation of how these samples align with or modify the GCSM for the Site provided in the 2024 GCSM document. Unless otherwise specified, the discussion that follows is focused on samples collected from monitoring well locations included in the targeted additional investigation sampling.

2.1 Constituent Transport and Fate

Arsenic speciation in groundwater is dependent on both pH and oxidation/reduction (redox) reactions and is typically present as arsenic (III) or arsenic (V) in environmental systems. Arsenic (III) is the predominant species under relatively reducing conditions and, at pH values less than 9 standard units (SU), forms the neutral complex $As(OH)_3$. Arsenic (V) is the predominant species under relatively oxidizing conditions and typically exists as $HAsO_4^{2-}$ at pH values above 7 SU and as H_2AsO4^- at pH values less than 7 SU. Arsenic (V) is more likely to be attenuated than neutral arsenic (III) species due to its negative charge and electrostatic interactions with soil/aquifer solids. In general, arsenic has a high sorption affinity for metal (i.e., aluminum, iron, and manganese) oxyhydroxides and may also sorb to clay minerals (Rahman et al. 2019, Nguyen et al. 2021). Arsenic sorption is typically favored at lower pH values where electrostatics enhance attenuation to material surfaces, and also under oxidizing conditions due to the greater propensity for attenuation of the negatively charged $HAsO_4^{2-}$ species relative to neutral $As(OH)_3$ species. Further, the presence of divalent cations (such as calcium [Ca^{2+}]) can promote arsenic (V) absorption (Nguyen et al. 2021).

2.2 Solids Characterization

Additional solids were characterized to determine the type and abundance of minerals present in the UAU, their geochemical properties, and their effect on the geochemistry of the groundwater system. Solids were collected from boring B100, which was located to the west of the Old West Polishing Pond and immediately adjacent to monitoring well 21R. Solids were collected from two intervals (37 to 38 feet below ground surface [bgs] and 48 to 49 ft bgs) within the UAU, representing an upper sandy silt interval and a lower gravel interval with silty/clayey interlayers.

The monitoring well locations and the location of B100 are shown on Attachment A. The boring log for B100 is provided in Attachment B.

2.2.1 Loss on Ignition and Cation Exchange Capacity

Total organic carbon (TOC) represents only the carbon component of organic matter within a solid material, while loss on ignition (LOI) represents the combustible portions of a solid material and

is often used as an approximation of organic matter in a sample. The TOC and LOI values for solids are presented in Table 1 and laboratory analytical results are provided in Attachment C.[2]

TOC values for the B100 samples ranged from <0.11% to 2.5%, while LOI ranged from 0.8 to 6.4%. Both TOC and LOI were relatively lower in the B100 samples compared to those previously analyzed in the same UAU HSU (TOC of 0.34 to 4.6%; LOI of 11.6 to 21.5%; Table 1); suggesting that there is more variable organic matter content within UAU solids than previously thought. This variability is of particular note as solids from SB-51, advanced adjacent to the other monitoring network location with an exceedance of arsenic, has relatively high levels of organic matter considered more aligned with the reducing conditions typically associated with elevated arsenic concentrations.

2.2.2 Total Metals via Bulk Characterization

Total metals were analyzed to determine the major and trace metal content of aquifer solids with results presented in Table 2, and laboratory analytical results in Attachment C. For B100, analysis was completed for total arsenic, aluminum, iron, and manganese. Arsenic was detected in B100 solids at concentrations similar to previous site solids, ranging from 2.3 to 4.6 micrograms per gram (µg/g). Aluminum concentrations were greater in solids from B100 (8,700 to 30,000 µg/g) than any previously analyzed solids, while iron (4,800 to 12,000 µg/g) and manganese (120 to 300 µg/g) concentrations had overlapping ranges with other UAU solids. The presence of these metals (aluminum, iron, and manganese) in the aquifer solids at B100 at similar concentrations provides support that these metals may provide potential attenuation sites for arsenic in the form of metal oxyhydroxides, consistent with the conclusions of the prior GCSM.

2.2.3 Sequential Extraction Procedure Analysis of Metals

Material from each of the two intervals for B100 samples were submitted for sequential extraction procedure (SEP) for metals. SEPs are chemical extractions used to dissolve metals from specific solid-associated phases. SEPs use progressively stronger reagents to solubilize metals from increasingly recalcitrant phases. Although these procedures do not identify the discrete solid phases in a soil/aquifer matrix, they do provide a means to evaluate the class of solids and relative stability in relation to general solubility, changes in redox potential, and pH fluctuations (Tessier et al. 1979, Kuo et al. 1983, Sposito et al. 1984, Hickey and Kittrick 1984, Gruebel et al. 1988). Therefore, SEP data are useful to infer the mechanism and potential reversibility of attenuation processes. The results of the 7-step extraction procedure and analysis are provided in Table 3 and Attachment C. Solids samples from previous investigations (e.g. SB-34, SB-51) were analyzed for metal association via SEP by a different 6-step extraction procedure (as reported in Geosyntec 2024); therefore, the results are not directly comparable to the additional investigation samples.

[2] Analytical laboratory reports are only provided for the additional data collected in 2024. For additional data that was previously collected and is shown within table for comparison, the analytical data were provided as attachments to the GCSM (Geosyntec 2024).

Arsenic in aquifer solids from B100 was bound predominantly to the residual phase (42 to 44%). Arsenic was also bound to the metal oxide phase (0.38 to 0.69 µg/g [16% and 14%, respectively]), which includes crystalline iron and manganese oxides, to the non-crystalline materials (including amorphous metal oxides; 0.29 to 1.0 µg/g [12% and 21%, respectively]) and to sulfides (0.67 to 0.94 µg/g [20% and 28%, respectively]). B100 solids therefore had arsenic bound to metal oxides, both amorphous and crystalline, at relative distributions that are within the same range as those previously detected for SB-34 and SB-51. This suggests that iron and manganese oxides in these solids have some capacity to serve as adsorption sites for arsenic, but at a lower capacity than at other locations within the UAU. Overall, these results suggest some attenuation via interaction with metal oxides may be feasible in the aquifer. The sum of the arsenic measured in the SEP extractions (Table 3) was well correlated with the reported total arsenic concentrations in the solid samples (Table 2).

As with previous samples, aluminum within SB100 solids was almost exclusively associated with the residual metal phase (i.e., clays and feldspars), indicating that aluminum oxides could contribute to the sorptive capacity of solids within the aquifer. Iron was primarily detected in solid fractions associated with non-crystalline materials, oxides, sulfides and residual metal phases. Between 20% and 24% of the iron extracted from the aquifer solids was associated with the oxide phase, indicating that iron oxides are present at significant concentrations and may provide potential sorption sites for arsenic, consistent with previously analyzed aquifer solids. Manganese was primarily detected in solid fractions associated with carbonates, metal oxides, and non-crystalline materials, with lesser amounts bound to residual metals, a distribution similar to previously analyzed UAU solids.

2.2.4 Mineralogical Analysis

X-Ray diffraction (XRD) with Rietveld refinement was conducted for identification of minerals in aquifer solid samples. XRD is an analytical technique that provides information about the identity of the crystalline material within a sample but does not provide information about non-crystalline or amorphous phases. XRD results are normalized to 100% of the total weight, meaning that material not characterized by XRD is ignored in the percent calculation.

B100 sample solids from the UAU were predominantly composed of quartz, ranging from 60.9 to 87.6% of the minerals present (Table 4; Attachment D)[3]. B100 had a higher quartz content than the previously analyzed samples (Geosyntec 2024). Feldspar minerals (4.2 to 8.7%), carbonates including dolomite and calcite (1.1 to 11.4% total), and clays identified as chlorite, kaolinite and illite/muscovite (0 to 7.2% total) were identified as additional primary crystalline mineral phases. These results are consistent with the field observations documented in the boring log provided in Attachment B. Unlike previously analyzed UAU solids with low abundances of magnetite

[3] 2021 solids samples included in the GCSM were analyzed by SGS Minerals (Ontario, Canada), whereas 2024 samples were analyzed by Eurofins J3 Resources, Inc. (Pasadena, Texas). Due to differences in analytical reporting methodology, only 2024 samples are presented in Table 4.

(detected to 0.5%) detected (Geosyntec 2024), no crystalline forms of iron oxides were detected in B100 sample solids. When considered with the SEP analyses that indicated that the iron present in B100 sample solids was present relatively equally within the crystalline and amorphous metal oxide fractions and the previous XRD analyses, both amorphous and crystalline iron oxides are likely important sorption surfaces at UAU locations.

2.3 Aqueous Characterization

Monitoring well locations in the vicinity of the WAPS are shown in Attachment A. Groundwater at both wells with arsenic GWPS exceedances (21R and 51) and background well 34 was sampled in September 2024 for analysis of aqueous arsenic speciation and select aqueous metals (total and dissolved). Results of both analyses are provided in Tables 5 and 6, respectively.

2.3.1 Exceedance Parameters

Boron groundwater concentrations are declining at both 21R and 51, with recent results below the GWPS at both locations (Figure 1). The historically elevated boron concentrations suggest that there may have been previous influence of porewater at 21R and 51. Arsenic concentrations in groundwater remain in exceedance of the GWPS at 21R and 51, consistent with the prior GCSM (Geosyntec 2024). Arsenic concentrations in groundwater at 21R and 51 generally appear stable and above the concentrations reported at background well 34 (Figure 2). As arsenic concentrations exhibit a different behavior from boron, this suggests a potential ongoing source to groundwater either from geogenic arsenic or the effect of previously sorbed arsenic that was attenuated via interaction with aquifer solids.

2.3.2 Redox/pH Summary

The redox potential and pH in aqueous systems are major controls on the speciation of redox-active chemicals such as iron, manganese, and arsenic. UAU groundwater had previously varied between 6.8 to 7.7 standard units (SU) at all wells in the network, with slightly higher pH values observed along the north side of the WAPS compared to background (Geosyntec 2024). The September 2024 groundwater samples fell within the same range previously documented for UAU groundwaters (Table 5).

Redox conditions were found to vary across the site, with the east side of the WAPS generally exhibiting more oxidizing conditions and the west side exhibiting more reducing conditions (Geosyntec 2024). The September 2024 ORP field measurements at the wells of interest were reducing (-133 to -174 millivolts), which was consistent with previous results. The consistently reducing conditions at 21R and 51 remain aligned with the elevated arsenic concentrations detected at these wells.

2.3.3 Exceedance Parameters: Arsenic Speciation

Aqueous arsenic concentrations were reported to be approximately two orders of magnitude lower at background well 34 compared to wells 21R and 51 with exceedances, based on total arsenic concentrations (Table 6) and arsenic speciation analyses (Table 5). While aqueous arsenic at background well 34 was nearly evenly comprised of arsenite (arsenic with a 3+ oxidation state)

and arsenate (arsenic with a 5+ oxidation state), arsenite was reported as the dominant oxidation state in wells 21R and 51 (Table 5). Arsenic speciation results reflect the higher arsenic concentrations at the wells with exceedances compared to the nearest background locations and indicate that arsenite, the more mobile oxidation state of the two, dominates aqueous arsenic at these locations.

2.3.4 Pourbaix Diagrams

Eh-pH, or Pourbaix, diagrams can be used to illustrate the predicted stability of specific phases at thermodynamic equilibrium under the conditions observed for a groundwater sample. Select crystalline mineral species were suppressed to be representative of anticipated groundwater conditions (e.g. mineral formation not anticipated to be kinetically favored), except when identified in XRD data from solids in the site. Conditions detected at well 21R on 8 October 2024 were used to represent wells from the 2024 groundwater sampling effort, which tend to be more reducing than other well locations in the monitoring network (Table 7).[4] To make groundwater samples comparable to previously analyzed GCSM data, field measured Eh values were utilized to generate Pourbaix diagrams.

Crystalline magnetite is expected to be stable at the relevant groundwater sample locations (Figure 3), which is consistent with the low abundances of magnetite detected in aquifer solids at nearby locations via XRD analysis at abundances ranging between 0.2 and 0.5 wt% (Table 4); however, magnetite was not identified in solids from B100. When magnetite is suppressed, amorphous iron oxyhydroxides (represented by ferrihydrite) are generally not predicted to be stable in the aquifer at locations with reducing conditions (Figure 4). This contrasts with monitoring wells on the eastern side of the site, which exhibited greater stability of iron oxides overall due to varying redox conditions, as noted in the May 2024 GCSM (Geosyntec 2024). Ankerite, which is represented by siderite in Figures 1 and 2 (as a similar iron-containing carbonate), may be stable under reducing conditions (Figure 2). Siderite stability is consistent with XRD detection of ankerite in aquifer solids at abundances ranging from 1.3 to 6.0 wt% at nearby locations (Table 4); however, no crystalline iron carbonates were detected in solids from B100. A review of Eh-pH conditions for manganese found that solid phase manganese minerals, including manganese oxides, are not predicted to be stable under conditions within the UAU for the relevant groundwater sampling locations (Figure 5).

Arsenic in groundwater samples is predicted to primarily exist as the arsenic (V) species $HAsO_4^{2-}$ using field-measured ORP values, even under reducing aquifer conditions that predominate at well 21R (Figure 6). However, the arsenic speciation results (Section 2.3.2) contrast with the existing GCSM for arsenic at 21R and 51, which posited that arsenate species may be more prevalent at these locations. Recently collected data indicate that the consistently reducing conditions at these wells are associated with arsenic speciation favoring more mobile species (i.e., arsenite), a trait

[4] Field ORP measurements were converted to Eh by adding +200 millivolts to correct for the Ag/AgCl electrode.

which is likely exclusive to the highly reducing, organic-rich lithology underlying the western portion of the WAPS.

2.3.5 Illinois River Water Sampling

Samples were previously collected from the Illinois River via the shoreline of the site immediately adjacent to the WAPS to help characterize local conditions, as groundwater monitoring has indicated occasional reversal of groundwater flow direction at well 22 (located on the eastern portion of the site) due to elevated river levels associated with flooding events. As this addendum is focused on the western portion of the site, these results are not discussed herein but are provided in Attachment E to complete the documentation of relevant analytical data associated with the site.

3. EXTENSION AND MODIFICATION OF GEOCHEMICAL SITE CONDITIONS

3.1 Source and Mobilization Mechanisms

Arsenic is naturally present within coals and is concentrated within CCR. Arsenic exhibited elevated concentrations in CCR porewater from the WAPS at the time of collection in 2017. Given the historical boron concentrations and decreasing trends relative to arsenic concentration trends at the wells of concern, there may have been previous influence of porewater on the UAU solids near wells 21R and 51. However, arsenic was detected within UAU aquifer solids from both compliance and background well locations, which is supportive of a naturally occurring geogenic source of arsenic. Therefore, previous impacts from CCR porewater and native geological material are both potential sources of arsenic to groundwater.

3.2 Potential and Observed Attenuation Mechanisms

The results of the additional investigation sampling modify the potential and observed attenuation mechanisms for arsenic described in the previously submitted GCSM. Speciation analysis indicates that the neutral arsenite species is predominant at compliance wells (21R and 51) with arsenic GWPS exceedances. Arsenite is expected to be generally more mobile, with lower affinity for sorption onto metal (oxy)hydroxides, which combined with the lowered stability for metal (oxy)hydroxides at these locations, is likely leading to a degree of arsenic desorption (whether geogenic or from prior CCR porewater influences) at locations within the highly reducing, organic-rich lithology underlying the western portion of the WAPS. While the primary mechanism of potential arsenic attenuation remains sorption onto iron oxides and oxyhydroxides associated with solids throughout the UAU (as supported by SEP results demonstrating that between a quarter and a third of all arsenic is associated with metal oxide phases), this mechanism is likely not prevalent to the same degree in locations with reducing conditions.

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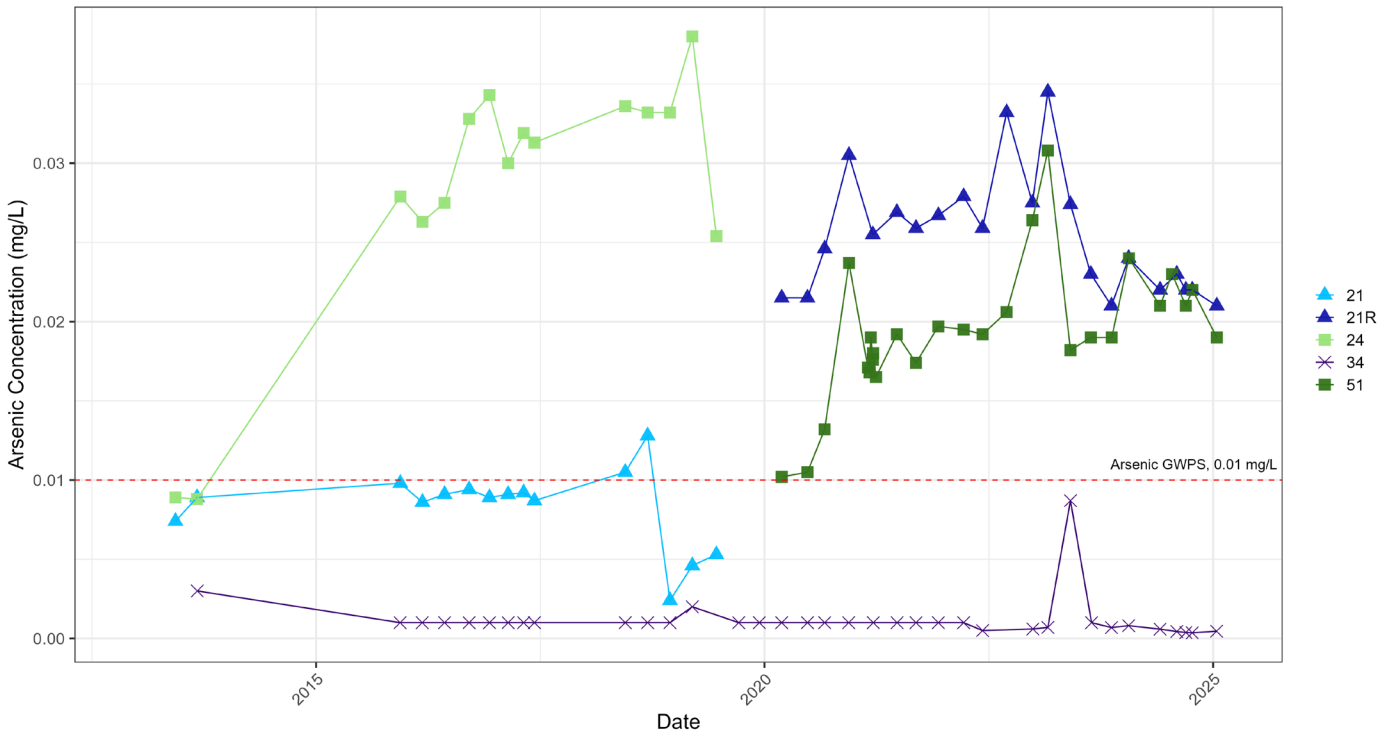
FIGURES



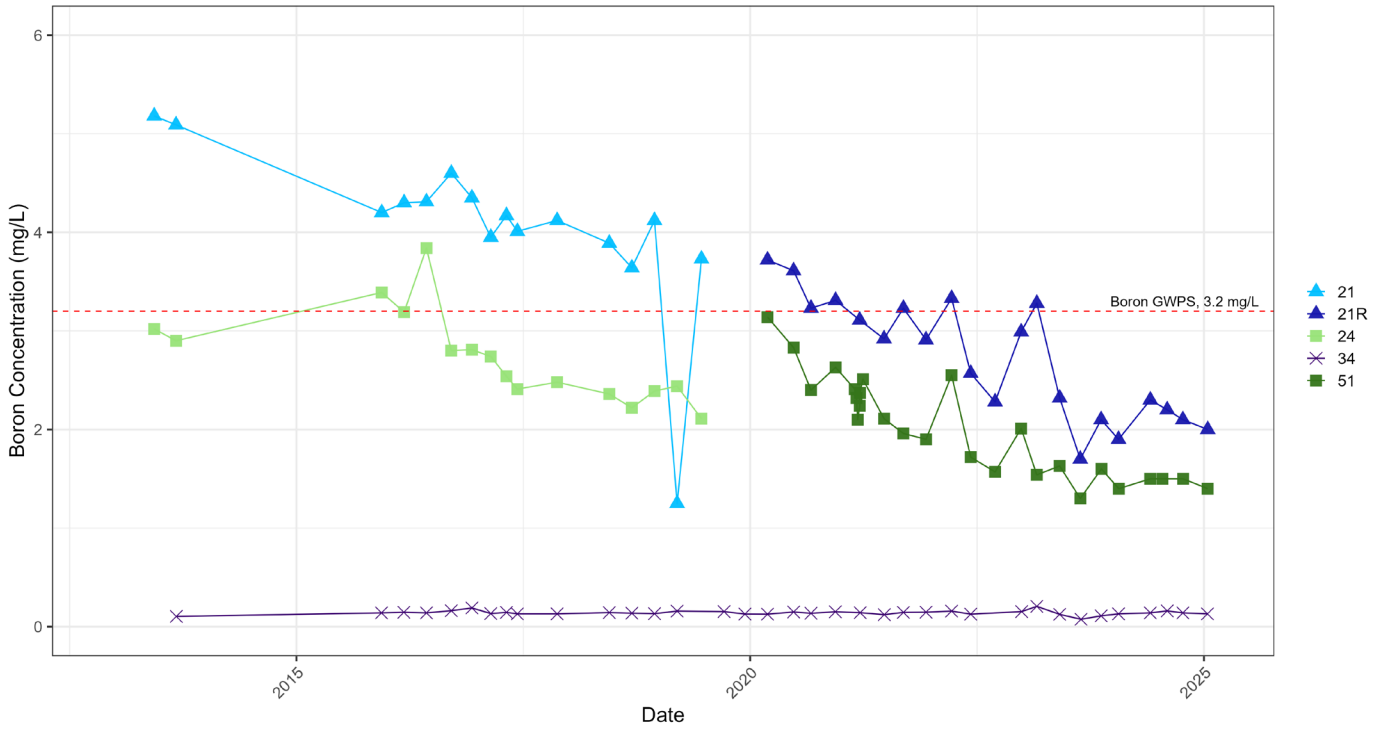
Notes:
1. Wells 21 and 24 were abandoned during closure activities and replaced with 21R and 51, respectively.
2. mg/L: milligrams per liter
3. GWPS: Groundwater Protection Standard

Total Arsenic Concentration Time Series
Hennepin West Ash Pond System

Geosyntec consultants

Columbus, Ohio | April 2025

Figure **1**



Notes:
1. Wells 21 and 24 were abandoned during closure activities and replaced with 21R and 51, respectively.
2. mg/L: milligrams per liter
3. GWPS: Groundwater Protection Standard

Total Boron Concentration Time Series
Hennepin West Ash Pond System

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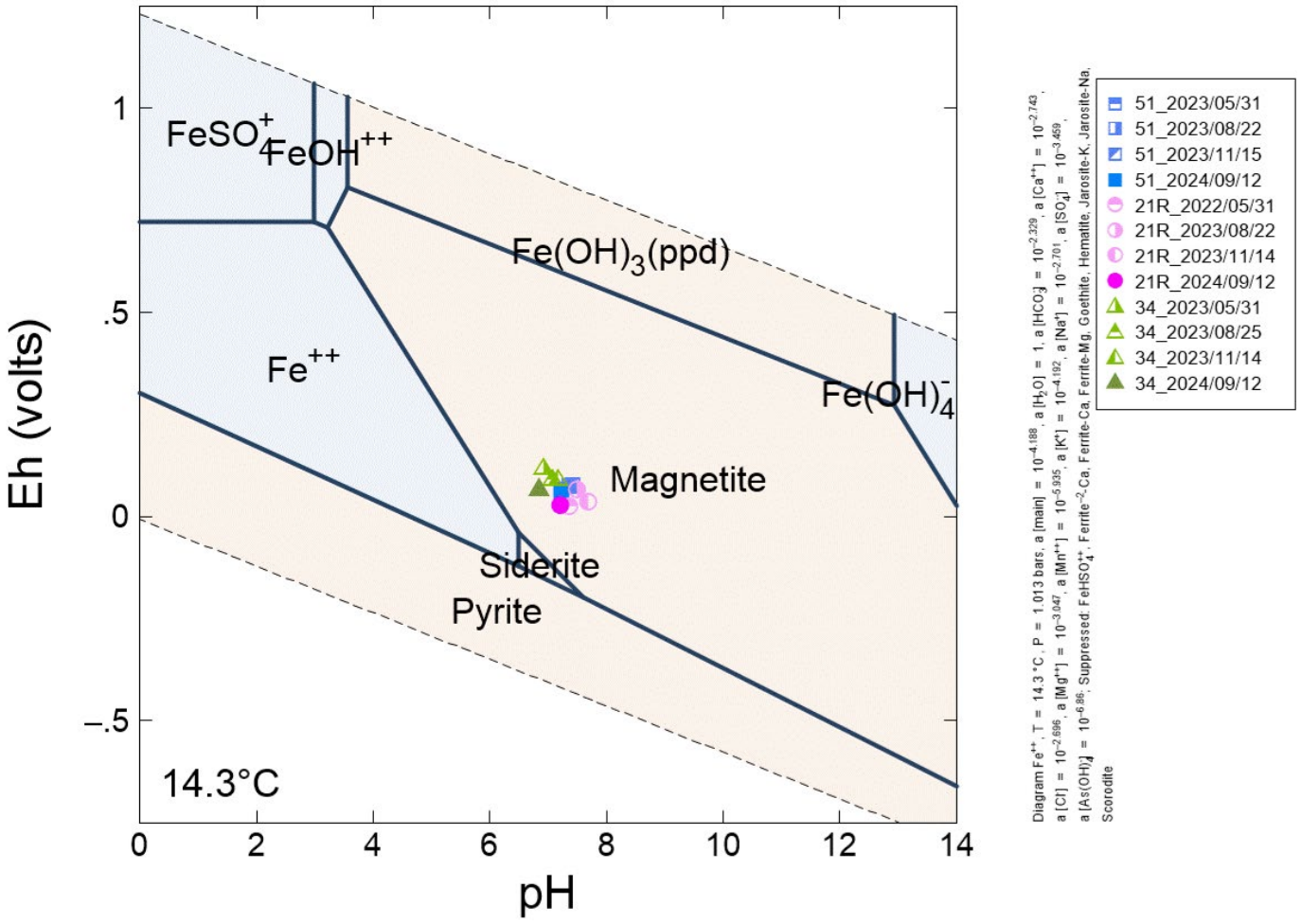
Figure **2**



Notes:

1. Diagram was generated using conditions observed at well 21R on 10/8/24 to represent iron stability under reducing conditions.
2. Ferrite-Ca, ferrite-Mg, goethite, hematite, jarosite-K, jarosite-Na, and scorodite were suppressed during model generation.

Iron Pourbaix Diagram, Magnetite – 21R
Hennepin West Ash Pond System

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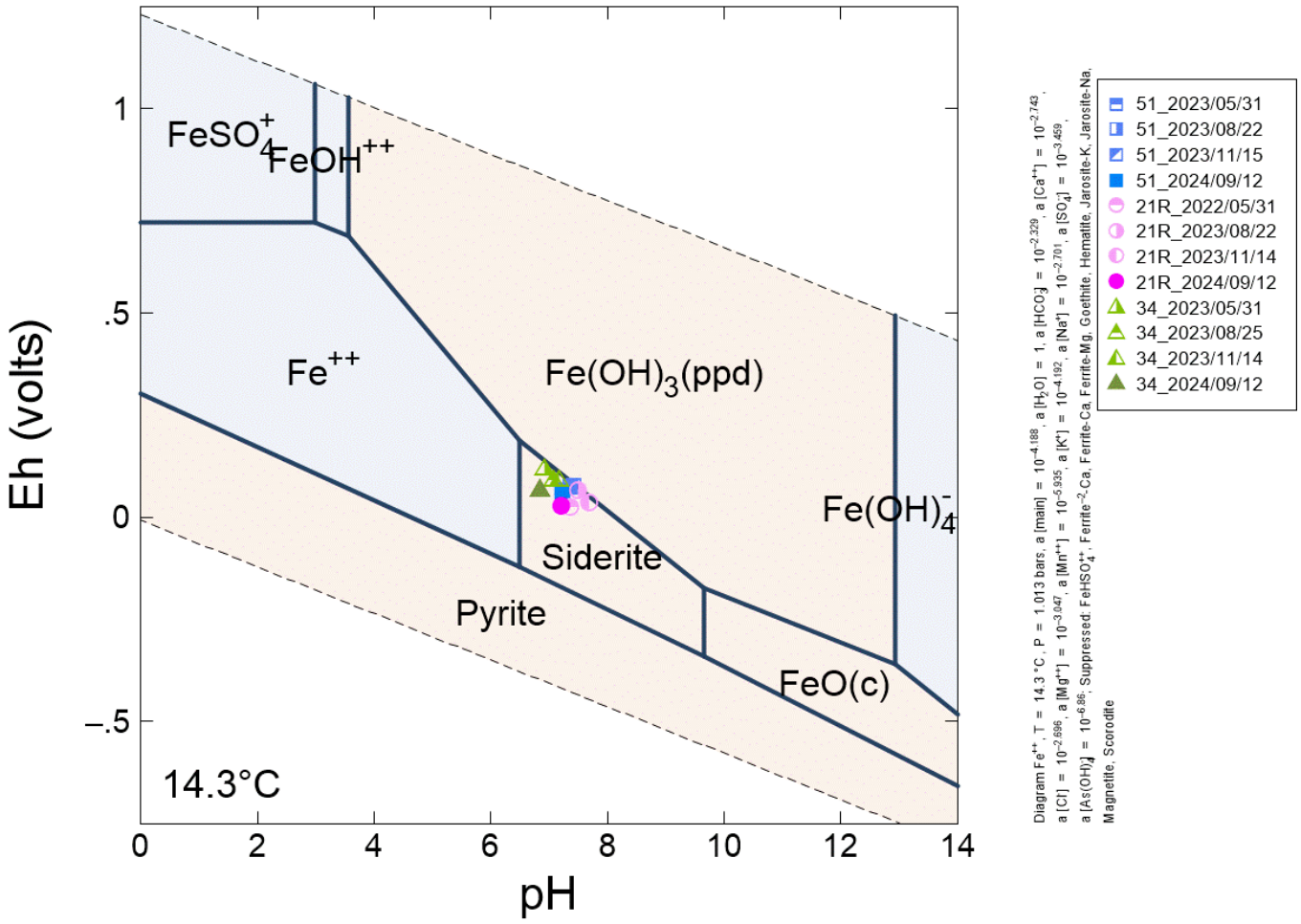
Figure **3**



Notes:

1. Diagram was generated using conditions observed at well 21R on 10/8/24 to represent iron stability under reducing conditions.
2. Ferrite-Ca, ferrite-Mg, goethite, hematite, jarosite-K, jarosite-Na, magnetite, and scorodite were suppressed during model generation.

Iron Pourbaix Diagram, Ferrihydrite – 21R
Hennepin West Ash Pond System

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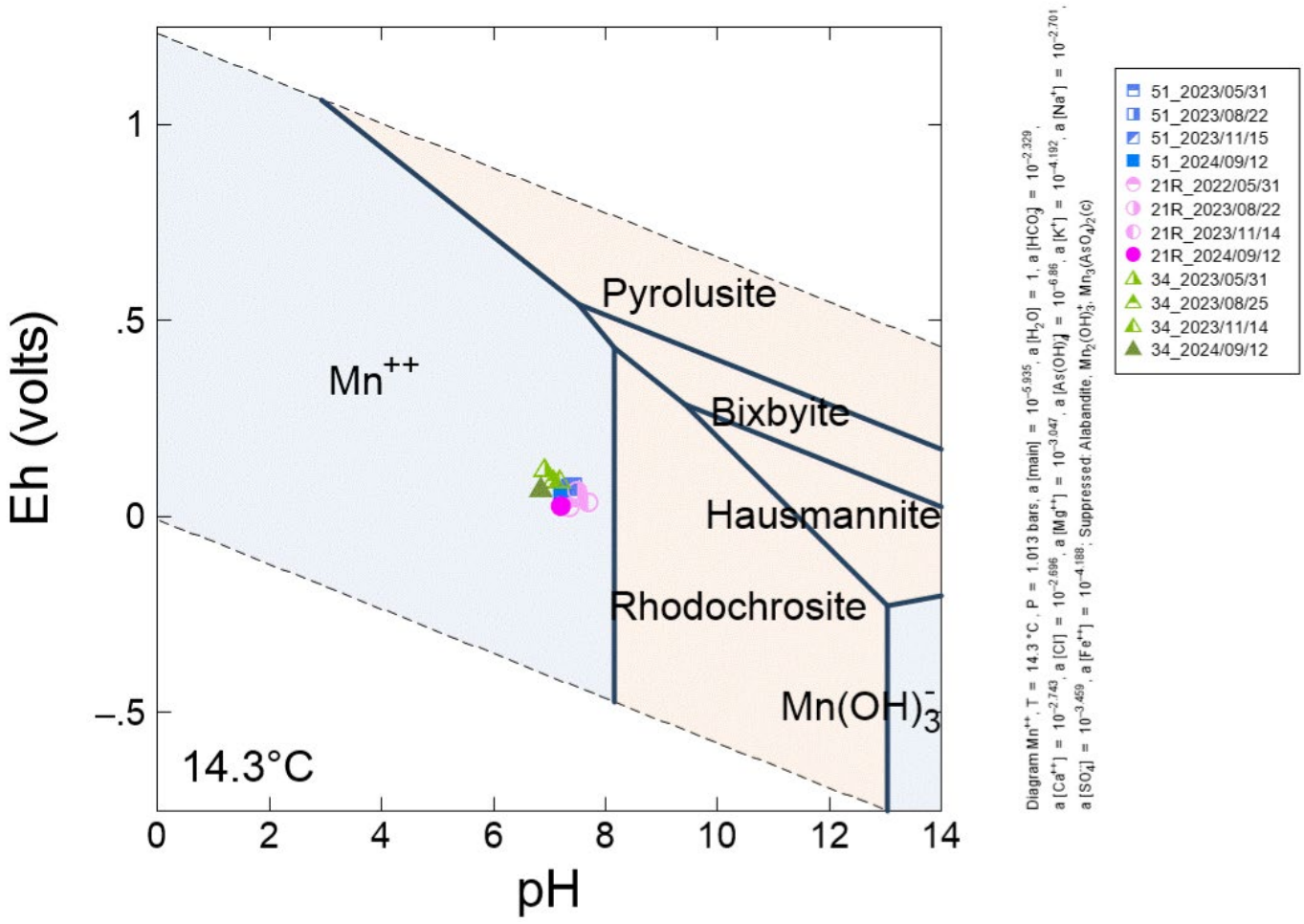
Figure **4**



Notes:

1. Diagram was generated using conditions observed at well 21R on 10/8/24 to represent manganese stability under reducing conditions.
2. Alabandite, $Mn_3(AsO_4)(c)$, and $Mn_2(OH)_3^+$ were suppressed during model generation.

Manganese Pourbaix Diagram – 21R
Hennepin West Ash Pond System

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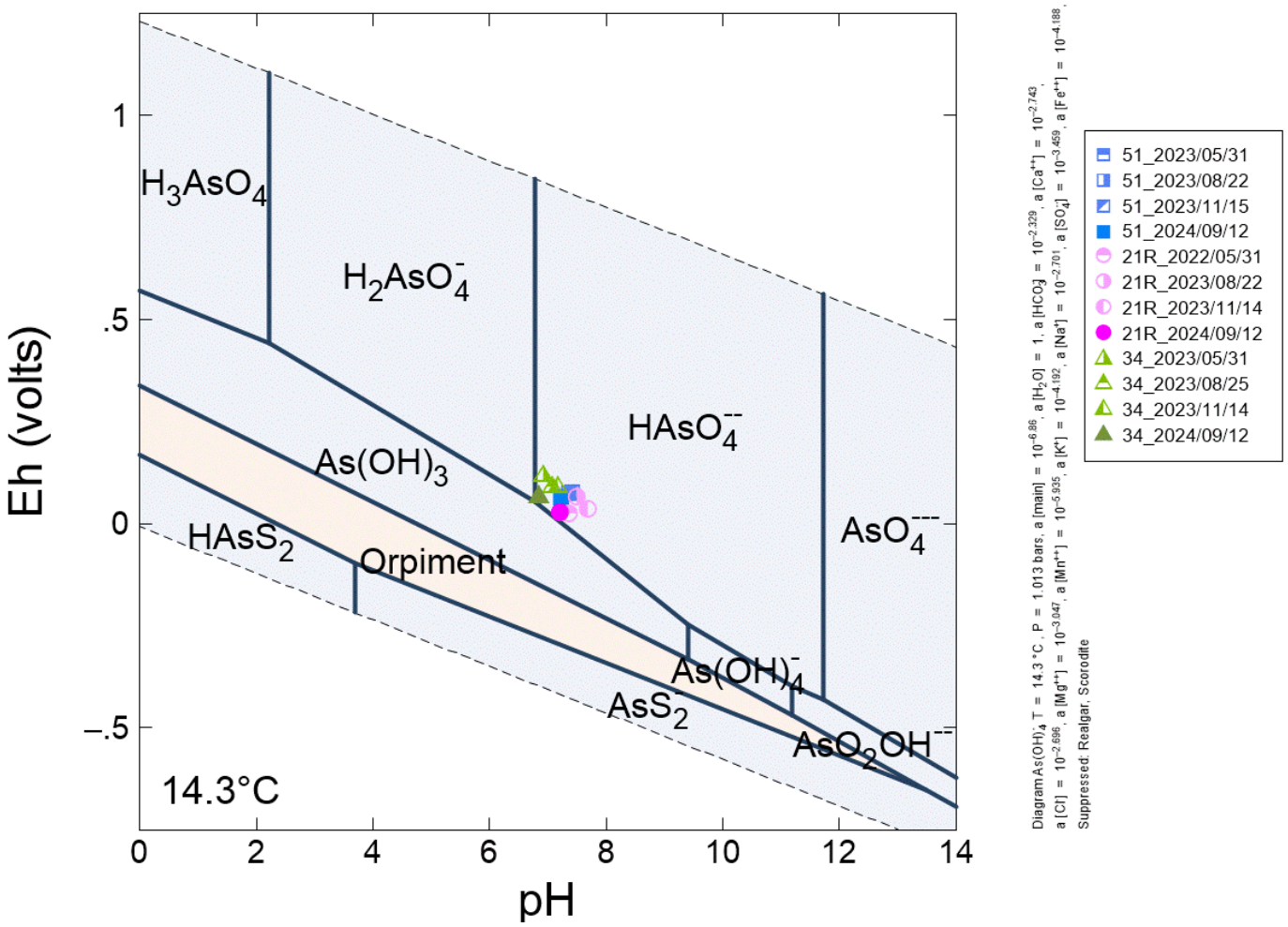
Figure **5**



Notes:

1. Diagram was generated using conditions observed at well 21R on 10/8/24 to represent arsenic stability under reducing conditions.
2. Scorodite and realgar were suppressed during model generation.

Arsenic Pourbaix Diagram – 21R
Hennepin West Ash Pond System

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Figure **6**

TABLES

Table 1 - Total Organic Carbon and Loss on Ignition in Aquifer Solids
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Field Boring Location	SB-22		SB-34	SB-51	B100	
Sample Depth (ft bgs)	26-27	29-30	32-33	42-43	37-38	48-49
Location	Downgradient		Background	Downgradient	Downgradient	
Sample Collection Date	4-Mar-21	4-Mar-21	4-Mar-21	4-Mar-21	29-Oct-24	29-Oct-24
Field Boring Description	Fine sand	Gravel with sand and trace clay	Fine-medium sand	Silty clay with trace sand	Sandy Silt	Gravel with some silty/clayey layers
TOC %	0.34	4.6	1.9	3.6	2.5	< 0.11
LOI %	11.6	15.3	13.3	21.5	6.4	0.8

Notes
Sample depth is shown in feet below ground surface (ft bgs)
TOC - total organic carbon
LOI - loss on ignition
Non-detects are shown as less than the reporting limit.

Table 2 - Bulk Characterization of Aquifer Solids
Geochemical Conceptual Site Model
Hennepin, Illinois

Geosyntec Consultants, Inc.

Field Boring Location	SB-22		SB-34	SB-51	B100	
Sample Depth (ft bgs)	26-27	29-30	32-33	42-43	37-38	48-49
Location	Downgradient		Background	Downgradient	Downgradient	
Sample Collection Date	4-Mar-21	4-Mar-21	4-Mar-21	4-Mar-21	29-Oct-24	29-Oct-24
Field Boring Description	Fine sand	Gravel with sand and trace clay	Fine-medium sand	Silty clay with trace sand	Sandy Silt	Gravel with some silty/clayey layers
Aluminum	2800	3700	5000	8200	30000	8700
Antimony	< 0.8	< 0.8	< 0.8	< 0.8	-	-
Arsenic	5.1	8.4	2.7	3.5	4.6	2.3
Barium	20	31	47	84	-	-
Beryllium	0.20	0.87	0.29	0.50	-	-
Bismuth	0.13	0.26	0.23	0.59	-	-
Boron	6	7	5	10	-	-
Cadmium	0.76	2.9	0.53	0.89	-	-
Calcium	56000	36000	52000	91000	-	-
Chromium	79	130	45	27	-	-
Cobalt	5.2	9.8	6.9	9.3	-	-
Copper	11	25	8	14	-	-
Iron	9400	12000	10000	14000	12000	4800
Lead	7.7	28	6.1	11	-	-
Lithium	4	6	6	12	-	-
Magnesium	21000	16000	13000	15000	-	-
Manganese	310	220	260	350	300	120
Molybdenum	3.1	5.0	0.9	2.0	-	-
Nickel	15	43	12	19	-	-
Potassium	910	1200	1200	1900	-	-
Phosphorous	350	330	380	430	-	-
Selenium	< 0.7	0.8	< 0.7	1.1	-	-
Silicon	5400	1600	7200	4500	-	-
Silver	< 0.05	0.08	< 0.05	0.06	-	-
Sodium	190	160	180	170	-	-
Thallium	0.13	0.26	0.16	0.25	-	-
Tin	< 0.5	0.5	1.1	0.6	-	-
Tungsten	0.07	0.10	0.06	0.05	-	-
Uranium	1.3	1.8	0.65	1.2	-	-
Vanadium	17	41	12	18	-	-
Yttrium	6.1	7.6	5.7	8.0	-	-
Zinc	46	91	40	67	-	-

Notes
Sample depth is shown in feet below ground surface (ft bgs)
All results are shown in µg/g (microgram per gram)
2021 total metals samples prepared via method SW 3050 and analyzed via USEPA method 6020A. 2024 total metals samples analyzed via USEPA method 6010B
Non-detect results are shown as less than the reporting limit
- indicates sample was not analyzed for analyte

Table 3 - SEP Analysis of Aquifer Solids
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Geosyntec Consultants, Inc.

Field Boring Location			**B100**			
Sample Depth (ft bgs)			**37-38**		**48-49**	
Location			**Downgradient**			
Sample Collection Date			**29-Oct-24**		**29-Oct-24**	
Field Boring Description			**Sandy Silt**		**Gravel with some silty/clayey layers**	
Fraction	**Reagent**	**Arsenic SEP**	µg/g	% of Total	µg/g	% of Total
1	$MgSO_4$	Exchangeable Metals	< 0.72	-	< 0.60	-
2	Sodium acetate, acetic acid	Bound to Carbonates	< 0.54	-	< 0.45	-
3	Ammonium oxalate	Bound to Non-crystalline Materials	1.0	21%	0.29 J	12%
4	Hydroxylamine HCl and acetic acid	Bound to Oxides	0.69 B	14%	0.38 J B	16%
5	NaClO	Bound to Organic Material	< 2.6 *-	-	< 2.2	-
6	HNO_3, HCl, and H_2O	Bound to Sulfides	0.94	20%	0.67	28%
7	HF, HNO_3, HCl, and H_3BO_3	Residual Metals	2.1	44%	1.0 J	42%
SEP Total			**4.8**	-	**2.4**	-
Fraction	**Reagent**	**Aluminum SEP**	µg/g	% of Total	µg/g	% of Total
1	$MgSO_4$	Exchangeable Metals	< 8.9	-	< 7.4	-
2	Sodium acetate, acetic acid	Bound to Carbonates	14 J	0%	7.3 J	0%
3	Ammonium oxalate	Bound to Non-crystalline Materials	210	1%	50	0%
4	Hydroxylamine HCl and acetic acid	Bound to Oxides	920	2%	110	1%
5	NaClO	Bound to Organic Material	93 J	0%	44 J	0%
6	HNO_3, HCl, and H_2O	Bound to Sulfides	2600	6%	580	5%
7	HF, HNO_3, HCl, and H_3BO_3	Residual Metals	38,000	91%	12,000	92%
SEP Total			**42,000**	-	**13,000**	-

Table 3 - SEP Analysis of Aquifer Solids
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Geosyntec Consultants, Inc.

Field Boring Location			B100			
Sample Depth (ft bgs)			37-38		48-49	
Location			Downgradient			
Sample Collection Date			29-Oct-24		29-Oct-24	
Field Boring Description			Sandy Silt		Gravel with some silty/clayey layers	
Fraction	**Reagent**	**Iron SEP**	µg/g	% of Total	µg/g	% of Total
1	$MgSO_4$	Exchangeable Metals	< 16	-	< 13	-
2	Sodium acetate, acetic acid	Bound to Carbonates	120	1%	220	4%
3	Ammonium oxalate	Bound to Non-crystalline Materials	2800	18%	1100	20%
4	Hydroxylamine HCl and acetic acid	Bound to Oxides	3800	24%	1100	20%
5	NaClO	Bound to Organic Material	120	1%	< 51	-
6	HNO_3, HCl, and H_2O	Bound to Sulfides	5000	31%	1900	35%
7	HF, HNO_3, HCl, and H_3BO_3	Residual Metals	4,300	27%	1,200	22%
SEP Total			**16,000**	-	**5,500**	-
Fraction	**Reagent**	**Manganese SEP**	µg/g	% of Total	µg/g	% of Total
1	$MgSO_4$	Exchangeable Metals	5.2	1%	3.5	3%
2	Sodium acetate, acetic acid	Bound to Carbonates	100	26%	37	31%
3	Ammonium oxalate	Bound to Non-crystalline Materials	68 B	18%	17 B	14%
4	Hydroxylamine HCl and acetic acid	Bound to Oxides	100	26%	30	25%
5	NaClO	Bound to Organic Material	18	5%	< 2.1	-
6	HNO_3, HCl, and H_2O	Bound to Sulfides	42	11%	17	14%
7	HF, HNO_3, HCl, and H_3BO_3	Residual Metals	44	12%	19	16%
SEP Total			**380**	-	**120**	-

Notes

Sample depth is shown in feet below ground surface (ft bgs)
Non-detect values are shown as less than the detection limit
SEP - sequential extraction procedure
µg/g - microgram per gram
B - Compound was found in the blank and sample
J - Result is less than the reporting limit but greater than or equal to the detection limit and the concentration is an approximate value
*- Laboratory control sample and sample duplicate is outside acceptance limits, low biased

Table 4 - XRD Analysis of Aquifer Solids
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Field Boring Location			B100	
Sample Depth (ft bgs)			37-38	48-49
Location			Downgradient	
Sample Collection Date			29-Oct-24	29-Oct-24
Field Boring Description			Sandy Silt	Gravel with some silty/clayey layers
Mineral/Compound	**Formula**	**Mineral Type**	**(wt %)**	**(wt %)**
Quartz	SiO_2	Silicate	60.9	87.6
Calcite	$CaCO_3$	Carbonate	7.3	1.1
Feldspar	$(Ca,Na)Si_3O_8$	Feldspar	8.7	4.2
Illite/Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	Clay/Mica	7.2	pp
Dolomite	$CaMg(CO_3)_2$	Carbonate	11.4	7.1
Kaolinite	$Al_2Si_2O_5(OH)_4$	Clay	2.0	ND
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$	Clay	2.6	ND

Notes
Sample depth is shown in feet below ground surface (ft bgs)
pp - possible presence; mineral may be present in the sample but its indentification is not definitive.
wt % - percentage by weight
ND - not detected in the sample

Table 5 - Arsenic Speciation Groundwater Redox Summary *Geosyntec Consultants, Inc.*
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Monitoring Well		34	21R	51
Type		Background	Compliance	Compliance
Date	Units	9/12/2024	9/12/2024	9/12/2024
Arsenic (III)	µg/L	0.141	21	18.1
Arsenic (V)	µg/L	0.103	2.36	2.48
DMAs	µg/L	<0.025	<0.025	<0.025
MMAs	µg/L	<0.020	<0.020	<0.02
pH	SU	6.85	7.38	7.23
Field ORP Measurement	mV	-132.8	-174.4	-146.2

Notes
DMA: Dimethylarsinate
MMA: Monomethylarsonate
mV: millivolts
SU: standard unit
µg/L: microgram per liter

Table 6 - Total and Dissolved Aqueous Iron, Manganese, and Arsenic Results
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Well ID	Well Classification	General Redox Condition	Date	Dissolved Iron (mg/L)	Total Iron (mg/L)	Dissolved Manganese (mg/L)	Total Manganese (mg/L)	Dissolved Arsenic (mg/L)	Total Arsenic (mg/L)
50	Downgradient	Oxidizing	31-May-23	< 0.02	0.11	0.18	0.28	-	0.0087
			25-Aug-23	< 0.047	0.27	0.27	0.052	-	0.001
22	Downgradient	Oxidizing	31-May-23	< 0.02	0.037	0.034	0.051	-	0.0087
			25-Aug-23	< 0.047	0.070	0.036	0.012	-	0.00023
22D	Downgradient	Reducing	31-May-23	1.9	2.4	0.065	0.070	-	0.0087
			22-Aug-23	2.2	2.3	0.065	0.063	-	0.0013
49	Downgradient	Oxidizing	31-May-23	< 0.02	0.91	0.0045	0.57	-	0.0087
			25-Aug-23	< 0.047	0.22	0.0044	0.049	-	0.00049
35	Downgradient	Oxidizing	31-May-23	< 0.02	0.054	0.57	0.76	-	0.0087
			24-Aug-23	< 0.047	< 0.047	0.50	0.52	-	0.001
23	Downgradient	Reducing	31-May-23	0.15	0.21	1.2	1.2	-	0.0087
			22-Aug-23	0.14	0.21	1.1	1.1	-	0.00089
51	Downgradient	Reducing	31-May-23	6.5	7.8	0.17	0.20	-	0.0182
			22-Aug-23	6.1	6.7	0.15	0.15	-	0.019
			12-Sep-24	6.5	7.4	0.17	0.19	0.020	0.021
21R	Downgradient	Reducing	31-May-23	5.6	8.5	0.11	0.16	-	0.0274
			22-Aug-23	5.4	7.9	0.11	0.14	-	0.023
			12-Sep-24	5.2	6.5	0.11	0.13	0.022	0.022
27	Downgradient	Reducing	31-May-23	0.26	0.53	0.66	0.68	-	0.0087
			24-Aug-23	0.21	0.24	0.66	0.67	-	0.001
32	Background	Oxidizing	31-May-23	< 0.02	0.30	0.050	0.10	-	0.0087
			22-Aug-23	< 0.047	0.11	0.092	0.11	-	0.00049
34	Background	Reducing	31-May-23	4.9	6.2	1.2	1.1	-	0.0087
			25-Aug-23	6.8	6.7	1.3	1.3	-	0.001
			12-Sep-24	6.8	7.5	1.4	1.4	0.00034	0.00038

Notes
Non-detect values are shown as less than the reporting limit
mg/L - milligrams per liter
Dissolved samples were field filtered using a 0.45 micron filter
- indicates sample was not analyzed for analyte

Table 7 - Eh-pH Diagram Inputs
Geochemical Conceptual Site Model
Hennepin West Ash Pond System, Illinois

Well ID		21R
Sample Collection Date		8-Oct-24
Input Parameter	**Units**	**Result**
pH	SU	7.41
Arsenic	mg/L	0.022
Bicarbonate Alkalinity	mg/L $CaCO_3$	370
Calcium	mg/L	130
Chloride	mg/L	83
Iron	mg/L	6.5
Magnesium	mg/L	39
Manganese	mg/L	0.13
Sodium	mg/L	53
Sulfate	mg/L	74
Temperature	℃	14.3

Notes
Iron and manganese data was collected on 9/12/2024.
mg/L - milligram per liter
SU - standard units
℃ - degree celsius

Attachment A
Site Layout Figure

MONITORING WELL
LEACHATE WELL
SOIL BORING
SITE FEATURE
PROPERTY BOUNDARY

*ALSO KNOWN AS OLD WEST ASH POND (OWAP)

0 200 400
Feet

FIGURE 1 - BORING LOCATION MAP

HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\2022286\MXD\Sampling_and_Analysis_Request\SAR_Maps.aprx\HEN West Monitoring Well Location Map

PROJECT: 169000XXXX | DATED: 1/13/2025 | DESIGNER: GALARNMC

Attachment B
B100 Boring Log

RAMBOLL

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Hennepin Bedrock Investigation		B-100

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Todd Schmalfedt Cascade Drilling LP	10/28/2024	10/29/2024	Sonic/HQ

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
	Feet (NAVD88)	449.73 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐

State Plane 1,688,599.07 N, 2,526,731.50 E E / W

1/4 of 1/4 of Section , T N, R

Lat 41° 18' 0.2268" Long 89° 19' 44.5512"

Local Grid Location Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Putnam	IL	Hennepin

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	120 70		0	0 - 8.2' **FILL, WELL-GRADED SAND:** SW, very dark grayish brown (10YR 3/2), fine to medium sand, gravel (5-15%), silt (0-10%), roots (0-5%), dry to moist.										
			1											
			2	2' dark yellowish brown (10YR 4/4).										
			3											
			4		(FILL) SW									
			5	5' brown (10YR 5/3), gravel (10-20%).										
			6											
			7											
			8											
			9	8.2 - 9.5' **CLAYEY SILT:** ML/CL, very dark gray (10YR 3/1), moist.	ML/CL									PP = 0.25
2 CS	120 117		10	9.5 - 30' **SILTY CLAY:** CL/ML, very dark gray (10YR 3/1), low toughness, medium plasticity, very soft, moist.										PP = 0.5
			11	10' gravel (0-5%), high plasticity.										
			12											
			13		CL/ML									PP = 0.5
			14											
			15											
			16	15.3' brown (10YR 4/3), shells (0-5%), wood (0-5%).										PP = 0.25
			17											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	Tel / Fax
	Ramboll 234 W Florida St, Milwaukee WI 53204	Tel: 262-901-0095 Fax:

Boring Number B-100 Page 2 of 4

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			18	9.5 - 30' **SILTY CLAY:** CL/ML, very dark gray (10YR 3/1), low toughness, medium plasticity, very soft, moist. *(continued)*										PP = 0.25
			19											
3 CS	120 99		20	20' very coarse sand (0-5%), wet.										PP = 0.5
			21											
			22											
			23											
			24		CL/ML									
			25											PP = 0.5
			26	25.2' moist. 25.6' dark gray (5YR 4/1).										
			27											
			28											
			29											
			30											
4 CS	120 120		31	30 - 40' **SILTY CLAY WITH SAND:** (CL/ML)S, dark gray (5YR 4/1), fine sand, shells (0-5%), wood (0-5%), low toughness, medium plasticity, moist.										PP = 0.5
			32											
			33											
			34	33.2' - 33.9' sand (25-35%).										
			35											
			36	35' - 36.8' sand (25-35%).	(CL/ML)S									PP = 0.5
			37											
			38											
			39											
			40											
5 CS	120 120		41	40 - 50' **WELL-GRADED SAND:** SW, gray (10YR 5/1), fine to coarse sand, gravel (0-5%), shells (0-5%), wet.										
			42											
			43		SW									
			44											
			45											

Boring Number B-100 Page 3 of 4

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			46	40 - 50' **WELL-GRADED SAND:** SW, gray (10YR 5/1), fine to coarse sand, gravel (0-5%), shells (0-5%), wet. *(continued)*	SW									
			47											
			48											
			49											
6 CS	120 120		50	50 - 58.7' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), shells (0-5%), low toughness, high plasticity, very soft, moist.										
			51											
			52											
			53											
			54		CL/ML									
			55											
			56											
			57											
			58											
			59	58.7 - 70' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, gray (10YR 6/1), subangular to subrounded gravel, cobbles (0-5%), loose, wet.										
7 CS	120 31		60											
			61											
			62											
			63											
			64		(GW)s									
			65											
			66											
			67											
			68											
			69											
			70	70 - 85.4' **SHALE:** BDX (SH), gray (10YR 5/1), moderately fractured, highly weathered to residual soil, thinly laminated, very weak, - 72.0' blocky, loose, dry.										
8 CS	24 24		71											
			72	72' - 72.8' moderately weathered.	BDX (SH)									
9 CS	36 36		73	72.8' - 73.5' gravel (5-15%).										

Boring Number B-100 Page 4 of 4

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			74	70 - 85.4' **SHALE:** BDX (SH), gray (10YR 5/1), moderately fractured, highly weathered to residual soil, thinly laminated, very weak, - 72.0' blocky, loose, dry. *(continued)*										
10 CS	60 29		75	75' gravel (5-15%).										75' - 80' significant outwash
			76											
			77											
			78											
			79											
			80		BDX (SH)									
11 CS	60 60		81											
			82											
			83											
			84											
			85	84.3' moderately to highly weathered, weak.										
12 CORE	60 54		86	85.4 - 100' **SHALE:** BDX (SH), very dark gray (10YR 3/1), moderately fractured, extremely narrow appetures, slightly weathered, thinly laminated, strong.										Core 1, RQD=72% Packer interval = 86' - 90.8', Lowest K = < 2.4E-06 cm/s
			87											
			88											
			89											
			90	90' fresh.										
13 CORE	60 60		91	90.9' 1.0" band of shaley limestone, lighter in color. 91' - 91.6' 0.5" bands of shaley limestone throughout, lighter in color.										Core 2, RQD=52% Packer interval = 90' - 94.8', Lowest K = < 2.4E-06 cm/s
			92	91.7' - 92.5 slightly weathered.										
			93		BDX (SH)									
			94											
			95	94.3' - 95.0' slightly weathered.										
14 CORE	60 60		96											Core 3, RQD=32% Packer interval = 95' - 99.8', Lowest K = < 2.3E-06 cm/s
			97											
			98											
			99											
			100	100' End of Boring.										

Attachment C
Site Solids SEP, TOC, and LOI Analytical Data

eurofins | Environment Testing

ANALYTICAL REPORT

PREPARED FOR

Attn: Allison Kreinberg
Geosyntec Consultants Inc
941 Chatham Lane
Suite 103
Columbus, Ohio 43221

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JOB DESCRIPTION

HEN W

JOB NUMBER

140-39235-1

Eurofins Knoxville
5815 Middlebrook Pike
Knoxville TN 37921

See page two for job notes and contact information.

my EOL

Job Notes

This report may not be reproduced except in full, and with written approval from the laboratory. The results relate only to the samples tested. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins TestAmerica Project Manager.

Authorization

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Authorized for release by
Ryan Henry, Project Manager I
William.Henry@et.eurofinsus.com
(865)291-3006

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Definitions/Glossary

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Qualifiers

Metals

Qualifier	Qualifier Description
*-	LCS and/or LCSD is outside acceptance limits, low biased.
B	Compound was found in the blank and sample.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
☼	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Job Narrative
140-39235-1

Receipt
The samples were received on 10/29/2024 at 9:30am and arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 0.5º C.

Receipt Exceptions
The Field Sampler was not listed on the Chain of Custody.

GC Semi VOA
Method Lloyd Kahn: Please note that the reporting limit for Lloyd Kahn TOC analysis is a nominal value and does not reflect adjustments in sample mass processed on an individual basis
HEN-B100-37-38 (140-39235-1), HEN-B100-48-49 (140-39235-2), (180-181930-A-3), (180-181930-A-3 MS) and (180-181930-A-3 MSD)

Method Lloyd Kahn: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for analytical batch 180-483870 were outside control limits for one or more analytes. See QC Sample Results for detail. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery is within acceptance limits.

Method Lloyd Kahn: The sample duplicate precision for the following sample associated with analytical batch 180-483870 was outside control limits however, the sample is ND and therefore results have been reported: HEN-B100-48-49 (140-39235-2).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
7 Step Sequential Extraction Procedure

These soil samples were prepared and analyzed using Eurofins TestAmerica Knoxville standard operating procedure KNOX-MT-0008, "7 Step Sequential Extraction Procedure". SW-846 Method 6010B as incorporated in Eurofins TestAmerica Knoxville standard operating procedure KNOX-MT-0007 was used to perform the final instrument analyses.

An aliquot of each sample was sequentially extracted using the steps listed below:

· Step 1 - Exchangeable Fraction: A 5 gram aliquot of sample was extracted with 25 mL of 1M magnesium sulfate (MgSO4), centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· Step 2 - Carbonate Fraction: The sample residue from step 1 was extracted with 25 mL of 1M sodium acetate/acetic acid (NaOAc/HOAc) at pH 5, centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· Step 3 - Non-crystalline Materials Fraction: The sample residue from step 2 was extracted with 25 mL of 0.2M ammonium oxalate (pH 3), centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· Step 4 - Metal Hydroxide Fraction: The sample residue from step 3 was extracted with 25 mL of 1M hydroxylamine hydrochloride solution in 25% v/v acetic acid, centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· Step 5 - Organic-bound Fraction: The sample residue from step 4 was extracted three times with 25 mL of 5% sodium hypochlorite (NaClO) at pH 9.5, centrifuged and filtered. The resulting leachates were combined and 5 mL were digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· Step 6 - Acid/Sulfide Fraction: The sample residue from step 5 was extracted with 25 mL of a 3:1:2 v/v solution of HCl-HNO3-H2O, centrifuged and filtered. 5 mL of the resulting leachate was diluted to 50 mL with reagent water and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· Step 7 - Residual Fraction: A 1.0 g aliquot of the sample residue from step 6 was digested using HF, HNO3, HCl and H3BO3. The digestate was analyzed by ICP using method 6010B. Results are reported in mg/kg on a dry weight basis.

In addition, a 1.0 g aliquot of the original sample was digested using HF, HNO3, HCl and H3BO3. The digestate was analyzed by ICP using method 6010B. Total metal results are reported in mg/kg on a dry weight basis.

Results were calculated using the following equation:

Result, µg/g or mg/Kg, dry weight = (C × V × V1 × D) / (W × S × V2)

Job ID: 140-39235-1 (Continued)

Where:
C = Concentration from instrument readout, µg/mL
V = Final volume of digestate, mL
D = Instrument dilution factor
V1 = Total volume of leachate, mL
V2 = Volume of leachate digested, mL
W = Wet weight of sample, g
S = Percent solids/100

A method blank, laboratory control sample and laboratory control sample duplicate were prepared and analyzed with each SEP step in order to provide information about both the presence of elements of interest in the extraction solutions, and the recovery of elements of interest from the extraction solutions. Results outside of laboratory QC limits do not reflect out of control performance, but rather the effect of the extraction solution upon the analyte.

A laboratory sample duplicate was prepared and analyzed with each batch of samples in order to provide information regarding the reproducibility of the procedure.

Method 6010B SEP: The LCS/LCSD recoveries for Arsenic were outside advisory limits. Samples were non-detect for this analyte. The LCS/LCSD for this prep step is known to have low recoveries as the limits are 60% to 100%. The slightly low recoveries of 56% and 50% do not significantly impact the data; therefore, the samples are reported.

HEN-B100-37-38 (140-39235-1), HEN-B100-48-49 (140-39235-2), (LCS 140-93113/5-B ^5) and (LCSD 140-93113/6-B ^5)

Methods 6010B, 6010B SEP: The following samples were diluted due to the presence of Silicon which interferes with Arsenic: HEN-B100-37-38 (140-39235-1), HEN-B100-48-49 (140-39235-2), (140-39235-B-1-D DU) and (140-39235-B-1-V DU). Elevated reporting limits (RLs) are provided.

Methods 6010B, 6010B SEP: The following samples were diluted due to the nature of the sample matrix: HEN-B100-37-38 (140-39235-1), HEN-B100-48-49 (140-39235-2), (140-39235-B-1-D DU) and (140-39235-B-1-V DU). Elevated reporting limits (RLs) are provided for Aluminum.

Methods 6010B, 6010B SEP: The serial dilution performed for the following samples associated with batch 140-93606 was outside control limits: HEN-B100-37-38 (140-39235-1), (140-39235-B-1-C SD ^5) and (140-39235-B-1-U SD ^5)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Sample Summary

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
140-39235-1	HEN-B100-37-38	Solid	10/28/24 15:40	10/29/24 09:30
140-39235-2	HEN-B100-48-49	Solid	10/28/24 16:00	10/29/24 09:30

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Client Sample ID: HEN-B100-37-38
Date Collected: 10/28/24 15:40
Date Received: 10/29/24 09:30

Lab Sample ID: 140-39235-1
Matrix: Solid
Percent Solids: 72.0

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		2.8	0.72	mg/Kg	☼	11/05/24 09:30	11/20/24 11:57	4
Aluminum	ND		56	8.9	mg/Kg	☼	11/05/24 09:30	11/20/24 11:57	4
Iron	ND		28	16	mg/Kg	☼	11/05/24 09:30	11/20/24 11:57	4
Manganese	**5.2**		4.2	0.17	mg/Kg	☼	11/05/24 09:30	11/20/24 11:57	4

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		2.1	0.54	mg/Kg	☼	11/06/24 10:30	11/20/24 12:52	3
Aluminum	**14**	**J**	42	6.7	mg/Kg	☼	11/06/24 10:30	11/20/24 12:52	3
Iron	**120**		21	12	mg/Kg	☼	11/06/24 10:30	11/20/24 12:52	3
Manganese	**100**		3.1	1.2	mg/Kg	☼	11/06/24 10:30	11/20/24 12:52	3

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**1.0**		0.69	0.18	mg/Kg	☼	11/07/24 09:30	11/20/24 13:47	1
Aluminum	**210**		14	2.9	mg/Kg	☼	11/07/24 09:30	11/20/24 13:47	1
Iron	**2800**		6.9	4.0	mg/Kg	☼	11/07/24 09:30	11/20/24 13:47	1
Manganese	**68**	**B**	1.0	0.037	mg/Kg	☼	11/07/24 09:30	11/20/24 13:47	1

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.69**	**B**	0.69	0.31	mg/Kg	☼	11/12/24 09:00	11/21/24 12:58	1
Aluminum	**920**		14	2.2	mg/Kg	☼	11/12/24 09:00	11/21/24 12:58	1
Iron	**3800**		6.9	4.0	mg/Kg	☼	11/12/24 09:00	11/21/24 12:58	1
Manganese	**100**		1.0	0.18	mg/Kg	☼	11/12/24 09:00	11/21/24 12:58	1

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND	*-	10	2.6	mg/Kg	☼	11/14/24 08:45	11/21/24 13:52	5
Aluminum	**93**	**J**	210	33	mg/Kg	☼	11/14/24 08:45	11/21/24 13:52	5
Iron	**120**		100	61	mg/Kg	☼	11/14/24 08:45	11/21/24 13:52	5
Manganese	**18**		16	2.6	mg/Kg	☼	11/14/24 08:45	11/21/24 13:52	5

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.94**		0.69	0.21	mg/Kg	☼	11/14/24 09:00	11/21/24 14:47	1
Aluminum	**2600**		14	2.2	mg/Kg	☼	11/14/24 09:00	11/21/24 14:47	1
Iron	**5000**		6.9	4.0	mg/Kg	☼	11/14/24 09:00	11/21/24 14:47	1
Manganese	**42**		1.0	0.35	mg/Kg	☼	11/14/24 09:00	11/21/24 14:47	1

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.1**		1.4	0.83	mg/Kg	☼	11/15/24 09:00	11/25/24 14:00	2
Aluminum	**38000**		140	22	mg/Kg	☼	11/15/24 09:00	11/25/24 12:17	10
Iron	**4300**		6.9	5.7	mg/Kg	☼	11/15/24 09:00	11/25/24 13:06	1
Manganese	**44**		1.0	0.43	mg/Kg	☼	11/15/24 09:00	11/25/24 13:06	1

Method: SW846 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**4.8**		0.50	0.13	mg/Kg			11/26/24 15:45	1
Aluminum	**42000**		10	1.6	mg/Kg			11/26/24 15:45	1

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Client Sample ID: HEN-B100-37-38
Date Collected: 10/28/24 15:40
Date Received: 10/29/24 09:30

Lab Sample ID: 140-39235-1
Matrix: Solid
Percent Solids: 72.0

Method: SW846 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	16000		5.0	4.1	mg/Kg			11/26/24 15:45	1
Manganese	380		0.75	0.052	mg/Kg			11/26/24 15:45	1

Method: SW846 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	30000		140	22	mg/Kg	☼	11/15/24 09:00	11/25/24 12:32	10
Arsenic	4.6		1.4	0.83	mg/Kg	☼	11/15/24 09:00	11/25/24 14:15	2
Iron	12000		6.9	5.7	mg/Kg	☼	11/15/24 09:00	11/25/24 13:21	1
Manganese	300		1.0	0.43	mg/Kg	☼	11/15/24 09:00	11/25/24 13:21	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates (EPA-Lloyd Kahn)	25000		1400	1300	mg/Kg	☼		11/07/24 14:04	1

Method: ASTM D2974 - Moisture, Ash and Organic Matter

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Loss on Ignition	6.4		0.5	0.5	%			11/18/24 10:31	1

Client Sample ID: HEN-B100-48-49
Date Collected: 10/28/24 16:00
Date Received: 10/29/24 09:30

Lab Sample ID: 140-39235-2
Matrix: Solid
Percent Solids: 86.2

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		2.3	0.60	mg/Kg	☼	11/05/24 09:30	11/20/24 12:07	4
Aluminum	ND		46	7.4	mg/Kg	☼	11/05/24 09:30	11/20/24 12:07	4
Iron	ND		23	13	mg/Kg	☼	11/05/24 09:30	11/20/24 12:07	4
Manganese	**3.5**		3.5	0.14	mg/Kg	☼	11/05/24 09:30	11/20/24 12:07	4

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.7	0.45	mg/Kg	☼	11/06/24 10:30	11/20/24 13:02	3
Aluminum	**7.3**	**J**	35	5.6	mg/Kg	☼	11/06/24 10:30	11/20/24 13:02	3
Iron	**220**		17	10	mg/Kg	☼	11/06/24 10:30	11/20/24 13:02	3
Manganese	**37**		2.6	0.97	mg/Kg	☼	11/06/24 10:30	11/20/24 13:02	3

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.29**	**J**	0.58	0.15	mg/Kg	☼	11/07/24 09:30	11/20/24 13:57	1
Aluminum	**50**		12	2.4	mg/Kg	☼	11/07/24 09:30	11/20/24 13:57	1
Iron	**1100**		5.8	3.4	mg/Kg	☼	11/07/24 09:30	11/20/24 13:57	1
Manganese	**17**	**B**	0.87	0.031	mg/Kg	☼	11/07/24 09:30	11/20/24 13:57	1

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.38**	**J B**	0.58	0.26	mg/Kg	☼	11/12/24 09:00	11/21/24 13:08	1
Aluminum	**110**		12	1.9	mg/Kg	☼	11/12/24 09:00	11/21/24 13:08	1
Iron	**1100**		5.8	3.4	mg/Kg	☼	11/12/24 09:00	11/21/24 13:08	1
Manganese	**30**		0.87	0.15	mg/Kg	☼	11/12/24 09:00	11/21/24 13:08	1

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND	*-	8.7	2.2	mg/Kg	☼	11/14/24 08:45	11/21/24 14:03	5
Aluminum	**44**	**J**	170	27	mg/Kg	☼	11/14/24 08:45	11/21/24 14:03	5
Iron	ND		87	51	mg/Kg	☼	11/14/24 08:45	11/21/24 14:03	5
Manganese	ND		13	2.1	mg/Kg	☼	11/14/24 08:45	11/21/24 14:03	5

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.67**		0.58	0.17	mg/Kg	☼	11/14/24 09:00	11/21/24 14:57	1
Aluminum	**580**		12	1.9	mg/Kg	☼	11/14/24 09:00	11/21/24 14:57	1
Iron	**1900**		5.8	3.4	mg/Kg	☼	11/14/24 09:00	11/21/24 14:57	1
Manganese	**17**		0.87	0.29	mg/Kg	☼	11/14/24 09:00	11/21/24 14:57	1

Method: SW846 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**1.0**	**J**	1.2	0.70	mg/Kg	☼	11/15/24 09:00	11/25/24 14:10	2
Aluminum	**12000**		120	19	mg/Kg	☼	11/15/24 09:00	11/25/24 12:27	10
Iron	**1200**		5.8	4.8	mg/Kg	☼	11/15/24 09:00	11/25/24 13:16	1
Manganese	**19**		0.87	0.36	mg/Kg	☼	11/15/24 09:00	11/25/24 13:16	1

Method: SW846 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.4**		0.50	0.13	mg/Kg			11/26/24 15:45	1
Aluminum	**13000**		10	1.6	mg/Kg			11/26/24 15:45	1

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Client Sample ID: HEN-B100-48-49

Date Collected: 10/28/24 16:00
Date Received: 10/29/24 09:30

Lab Sample ID: 140-39235-2

Matrix: Solid
Percent Solids: 86.2

Method: SW846 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	5500		5.0	4.1	mg/Kg			11/26/24 15:45	1
Manganese	120		0.75	0.052	mg/Kg			11/26/24 15:45	1

Method: SW846 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	8700		120	19	mg/Kg	☼	11/15/24 09:00	11/25/24 12:41	10
Arsenic	2.3		1.2	0.70	mg/Kg	☼	11/15/24 09:00	11/25/24 14:25	2
Iron	4800		5.8	4.8	mg/Kg	☼	11/15/24 09:00	11/25/24 13:35	1
Manganese	120		0.87	0.36	mg/Kg	☼	11/15/24 09:00	11/25/24 13:35	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates (EPA-Lloyd Kahn)	ND		1200	1100	mg/Kg	☼		11/07/24 14:27	1

Method: ASTM D2974 - Moisture, Ash and Organic Matter

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Loss on Ignition	0.8		0.5	0.5	%			11/18/24 10:31	1

Default Detection Limits

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Prep: 3010A

SEP: Exchangeable

Analyte	RL	MDL
Aluminum	10 mg/Kg	1.6 mg/Kg
Arsenic	0.50 mg/Kg	0.13 mg/Kg
Iron	5.0 mg/Kg	2.9 mg/Kg
Manganese	0.75 mg/Kg	0.031 mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Prep: 3010A

SEP: Carbonate

Analyte	RL	MDL
Aluminum	10 mg/Kg	1.6 mg/Kg
Arsenic	0.50 mg/Kg	0.13 mg/Kg
Iron	5.0 mg/Kg	2.9 mg/Kg
Manganese	0.75 mg/Kg	0.28 mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Prep: 3010A

SEP: Non-Crystalline

Analyte	RL	MDL
Aluminum	10 mg/Kg	2.1 mg/Kg
Arsenic	0.50 mg/Kg	0.13 mg/Kg
Iron	5.0 mg/Kg	2.9 mg/Kg
Manganese	0.75 mg/Kg	0.027 mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Prep: 3010A

SEP: Metal Hydroxide

Analyte	RL	MDL
Aluminum	10 mg/Kg	1.6 mg/Kg
Arsenic	0.50 mg/Kg	0.22 mg/Kg
Iron	5.0 mg/Kg	2.9 mg/Kg
Manganese	0.75 mg/Kg	0.13 mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Prep: 3010A

SEP: Organic-Bound

Analyte	RL	MDL
Aluminum	30 mg/Kg	4.7 mg/Kg
Arsenic	1.5 mg/Kg	0.38 mg/Kg
Iron	15 mg/Kg	8.8 mg/Kg
Manganese	2.3 mg/Kg	0.37 mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 6

SEP: Acid/Sulfide

Analyte	RL	MDL
Aluminum	10 mg/Kg	1.6 mg/Kg
Arsenic	0.50 mg/Kg	0.15 mg/Kg
Iron	5.0 mg/Kg	2.9 mg/Kg
Manganese	0.75 mg/Kg	0.25 mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Default Detection Limits

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Prep: Residual

Analyte	RL	MDL
Aluminum	10 mg/Kg	1.6 mg/Kg
Arsenic	0.50 mg/Kg	0.30 mg/Kg
Iron	5.0 mg/Kg	4.1 mg/Kg
Manganese	0.75 mg/Kg	0.31 mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	RL	MDL
Aluminum	10 mg/Kg	1.6 mg/Kg
Arsenic	0.50 mg/Kg	0.13 mg/Kg
Iron	5.0 mg/Kg	4.1 mg/Kg
Manganese	0.75 mg/Kg	0.052 mg/Kg

Method: 6010B - SEP Metals (ICP) - Total

Prep: Total

Analyte	RL	MDL
Aluminum	10 mg/Kg	1.6 mg/Kg
Arsenic	0.50 mg/Kg	0.30 mg/Kg
Iron	5.0 mg/Kg	4.1 mg/Kg
Manganese	0.75 mg/Kg	0.31 mg/Kg

General Chemistry

Analyte	RL	MDL
Total Organic Carbon - Duplicates	1000 mg/Kg	970 mg/Kg

Method: ASTM D2974 - Moisture, Ash and Organic Matter

Analyte	RL	RL
Loss on Ignition	0.5 %	0.5 %

Method: 6010B - SEP Metals (ICP) - Total

Lab Sample ID: MB 140-92840/4-A
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 92840

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		11/15/24 09:00	11/25/24 11:43	1
Arsenic	ND		0.50	0.30	mg/Kg		11/15/24 09:00	11/25/24 11:43	1
Iron	ND		5.0	4.1	mg/Kg		11/15/24 09:00	11/25/24 11:43	1
Manganese	ND		0.75	0.31	mg/Kg		11/15/24 09:00	11/25/24 11:43	1

Lab Sample ID: LCS 140-92840/5-A
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 92840

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Aluminum			100	98.9		mg/Kg		99	80 - 120		
Arsenic			5.00	5.17		mg/Kg		103	80 - 120		
Iron			50.0	52.9		mg/Kg		106	80 - 120		
Manganese			5.00	5.29		mg/Kg		106	80 - 120		

Lab Sample ID: LCSD 140-92840/6-A
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 92840

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Aluminum			100	96.6		mg/Kg		97	80 - 120	2	30
Arsenic			5.00	5.14		mg/Kg		103	80 - 120	1	30
Iron			50.0	51.5		mg/Kg		103	80 - 120	3	30
Manganese			5.00	5.28		mg/Kg		106	80 - 120	0	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: HEN-B100-37-38
Prep Type: Total/NA
Prep Batch: 92840

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Aluminum	30000			29500		mg/Kg	☼			3	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: HEN-B100-37-38
Prep Type: Total/NA
Prep Batch: 92840

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Iron	12000			12800		mg/Kg	☼			3	30
Manganese	300			318		mg/Kg	☼			4	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: HEN-B100-37-38
Prep Type: Total/NA
Prep Batch: 92840

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Arsenic	4.6			4.90		mg/Kg	☼			7	30

Method: 6010B SEP - SEP Metals (ICP)

Lab Sample ID: MB 140-92839/4-B ^4
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: Method Blank
Prep Type: Step 1
Prep Batch: 92863

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		2.0	0.52	mg/Kg		11/05/24 09:30	11/20/24 11:43	4
Aluminum	ND		40	6.4	mg/Kg		11/05/24 09:30	11/20/24 11:43	4
Iron	ND		20	12	mg/Kg		11/05/24 09:30	11/20/24 11:43	4
Manganese	ND		3.0	0.12	mg/Kg		11/05/24 09:30	11/20/24 11:43	4

Lab Sample ID: LCS 140-92839/5-B ^5
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: Lab Control Sample
Prep Type: Step 1
Prep Batch: 92863

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Arsenic	5.00	4.33		mg/Kg		87	80 - 120
Aluminum	100	85.0		mg/Kg		85	80 - 120
Iron	50.0	45.7		mg/Kg		91	80 - 120
Manganese	5.00	4.72		mg/Kg		94	80 - 120

Lab Sample ID: LCSD 140-92839/8-B ^5
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 1
Prep Batch: 92863

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Arsenic	5.00	4.51		mg/Kg		90	80 - 120	4	30
Aluminum	100	84.3		mg/Kg		84	80 - 120	1	30
Iron	50.0	46.4		mg/Kg		93	80 - 120	1	30
Manganese	5.00	4.75		mg/Kg		95	80 - 120	1	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: HEN-B100-37-38
Prep Type: Step 1
Prep Batch: 92863

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Arsenic	ND		ND		mg/Kg	☼	NC	30
Aluminum	ND		ND		mg/Kg	☼	NC	30
Iron	ND		ND		mg/Kg	☼	NC	30
Manganese	5.2		4.38		mg/Kg	☼	18	30

Lab Sample ID: MB 140-92892/4-B ^3
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: Method Blank
Prep Type: Step 2
Prep Batch: 92905

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.5	0.39	mg/Kg		11/06/24 10:30	11/20/24 12:37	3
Aluminum	ND		30	4.8	mg/Kg		11/06/24 10:30	11/20/24 12:37	3
Iron	ND		15	8.7	mg/Kg		11/06/24 10:30	11/20/24 12:37	3
Manganese	ND		2.3	0.84	mg/Kg		11/06/24 10:30	11/20/24 12:37	3

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-92892/5-B ^5
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: Lab Control Sample
Prep Type: Step 2
Prep Batch: 92905

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Arsenic			5.00	3.97		mg/Kg		79	60 - 120		
Aluminum			100	ND		mg/Kg		-3			
Iron			50.0	ND		mg/Kg		4			
Manganese			5.00	4.81		mg/Kg		96	80 - 120		

Lab Sample ID: LCSD 140-92892/6-B ^5
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 2
Prep Batch: 92905

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Arsenic			5.00	3.73		mg/Kg		75	60 - 120	6	30
Aluminum			100	ND		mg/Kg		-2		18	
Iron			50.0	ND		mg/Kg		3		31	
Manganese			5.00	4.82		mg/Kg		96	80 - 120	0	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: HEN-B100-37-38
Prep Type: Step 2
Prep Batch: 92905

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Arsenic	ND			ND		mg/Kg	☼			NC	30
Aluminum	14	J		14.0	J	mg/Kg	☼			0.9	
Iron	120			93.5		mg/Kg	☼			24	
Manganese	100			93.6		mg/Kg	☼			6	30

Lab Sample ID: MB 140-92946/4-B
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: Method Blank
Prep Type: Step 3
Prep Batch: 92970

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		0.50	0.13	mg/Kg		11/07/24 09:30	11/20/24 13:32	1
Aluminum	ND		10	2.1	mg/Kg		11/07/24 09:30	11/20/24 13:32	1
Iron	ND		5.0	2.9	mg/Kg		11/07/24 09:30	11/20/24 13:32	1
Manganese	0.0950	J	0.75	0.027	mg/Kg		11/07/24 09:30	11/20/24 13:32	1

Lab Sample ID: LCS 140-92946/5-B
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: Lab Control Sample
Prep Type: Step 3
Prep Batch: 92970

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Arsenic			5.00	4.56		mg/Kg		91	80 - 120		
Aluminum			100	87.5		mg/Kg		87	80 - 120		
Iron			50.0	47.3		mg/Kg		95	80 - 120		
Manganese			5.00	4.94		mg/Kg		99	80 - 120		

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCSD 140-92946/6-B
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 3
Prep Batch: 92970

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Arsenic			5.00	4.47		mg/Kg		89	80 - 120	2	30
Aluminum			100	85.6		mg/Kg		86	80 - 120	2	30
Iron			50.0	46.2		mg/Kg		92	80 - 120	2	30
Manganese			5.00	4.85		mg/Kg		97	80 - 120	2	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93481

Client Sample ID: HEN-B100-37-38
Prep Type: Step 3
Prep Batch: 92970

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Arsenic	1.0			1.08		mg/Kg	☼			3	30
Aluminum	210			199		mg/Kg	☼			4	30
Iron	2800			2620		mg/Kg	☼			7	30
Manganese	68	B		60.1		mg/Kg	☼			13	30

Lab Sample ID: MB 140-93062/4-B
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: Method Blank
Prep Type: Step 4
Prep Batch: 93086

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	0.220	J	0.50	0.22	mg/Kg		11/12/24 09:00	11/21/24 12:44	1
Aluminum	ND		10	1.6	mg/Kg		11/12/24 09:00	11/21/24 12:44	1
Iron	ND		5.0	2.9	mg/Kg		11/12/24 09:00	11/21/24 12:44	1
Manganese	ND		0.75	0.13	mg/Kg		11/12/24 09:00	11/21/24 12:44	1

Lab Sample ID: LCS 140-93062/5-B
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: Lab Control Sample
Prep Type: Step 4
Prep Batch: 93086

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Arsenic			5.00	5.34		mg/Kg		107	80 - 130		
Aluminum			100	101		mg/Kg		101	80 - 120		
Iron			50.0	52.4		mg/Kg		105	80 - 120		
Manganese			5.00	5.30		mg/Kg		106	80 - 120		

Lab Sample ID: LCSD 140-93062/6-B
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 4
Prep Batch: 93086

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Arsenic			5.00	5.21		mg/Kg		104	80 - 130	2	30
Aluminum			100	99.2		mg/Kg		99	80 - 120	2	30
Iron			50.0	52.1		mg/Kg		104	80 - 120	1	30
Manganese			5.00	5.25		mg/Kg		105	80 - 120	1	30

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: HEN-B100-37-38
Prep Type: Step 4
Prep Batch: 93086

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Arsenic	0.69	B	0.665	J	mg/Kg	☼	4	30
Aluminum	920		878		mg/Kg	☼	5	30
Iron	3800		3550		mg/Kg	☼	8	30
Manganese	100		90.9		mg/Kg	☼	13	30

Lab Sample ID: MB 140-93113/4-B ^5
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: Method Blank
Prep Type: Step 5
Prep Batch: 93216

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		7.5	1.9	mg/Kg		11/14/24 08:45	11/21/24 13:37	5
Aluminum	ND		150	24	mg/Kg		11/14/24 08:45	11/21/24 13:37	5
Iron	ND		75	44	mg/Kg		11/14/24 08:45	11/21/24 13:37	5
Manganese	ND		11	1.9	mg/Kg		11/14/24 08:45	11/21/24 13:37	5

Lab Sample ID: LCS 140-93113/5-B ^5
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: Lab Control Sample
Prep Type: Step 5
Prep Batch: 93216

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Arsenic	15.0	8.33	*-	mg/Kg		56	60 - 100
Aluminum	300	ND		mg/Kg		8	
Iron	150	ND		mg/Kg		0.2	
Manganese	15.0	3.56	J	mg/Kg		24	1 - 60

Lab Sample ID: LCSD 140-93113/6-B ^5
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 5
Prep Batch: 93216

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Arsenic	15.0	7.43	J *-	mg/Kg		50	60 - 100	12	30
Aluminum	300	41.5	J	mg/Kg		14		57	
Iron	150	ND		mg/Kg		0.6		101	
Manganese	15.0	4.05	J	mg/Kg		27	1 - 60	13	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: HEN-B100-37-38
Prep Type: Step 5
Prep Batch: 93216

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Arsenic	ND	*-	ND	*-	mg/Kg	☼	NC	30
Aluminum	93	J	100	J	mg/Kg	☼	8	
Iron	120		121		mg/Kg	☼	3	
Manganese	18		17.3		mg/Kg	☼	6	30

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-93221/4-A
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: Method Blank
Prep Type: Step 6
Prep Batch: 93221

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		0.50	0.15	mg/Kg		11/14/24 09:00	11/21/24 14:33	1
Aluminum	ND		10	1.6	mg/Kg		11/14/24 09:00	11/21/24 14:33	1
Iron	ND		5.0	2.9	mg/Kg		11/14/24 09:00	11/21/24 14:33	1
Manganese	ND		0.75	0.25	mg/Kg		11/14/24 09:00	11/21/24 14:33	1

Lab Sample ID: LCS 140-93221/5-A
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: Lab Control Sample
Prep Type: Step 6
Prep Batch: 93221

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Arsenic			5.00	4.80		mg/Kg		96	80 - 120		
Aluminum			100	94.2		mg/Kg		94	80 - 120		
Iron			50.0	48.8		mg/Kg		98	80 - 120		
Manganese			5.00	4.97		mg/Kg		99	80 - 120		

Lab Sample ID: LCSD 140-93221/6-A
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 6
Prep Batch: 93221

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Arsenic			5.00	4.91		mg/Kg		98	80 - 120	2	30
Aluminum			100	94.6		mg/Kg		95	80 - 120	0	30
Iron			50.0	49.2		mg/Kg		98	80 - 120	1	30
Manganese			5.00	5.03		mg/Kg		101	80 - 120	1	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93525

Client Sample ID: HEN-B100-37-38
Prep Type: Step 6
Prep Batch: 93221

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Arsenic	0.94			0.874		mg/Kg	☼			7	30
Aluminum	2600			2410		mg/Kg	☼			6	30
Iron	5000			4520		mg/Kg	☼			9	30
Manganese	42			38.0		mg/Kg	☼			11	30

Lab Sample ID: MB 140-93259/4-A
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: Method Blank
Prep Type: Step 7
Prep Batch: 93259

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		0.50	0.30	mg/Kg		11/15/24 09:00	11/25/24 11:18	1
Aluminum	ND		10	1.6	mg/Kg		11/15/24 09:00	11/25/24 11:18	1
Iron	ND		5.0	4.1	mg/Kg		11/15/24 09:00	11/25/24 11:18	1
Manganese	ND		0.75	0.31	mg/Kg		11/15/24 09:00	11/25/24 11:18	1

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-93259/5-A
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: Lab Control Sample
Prep Type: Step 7
Prep Batch: 93259

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Arsenic			5.00	5.15		mg/Kg		103	80 - 120		
Aluminum			100	96.6		mg/Kg		97	80 - 120		
Iron			50.0	53.0		mg/Kg		106	80 - 120		
Manganese			5.00	5.25		mg/Kg		105	80 - 120		

Lab Sample ID: LCSD 140-93259/6-A
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 7
Prep Batch: 93259

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Arsenic			5.00	5.05		mg/Kg		101	80 - 120	2	30
Aluminum			100	94.7		mg/Kg		95	80 - 120	2	30
Iron			50.0	50.9		mg/Kg		102	80 - 120	4	30
Manganese			5.00	5.18		mg/Kg		104	80 - 120	1	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: HEN-B100-37-38
Prep Type: Step 7
Prep Batch: 93259

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Aluminum	38000			35500		mg/Kg	☼			6	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: HEN-B100-37-38
Prep Type: Step 7
Prep Batch: 93259

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Iron	4300			4050		mg/Kg	☼			6	30
Manganese	44			43.4		mg/Kg	☼			0.5	30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 93606

Client Sample ID: HEN-B100-37-38
Prep Type: Step 7
Prep Batch: 93259

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Arsenic	2.1			2.15		mg/Kg	☼			0.06	30

Method: EPA-Lloyd Kahn - Organic Carbon, Total (TOC)

Lab Sample ID: MB 180-483870/4
Matrix: Solid
Analysis Batch: 483870

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	ND		1000	970	mg/Kg			11/07/24 11:57	1

Method: EPA-Lloyd Kahn - Organic Carbon, Total (TOC) (Continued)

Lab Sample ID: LCS 180-483870/5
Matrix: Solid
Analysis Batch: 483870

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Total Organic Carbon - Duplicates			40000	44500		mg/Kg		111	75 - 125		

Method: ASTM D2974 - Moisture, Ash and Organic Matter

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Analysis Batch: 484644

Client Sample ID: HEN-B100-37-38
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Loss on Ignition	6.4			6.1		%				5	10

Metals

SEP Batch: 92839

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 1	Solid	Exchangeable	
140-39235-2	HEN-B100-48-49	Step 1	Solid	Exchangeable	
MB 140-92839/4-B ^4	Method Blank	Step 1	Solid	Exchangeable	
LCS 140-92839/5-B ^5	Lab Control Sample	Step 1	Solid	Exchangeable	
LCSD 140-92839/8-B ^5	Lab Control Sample Dup	Step 1	Solid	Exchangeable	
140-39235-1 DU	HEN-B100-37-38	Step 1	Solid	Exchangeable	

Prep Batch: 92840

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Total/NA	Solid	Total	
140-39235-2	HEN-B100-48-49	Total/NA	Solid	Total	
MB 140-92840/4-A	Method Blank	Total/NA	Solid	Total	
LCS 140-92840/5-A	Lab Control Sample	Total/NA	Solid	Total	
LCSD 140-92840/6-A	Lab Control Sample Dup	Total/NA	Solid	Total	
140-39235-1 DU	HEN-B100-37-38	Total/NA	Solid	Total	

Prep Batch: 92863

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 1	Solid	3010A	92839
140-39235-2	HEN-B100-48-49	Step 1	Solid	3010A	92839
MB 140-92839/4-B ^4	Method Blank	Step 1	Solid	3010A	92839
LCS 140-92839/5-B ^5	Lab Control Sample	Step 1	Solid	3010A	92839
LCSD 140-92839/8-B ^5	Lab Control Sample Dup	Step 1	Solid	3010A	92839
140-39235-1 DU	HEN-B100-37-38	Step 1	Solid	3010A	92839

SEP Batch: 92892

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 2	Solid	Carbonate	
140-39235-2	HEN-B100-48-49	Step 2	Solid	Carbonate	
MB 140-92892/4-B ^3	Method Blank	Step 2	Solid	Carbonate	
LCS 140-92892/5-B ^5	Lab Control Sample	Step 2	Solid	Carbonate	
LCSD 140-92892/6-B ^5	Lab Control Sample Dup	Step 2	Solid	Carbonate	
140-39235-1 DU	HEN-B100-37-38	Step 2	Solid	Carbonate	

Prep Batch: 92905

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 2	Solid	3010A	92892
140-39235-2	HEN-B100-48-49	Step 2	Solid	3010A	92892
MB 140-92892/4-B ^3	Method Blank	Step 2	Solid	3010A	92892
LCS 140-92892/5-B ^5	Lab Control Sample	Step 2	Solid	3010A	92892
LCSD 140-92892/6-B ^5	Lab Control Sample Dup	Step 2	Solid	3010A	92892
140-39235-1 DU	HEN-B100-37-38	Step 2	Solid	3010A	92892

SEP Batch: 92946

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 3	Solid	Non-Crystalline	
140-39235-2	HEN-B100-48-49	Step 3	Solid	Non-Crystalline	
MB 140-92946/4-B	Method Blank	Step 3	Solid	Non-Crystalline	
LCS 140-92946/5-B	Lab Control Sample	Step 3	Solid	Non-Crystalline	
LCSD 140-92946/6-B	Lab Control Sample Dup	Step 3	Solid	Non-Crystalline	
140-39235-1 DU	HEN-B100-37-38	Step 3	Solid	Non-Crystalline	

Metals

Prep Batch: 92970

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 3	Solid	3010A	92946
140-39235-2	HEN-B100-48-49	Step 3	Solid	3010A	92946
MB 140-92946/4-B	Method Blank	Step 3	Solid	3010A	92946
LCS 140-92946/5-B	Lab Control Sample	Step 3	Solid	3010A	92946
LCSD 140-92946/6-B	Lab Control Sample Dup	Step 3	Solid	3010A	92946
140-39235-1 DU	HEN-B100-37-38	Step 3	Solid	3010A	92946

SEP Batch: 93062

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 4	Solid	Metal Hydroxide	
140-39235-2	HEN-B100-48-49	Step 4	Solid	Metal Hydroxide	
MB 140-93062/4-B	Method Blank	Step 4	Solid	Metal Hydroxide	
LCS 140-93062/5-B	Lab Control Sample	Step 4	Solid	Metal Hydroxide	
LCSD 140-93062/6-B	Lab Control Sample Dup	Step 4	Solid	Metal Hydroxide	
140-39235-1 DU	HEN-B100-37-38	Step 4	Solid	Metal Hydroxide	

Prep Batch: 93086

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 4	Solid	3010A	93062
140-39235-2	HEN-B100-48-49	Step 4	Solid	3010A	93062
MB 140-93062/4-B	Method Blank	Step 4	Solid	3010A	93062
LCS 140-93062/5-B	Lab Control Sample	Step 4	Solid	3010A	93062
LCSD 140-93062/6-B	Lab Control Sample Dup	Step 4	Solid	3010A	93062
140-39235-1 DU	HEN-B100-37-38	Step 4	Solid	3010A	93062

SEP Batch: 93113

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 5	Solid	Organic-Bound	
140-39235-2	HEN-B100-48-49	Step 5	Solid	Organic-Bound	
MB 140-93113/4-B ^5	Method Blank	Step 5	Solid	Organic-Bound	
LCS 140-93113/5-B ^5	Lab Control Sample	Step 5	Solid	Organic-Bound	
LCSD 140-93113/6-B ^5	Lab Control Sample Dup	Step 5	Solid	Organic-Bound	
140-39235-1 DU	HEN-B100-37-38	Step 5	Solid	Organic-Bound	

Prep Batch: 93216

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 5	Solid	3010A	93113
140-39235-2	HEN-B100-48-49	Step 5	Solid	3010A	93113
MB 140-93113/4-B ^5	Method Blank	Step 5	Solid	3010A	93113
LCS 140-93113/5-B ^5	Lab Control Sample	Step 5	Solid	3010A	93113
LCSD 140-93113/6-B ^5	Lab Control Sample Dup	Step 5	Solid	3010A	93113
140-39235-1 DU	HEN-B100-37-38	Step 5	Solid	3010A	93113

SEP Batch: 93221

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 6	Solid	Acid/Sulfide	
140-39235-2	HEN-B100-48-49	Step 6	Solid	Acid/Sulfide	
MB 140-93221/4-A	Method Blank	Step 6	Solid	Acid/Sulfide	
LCS 140-93221/5-A	Lab Control Sample	Step 6	Solid	Acid/Sulfide	
LCSD 140-93221/6-A	Lab Control Sample Dup	Step 6	Solid	Acid/Sulfide	
140-39235-1 DU	HEN-B100-37-38	Step 6	Solid	Acid/Sulfide	

Metals

Prep Batch: 93259

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 7	Solid	Residual	
140-39235-2	HEN-B100-48-49	Step 7	Solid	Residual	
MB 140-93259/4-A	Method Blank	Step 7	Solid	Residual	
LCS 140-93259/5-A	Lab Control Sample	Step 7	Solid	Residual	
LCSD 140-93259/6-A	Lab Control Sample Dup	Step 7	Solid	Residual	
140-39235-1 DU	HEN-B100-37-38	Step 7	Solid	Residual	

Analysis Batch: 93481

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 1	Solid	6010B SEP	92863
140-39235-1	HEN-B100-37-38	Step 2	Solid	6010B SEP	92905
140-39235-1	HEN-B100-37-38	Step 3	Solid	6010B SEP	92970
140-39235-2	HEN-B100-48-49	Step 1	Solid	6010B SEP	92863
140-39235-2	HEN-B100-48-49	Step 2	Solid	6010B SEP	92905
140-39235-2	HEN-B100-48-49	Step 3	Solid	6010B SEP	92970
MB 140-92839/4-B ^4	Method Blank	Step 1	Solid	6010B SEP	92863
MB 140-92892/4-B ^3	Method Blank	Step 2	Solid	6010B SEP	92905
MB 140-92946/4-B	Method Blank	Step 3	Solid	6010B SEP	92970
LCS 140-92839/5-B ^5	Lab Control Sample	Step 1	Solid	6010B SEP	92863
LCS 140-92892/5-B ^5	Lab Control Sample	Step 2	Solid	6010B SEP	92905
LCS 140-92946/5-B	Lab Control Sample	Step 3	Solid	6010B SEP	92970
LCSD 140-92839/8-B ^5	Lab Control Sample Dup	Step 1	Solid	6010B SEP	92863
LCSD 140-92892/6-B ^5	Lab Control Sample Dup	Step 2	Solid	6010B SEP	92905
LCSD 140-92946/6-B	Lab Control Sample Dup	Step 3	Solid	6010B SEP	92970
140-39235-1 DU	HEN-B100-37-38	Step 1	Solid	6010B SEP	92863
140-39235-1 DU	HEN-B100-37-38	Step 2	Solid	6010B SEP	92905
140-39235-1 DU	HEN-B100-37-38	Step 3	Solid	6010B SEP	92970

Analysis Batch: 93525

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 4	Solid	6010B SEP	93086
140-39235-1	HEN-B100-37-38	Step 5	Solid	6010B SEP	93216
140-39235-1	HEN-B100-37-38	Step 6	Solid	6010B SEP	93221
140-39235-2	HEN-B100-48-49	Step 4	Solid	6010B SEP	93086
140-39235-2	HEN-B100-48-49	Step 5	Solid	6010B SEP	93216
140-39235-2	HEN-B100-48-49	Step 6	Solid	6010B SEP	93221
MB 140-93062/4-B	Method Blank	Step 4	Solid	6010B SEP	93086
MB 140-93113/4-B ^5	Method Blank	Step 5	Solid	6010B SEP	93216
MB 140-93221/4-A	Method Blank	Step 6	Solid	6010B SEP	93221
LCS 140-93062/5-B	Lab Control Sample	Step 4	Solid	6010B SEP	93086
LCS 140-93113/5-B ^5	Lab Control Sample	Step 5	Solid	6010B SEP	93216
LCS 140-93221/5-A	Lab Control Sample	Step 6	Solid	6010B SEP	93221
LCSD 140-93062/6-B	Lab Control Sample Dup	Step 4	Solid	6010B SEP	93086
LCSD 140-93113/6-B ^5	Lab Control Sample Dup	Step 5	Solid	6010B SEP	93216
LCSD 140-93221/6-A	Lab Control Sample Dup	Step 6	Solid	6010B SEP	93221
140-39235-1 DU	HEN-B100-37-38	Step 4	Solid	6010B SEP	93086
140-39235-1 DU	HEN-B100-37-38	Step 5	Solid	6010B SEP	93216
140-39235-1 DU	HEN-B100-37-38	Step 6	Solid	6010B SEP	93221

Metals

Analysis Batch: 93606

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Step 7	Solid	6010B SEP	93259
140-39235-1	HEN-B100-37-38	Step 7	Solid	6010B SEP	93259
140-39235-1	HEN-B100-37-38	Step 7	Solid	6010B SEP	93259
140-39235-1	HEN-B100-37-38	Total/NA	Solid	6010B	92840
140-39235-1	HEN-B100-37-38	Total/NA	Solid	6010B	92840
140-39235-1	HEN-B100-37-38	Total/NA	Solid	6010B	92840
140-39235-2	HEN-B100-48-49	Step 7	Solid	6010B SEP	93259
140-39235-2	HEN-B100-48-49	Step 7	Solid	6010B SEP	93259
140-39235-2	HEN-B100-48-49	Step 7	Solid	6010B SEP	93259
140-39235-2	HEN-B100-48-49	Total/NA	Solid	6010B	92840
140-39235-2	HEN-B100-48-49	Total/NA	Solid	6010B	92840
140-39235-2	HEN-B100-48-49	Total/NA	Solid	6010B	92840
MB 140-92840/4-A	Method Blank	Total/NA	Solid	6010B	92840
MB 140-93259/4-A	Method Blank	Step 7	Solid	6010B SEP	93259
LCS 140-92840/5-A	Lab Control Sample	Total/NA	Solid	6010B	92840
LCS 140-93259/5-A	Lab Control Sample	Step 7	Solid	6010B SEP	93259
LCSD 140-92840/6-A	Lab Control Sample Dup	Total/NA	Solid	6010B	92840
LCSD 140-93259/6-A	Lab Control Sample Dup	Step 7	Solid	6010B SEP	93259
140-39235-1 DU	HEN-B100-37-38	Step 7	Solid	6010B SEP	93259
140-39235-1 DU	HEN-B100-37-38	Step 7	Solid	6010B SEP	93259
140-39235-1 DU	HEN-B100-37-38	Step 7	Solid	6010B SEP	93259
140-39235-1 DU	HEN-B100-37-38	Total/NA	Solid	6010B	92840
140-39235-1 DU	HEN-B100-37-38	Total/NA	Solid	6010B	92840
140-39235-1 DU	HEN-B100-37-38	Total/NA	Solid	6010B	92840

Analysis Batch: 93649

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Sum of Steps 1-7	Solid	6010B SEP	
140-39235-2	HEN-B100-48-49	Sum of Steps 1-7	Solid	6010B SEP	

General Chemistry

Analysis Batch: 93334

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Total/NA	Solid	Moisture	
140-39235-2	HEN-B100-48-49	Total/NA	Solid	Moisture	

Analysis Batch: 483870

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Total/NA	Solid	EPA-Lloyd Kahn	
140-39235-2	HEN-B100-48-49	Total/NA	Solid	EPA-Lloyd Kahn	
MB 180-483870/4	Method Blank	Total/NA	Solid	EPA-Lloyd Kahn	
LCS 180-483870/5	Lab Control Sample	Total/NA	Solid	EPA-Lloyd Kahn	

Geotechnical

Analysis Batch: 484644

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-39235-1	HEN-B100-37-38	Total/NA	Solid	ASTM D2974	
140-39235-2	HEN-B100-48-49	Total/NA	Solid	ASTM D2974	
140-39235-1 DU	HEN-B100-37-38	Total/NA	Solid	ASTM D2974	

Client Sample ID: HEN-B100-37-38

Lab Sample ID: 140-39235-1

Date Collected: 10/28/24 15:40

Matrix: Solid

Date Received: 10/29/24 09:30

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			93649	11/26/24 15:45	KNC	EET KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			93334	11/18/24 09:58	TXR	EET KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	ASTM D2974		1			484644	11/18/24 10:31	ELS	EET PIT
	Instrument ID: NOEQUIP									

Client Sample ID: HEN-B100-37-38

Lab Sample ID: 140-39235-1

Date Collected: 10/28/24 15:40

Matrix: Solid

Date Received: 10/29/24 09:30

Percent Solids: 72.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		10			93606	11/25/24 12:32	BND	EET KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		1			93606	11/25/24 13:21	BND	EET KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		2			93606	11/25/24 14:15	BND	EET KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	92839	11/04/24 09:15	BND	EET KNX
Step 1	Prep	3010A			5 mL	50 mL	92863	11/05/24 09:30	BND	EET KNX
Step 1	Analysis	6010B SEP		4			93481	11/20/24 11:57	BND	EET KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5.000 g	25 mL	92892	11/05/24 09:32	BND	EET KNX
Step 2	Prep	3010A			5 mL	50 mL	92905	11/06/24 10:30	BND	EET KNX
Step 2	Analysis	6010B SEP		3			93481	11/20/24 12:52	BND	EET KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	92946	11/06/24 09:30	BND	EET KNX
Step 3	Prep	3010A			5 mL	50 mL	92970	11/07/24 09:30	BND	EET KNX
Step 3	Analysis	6010B SEP		1			93481	11/20/24 13:47	BND	EET KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	93062	11/11/24 08:30	BND	EET KNX
Step 4	Prep	3010A			5 mL	50 mL	93086	11/12/24 09:00	BND	EET KNX
Step 4	Analysis	6010B SEP		1			93525	11/21/24 12:58	BND	EET KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	93113	11/12/24 09:20	BND	EET KNX
Step 5	Prep	3010A			5 mL	50 mL	93216	11/14/24 08:45	BND	EET KNX
Step 5	Analysis	6010B SEP		5			93525	11/21/24 13:52	BND	EET KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	93221	11/14/24 09:00	BND	EET KNX
Step 6	Analysis	6010B SEP		1			93525	11/21/24 14:47	BND	EET KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Client Sample ID: HEN-B100-37-38
Date Collected: 10/28/24 15:40
Date Received: 10/29/24 09:30

Lab Sample ID: 140-39235-1
Matrix: Solid
Percent Solids: 72.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		10			93606	11/25/24 12:17	BND	EET KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		1			93606	11/25/24 13:06	BND	EET KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		2			93606	11/25/24 14:00	BND	EET KNX
	Instrument ID: DUO									
Total/NA	Analysis	EPA-Lloyd Kahn		1			483870	11/07/24 14:04	SMW	EET PIT
	Instrument ID: FLASHSMART2									

Client Sample ID: HEN-B100-48-49
Date Collected: 10/28/24 16:00
Date Received: 10/29/24 09:30

Lab Sample ID: 140-39235-2
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			93649	11/26/24 15:45	KNC	EET KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			93334	11/18/24 09:58	TXR	EET KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	ASTM D2974		1			484644	11/18/24 10:31	ELS	EET PIT
	Instrument ID: NOEQUIP									

Client Sample ID: HEN-B100-48-49
Date Collected: 10/28/24 16:00
Date Received: 10/29/24 09:30

Lab Sample ID: 140-39235-2
Matrix: Solid
Percent Solids: 86.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		10			93606	11/25/24 12:41	BND	EET KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		1			93606	11/25/24 13:35	BND	EET KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		2			93606	11/25/24 14:25	BND	EET KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	92839	11/04/24 09:15	BND	EET KNX
Step 1	Prep	3010A			5 mL	50 mL	92863	11/05/24 09:30	BND	EET KNX
Step 1	Analysis	6010B SEP		4			93481	11/20/24 12:07	BND	EET KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5.000 g	25 mL	92892	11/05/24 09:32	BND	EET KNX
Step 2	Prep	3010A			5 mL	50 mL	92905	11/06/24 10:30	BND	EET KNX
Step 2	Analysis	6010B SEP		3			93481	11/20/24 13:02	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: HEN-B100-48-49

Lab Sample ID: 140-39235-2

Date Collected: 10/28/24 16:00

Matrix: Solid

Date Received: 10/29/24 09:30

Percent Solids: 86.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	92946	11/06/24 09:30	BND	EET KNX
Step 3	Prep	3010A			5 mL	50 mL	92970	11/07/24 09:30	BND	EET KNX
Step 3	Analysis	6010B SEP		1			93481	11/20/24 13:57	BND	EET KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	93062	11/11/24 08:30	BND	EET KNX
Step 4	Prep	3010A			5 mL	50 mL	93086	11/12/24 09:00	BND	EET KNX
Step 4	Analysis	6010B SEP		1			93525	11/21/24 13:08	BND	EET KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	93113	11/12/24 09:20	BND	EET KNX
Step 5	Prep	3010A			5 mL	50 mL	93216	11/14/24 08:45	BND	EET KNX
Step 5	Analysis	6010B SEP		5			93525	11/21/24 14:03	BND	EET KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	93221	11/14/24 09:00	BND	EET KNX
Step 6	Analysis	6010B SEP		1			93525	11/21/24 14:57	BND	EET KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		10			93606	11/25/24 12:27	BND	EET KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		1			93606	11/25/24 13:16	BND	EET KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		2			93606	11/25/24 14:10	BND	EET KNX
	Instrument ID: DUO									
Total/NA	Analysis	EPA-Lloyd Kahn		1			483870	11/07/24 14:27	SMW	EET PIT
	Instrument ID: FLASHSMART2									

Client Sample ID: Method Blank

Lab Sample ID: MB 140-92839/4-B ^4

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5.000 g	25 mL	92839	11/04/24 09:15	BND	EET KNX
Step 1	Prep	3010A			5 mL	50 mL	92863	11/05/24 09:30	BND	EET KNX
Step 1	Analysis	6010B SEP		4			93481	11/20/24 11:43	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank

Lab Sample ID: MB 140-92840/4-A

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		1			93606	11/25/24 11:43	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-92892/4-B ^3

Date Collected: N/A
Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	92892	11/05/24 09:32	BND	EET KNX
Step 2	Prep	3010A			5 mL	50 mL	92905	11/06/24 10:30	BND	EET KNX
Step 2	Analysis	6010B SEP		3			93481	11/20/24 12:37	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-92946/4-B

Date Collected: N/A
Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	92946	11/06/24 09:30	BND	EET KNX
Step 3	Prep	3010A			5 mL	50 mL	92970	11/07/24 09:30	BND	EET KNX
Step 3	Analysis	6010B SEP		1			93481	11/20/24 13:32	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-93062/4-B

Date Collected: N/A
Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	93062	11/11/24 08:30	BND	EET KNX
Step 4	Prep	3010A			5 mL	50 mL	93086	11/12/24 09:00	BND	EET KNX
Step 4	Analysis	6010B SEP		1			93525	11/21/24 12:44	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-93113/4-B ^5

Date Collected: N/A
Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5.000 g	75 mL	93113	11/12/24 09:20	BND	EET KNX
Step 5	Prep	3010A			5 mL	50 mL	93216	11/14/24 08:45	BND	EET KNX
Step 5	Analysis	6010B SEP		5			93525	11/21/24 13:37	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-93221/4-A

Date Collected: N/A
Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	93221	11/14/24 09:00	BND	EET KNX
Step 6	Analysis	6010B SEP		1			93525	11/21/24 14:33	BND	EET KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Client Sample ID: Method Blank
Lab Sample ID: MB 140-93259/4-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		1			93606	11/25/24 11:18	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 180-483870/4
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA-Lloyd Kahn		1	20.08 mg	20.08 mg	483870	11/07/24 11:57	SMW	EET PIT
	Instrument ID: FLASHSMART2									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-92839/5-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5.000 g	25 mL	92839	11/04/24 09:15	BND	EET KNX
Step 1	Prep	3010A			5 mL	50 mL	92863	11/05/24 09:30	BND	EET KNX
Step 1	Analysis	6010B SEP		5			93481	11/20/24 11:48	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-92840/5-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		1			93606	11/25/24 11:48	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-92892/5-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	92892	11/05/24 09:32	BND	EET KNX
Step 2	Prep	3010A			5 mL	50 mL	92905	11/06/24 10:30	BND	EET KNX
Step 2	Analysis	6010B SEP		5			93481	11/20/24 12:42	BND	EET KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-92946/5-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	92946	11/06/24 09:30	BND	EET KNX
Step 3	Prep	3010A			5 mL	50 mL	92970	11/07/24 09:30	BND	EET KNX
Step 3	Analysis	6010B SEP		1			93481	11/20/24 13:37	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-93062/5-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	93062	11/11/24 08:30	BND	EET KNX
Step 4	Prep	3010A			5 mL	50 mL	93086	11/12/24 09:00	BND	EET KNX
Step 4	Analysis	6010B SEP		1			93525	11/21/24 12:49	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-93113/5-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5.000 g	75 mL	93113	11/12/24 09:20	BND	EET KNX
Step 5	Prep	3010A			5 mL	50 mL	93216	11/14/24 08:45	BND	EET KNX
Step 5	Analysis	6010B SEP		5			93525	11/21/24 13:42	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-93221/5-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	93221	11/14/24 09:00	BND	EET KNX
Step 6	Analysis	6010B SEP		1			93525	11/21/24 14:38	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-93259/5-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		1			93606	11/25/24 11:23	BND	EET KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 180-483870/5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA-Lloyd Kahn		1	10.09 mg	10.09 mg	483870	11/07/24 12:12	SMW	EET PIT
	Instrument ID: FLASHSMART2									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-92839/8-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5.000 g	25 mL	92839	11/04/24 09:15	BND	EET KNX
Step 1	Prep	3010A			5 mL	50 mL	92863	11/05/24 09:30	BND	EET KNX
Step 1	Analysis	6010B SEP		5			93481	11/20/24 11:53	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-92840/6-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		1			93606	11/25/24 11:53	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-92892/6-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	92892	11/05/24 09:32	BND	EET KNX
Step 2	Prep	3010A			5 mL	50 mL	92905	11/06/24 10:30	BND	EET KNX
Step 2	Analysis	6010B SEP		5			93481	11/20/24 12:47	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-92946/6-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	92946	11/06/24 09:30	BND	EET KNX
Step 3	Prep	3010A			5 mL	50 mL	92970	11/07/24 09:30	BND	EET KNX
Step 3	Analysis	6010B SEP		1			93481	11/20/24 13:42	BND	EET KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-93062/6-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	93062	11/11/24 08:30	BND	EET KNX
Step 4	Prep	3010A			5 mL	50 mL	93086	11/12/24 09:00	BND	EET KNX
Step 4	Analysis	6010B SEP		1			93525	11/21/24 12:54	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-93113/6-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5.000 g	75 mL	93113	11/12/24 09:20	BND	EET KNX
Step 5	Prep	3010A			5 mL	50 mL	93216	11/14/24 08:45	BND	EET KNX
Step 5	Analysis	6010B SEP		5			93525	11/21/24 13:47	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-93221/6-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	93221	11/14/24 09:00	BND	EET KNX
Step 6	Analysis	6010B SEP		1			93525	11/21/24 14:42	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-93259/6-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		1			93606	11/25/24 11:28	BND	EET KNX
	Instrument ID: DUO									

Client Sample ID: HEN-B100-37-38
Lab Sample ID: 140-39235-1 DU
Date Collected: 10/28/24 15:40
Matrix: Solid
Date Received: 10/29/24 09:30

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	ASTM D2974		1			484644	11/18/24 10:31	ELS	EET PIT
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Client Sample ID: HEN-B100-37-38
Date Collected: 10/28/24 15:40
Date Received: 10/29/24 09:30

Lab Sample ID: 140-39235-1 DU
Matrix: Solid
Percent Solids: 72.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		10			93606	11/25/24 12:37	BND	EET KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		1			93606	11/25/24 13:26	BND	EET KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	92840	11/15/24 09:00	BND	EET KNX
Total/NA	Analysis	6010B		2			93606	11/25/24 14:20	BND	EET KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	92839	11/04/24 09:15	BND	EET KNX
Step 1	Prep	3010A			5 mL	50 mL	92863	11/05/24 09:30	BND	EET KNX
Step 1	Analysis	6010B SEP		4			93481	11/20/24 12:02	BND	EET KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5.000 g	25 mL	92892	11/05/24 09:32	BND	EET KNX
Step 2	Prep	3010A			5 mL	50 mL	92905	11/06/24 10:30	BND	EET KNX
Step 2	Analysis	6010B SEP		3			93481	11/20/24 12:57	BND	EET KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	92946	11/06/24 09:30	BND	EET KNX
Step 3	Prep	3010A			5 mL	50 mL	92970	11/07/24 09:30	BND	EET KNX
Step 3	Analysis	6010B SEP		1			93481	11/20/24 13:52	BND	EET KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	93062	11/11/24 08:30	BND	EET KNX
Step 4	Prep	3010A			5 mL	50 mL	93086	11/12/24 09:00	BND	EET KNX
Step 4	Analysis	6010B SEP		1			93525	11/21/24 13:03	BND	EET KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	93113	11/12/24 09:20	BND	EET KNX
Step 5	Prep	3010A			5 mL	50 mL	93216	11/14/24 08:45	BND	EET KNX
Step 5	Analysis	6010B SEP		5			93525	11/21/24 13:58	BND	EET KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	93221	11/14/24 09:00	BND	EET KNX
Step 6	Analysis	6010B SEP		1			93525	11/21/24 14:52	BND	EET KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		10			93606	11/25/24 12:22	BND	EET KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		1			93606	11/25/24 13:11	BND	EET KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	93259	11/15/24 09:00	BND	EET KNX
Step 7	Analysis	6010B SEP		2			93606	11/25/24 14:05	BND	EET KNX
	Instrument ID: DUO									

Laboratory References:

EET KNX = Eurofins Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

EET PIT = Eurofins Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Accreditation/Certification Summary

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Laboratory: Eurofins Knoxville

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
	AFCEE	N/A	
ANAB	Dept. of Defense ELAP	L2311	02-13-25
ANAB	Dept. of Energy	L2311.01	02-13-25
ANAB	ISO/IEC 17025	L2311	02-13-25
Arkansas DEQ	State	88-0688	06-17-25
Colorado	State	TN00009	02-28-25
Connecticut	State	PH-0223	10-01-26
Florida	NELAP	E87177	06-30-25
Georgia (DW)	State	906	07-27-25
Hawaii	State	NA	07-27-25
Kansas	NELAP	E-10349	10-31-25
Kentucky (DW)	State	90101	12-31-24
Louisiana (All)	NELAP	83979	06-30-25
Louisiana (DW)	State	LA019	12-31-24
Maryland	State	277	03-31-25
Michigan	State	9933	07-27-25
Nevada	State	TN00009	07-31-25
New Hampshire	NELAP	2999	01-17-25
New Jersey	NELAP	TN001	06-30-25
New York	NELAP	10781	03-31-25
North Carolina (DW)	State	21705	07-31-25
North Carolina (WW/SW)	State	64	12-31-24
Oklahoma	State	9415	12-31-24
Oregon	NELAP	TNI0189	01-01-25
Pennsylvania	NELAP	68-00576	12-31-25
Tennessee	State	02014	07-27-25
Texas	NELAP	T104704380	08-31-25
US Fish & Wildlife	US Federal Programs	058448	07-31-25
USDA	US Federal Programs	525-22-279-18762	10-06-25
Utah	NELAP	TN00009	07-31-25
Virginia	NELAP	460176	09-14-25
Washington	State	C593	01-19-25
West Virginia (DW)	State	9955C	12-31-24
West Virginia DEP	State	345	04-30-25
Wisconsin	State	998044300	08-31-25

Laboratory: Eurofins Pittsburgh

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Arkansas DEQ	State	19-033-0	06-28-25
California	State	2891	04-30-24 *
Connecticut	State	PH-0688	09-30-24 *
Florida	NELAP	E871008	06-30-25
Georgia	State	PA 02-00416	04-30-25
Illinois	NELAP	004375	07-31-25
Kansas	NELAP	E-10350	01-31-25
Kentucky (UST)	State	162013	04-30-25
Kentucky (WW)	State	KY98043	12-31-24
Louisiana	NELAP	04041	06-30-22 *

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Accreditation/Certification Summary

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Laboratory: Eurofins Pittsburgh (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Louisiana (All)	NELAP	04041	06-30-25
Maine	State	PA00164	03-06-26
Minnesota	NELAP	042-999-482	12-31-24
New Hampshire	NELAP	2030	04-04-25
New Jersey	NELAP	PA005	06-30-25
New York	NELAP	11182	04-01-25
North Carolina (WW/SW)	State	434	12-31-24
North Dakota	State	R-227	04-30-24 *
Oregon	NELAP	PA-2151	02-06-25
Pennsylvania	NELAP	02-00416	04-30-25
Rhode Island	State	LAO00362	01-01-25
South Carolina	State	89014	04-30-25
Texas	NELAP	T104704528	03-31-25
US Fish & Wildlife	US Federal Programs	058448	04-30-25
USDA	US Federal Programs	P330-16-00211	04-11-26
Utah	NELAP	PA001462024-14	05-31-25
Virginia	NELAP	10043	07-14-24 *
West Virginia DEP	State	142	01-31-25
Wisconsin	State	998027800	08-31-25

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Method Summary

Client: Geosyntec Consultants Inc
Project/Site: HEN W

Job ID: 140-39235-1

Method	Method Description	Protocol	Laboratory
6010B	SEP Metals (ICP) - Total	SW846	EET KNX
6010B SEP	SEP Metals (ICP)	SW846	EET KNX
EPA-Lloyd Kahn	Organic Carbon, Total (TOC)	EPA	EET PIT
Moisture	Percent Moisture	EPA	EET KNX
ASTM D2974	Moisture, Ash and Organic Matter	ASTM	EET PIT
3010A	Preparation, Total Metals	SW846	EET KNX
Acid/Sulfide	Sequential Extraction Procedure, Acid/Sulfide Fraction	TAL-KNOX	EET KNX
Carbonate	Sequential Extraction Procedure, Carbonate Fraction	TAL-KNOX	EET KNX
Exchangeable	Sequential Extraction Procedure, Exchangeable Fraction	TAL-KNOX	EET KNX
Metal Hydroxide	Sequential Extraction Procedure, Metal Hydroxide Fraction	TAL-KNOX	EET KNX
Non-Crystalline	Sequential Extraction Procedure, Non-crystalline Materials	TAL-KNOX	EET KNX
Organic-Bound	Sequential Extraction Procedure, Organic Bound Fraction	TAL-KNOX	EET KNX
Residual	Sequential Extraction Procedure, Residual Fraction	TAL-KNOX	EET KNX
Total	Preparation, Total Material	TAL-KNOX	EET KNX

Protocol References:

ASTM = ASTM International

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL-KNOX = TestAmerica Laboratories, Knoxville, Facility Standard Operating Procedure.

Laboratory References:

EET KNX = Eurofins Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

EET PIT = Eurofins Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Eurofins Knoxville
5815 Middlebrook Pike

Knoxville, TN 37921-5947
phone 865.291.3000 fax 865.584.4315

Chain of Custody Record

eurofins | Environment Testing America

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

Eurofins Environment Testing America

Client Contact	Project Manager: Allison Kreinberg	Site Contact:	Date:	COC No:
Geosyntec Consultants Inc	Email: akreinberg@Geosyntec.com	Lab Contact:	Carrier:	1 of 1 COCs
500 W Wilson Bridge Rd, Suite 250	Tel/Fax: 216-544-5007			TALS Project #:
Worthington, OH 43085	**Analysis Turnaround Time**			Sampler:
(216) 544-5007 Phone	☐ CALENDAR DAYS ☐ WORKING DAYS			**For Lab Use Only:**
(xxx) xxx-xxxx FAX	TAT if different from Below Standard			Walk-in Client:
Project Name: HEN W	☒ 2 weeks			Lab Sampling:
Site:	☐ 1 week			
P O # Quote 14007643-0	☐ 2 days			Job / SDG No.:
	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	SEP (As, Al, Fe, Mn)	Loss on Ignition	Total Organic Carbon	Sample Specific Notes:
HEN-B100-37-38	10/28/24	1540	C	S	1	N	N	X	X	X	
HEN-B100-48-44	"	1600	C	S	1	N	N	X	X	X	

140-39235 Chain of Custody

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☒ Disposal by Lab ☐ Archive for _____ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No	Custody Seal No.:		Cooler Temp. (°C): Obs'd:	Corr'd:	Therm ID No.:
Relinquished by: Spencer Kapinocki	Company: Geosyntec	Date/Time: 10/28/24 1730	Received by: Fedex	Company:	Date/Time:
Relinquished by: Fedex	Company:	Date/Time:	Received by: [signature]	Company: FEDEX	Date/Time: 10-29-24 0930
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

11/27/2024

Loc: 140
39235

EUROFINS KNOXVILLE SAMPLE RECEIPT/CONDITION UPON RECEIPT ANOMALY CHECKLIST Log In Number:

Review Items	Yes	No	NA	If No, what was the problem?
1. Are the shipping containers intact?	/			☐ Containers, Broken
2. Were ambient air containers received intact?			/	☐ Checked in lab
3. The coolers/containers custody seal if present, is it intact?	/			☐ Yes ☐ NA
4. Is the cooler temperature within limits? (> freezing temp. of water to 6 °C, VOST: 10°C) Thermometer ID : SC 76 Correction factor: +0.2°C	/			☐ Cooler Out of Temp, Client Contacted, Proceed/Cancel ☐ Cooler Out of Temp, Same Day Receipt
5. Were all of the sample containers received intact?	/			☐ Containers, Broken
6. Were samples received in appropriate containers?	/			☐ Containers, Improper; Client Contacted; Proceed/Cancel
7. Do sample container labels match COC? (IDs, Dates, Times)	/			☐ COC & Samples Do Not Match ☐ COC Incorrect/Incomplete ☐ COC Not Received
8. Were all of the samples listed on the COC received?	/			☐ Sample Received, Not on COC ☐ Sample on COC, Not Received
9. Is the date/time of sample collection noted?	/			☐ COC; No Date/Time; Client Contacted
10. Was the sampler identified on the COC?		/		☑ Sampler Not Listed on COC
11. Is the client and project name/# identified?	/			☐ COC Incorrect/Incomplete
12. Are tests/parameters listed for each sample?	/			☐ COC No tests on COC
13. Is the matrix of the samples noted?	/			☐ COC Incorrect/Incomplete
14. Was COC relinquished? (Signed/Dated/Timed)	/			☐ COC Incorrect/Incomplete
15. Were samples received within holding time?	/			☐ Holding Time - Receipt
16. Were samples received with correct chemical preservative (excluding Encore)?			/	☐ pH Adjusted, pH Included (See box 16A) ☐ Incorrect Preservative
17. Were VOA samples received without headspace?			/	☐ Headspace (VOA only)
18. Did you check for residual chlorine, if necessary? (e.g. 1613B, 1668) Chlorine test strip lot number:			/	☐ Residual Chlorine
19. For 1613B water samples is pH<9?			/	☐ If no, notify lab to adjust
20. For rad samples was sample activity info. Provided?			/	☐ Project missing info

Comments/Actions Taken

Custody Seal Intact
Received at RT 0.3/ct 0.5c
CAR 10-29-24
Fedex Post 291168640307

10

Labeling Verified by: **Date:**

pH test strip lot number:

	Box 16A: pH Preservation	Box 18A: Residual Chlorine
Preservative:		
Lot Number:		
Exp Date:		
Analyst:		
Date:		
Time:		

Project #: 14006199 PM Instructions:

Sample Receiving Associate: Lu Ruan Date: 10-29-24

QA026R33.doc, 11/10/23

11/27/2024

FedEx

eurofins

RT 198
FZ 197

1
10:30

A nt Testing
4092
10.30

Part # 159469-494 MTW EXP 04/25

ORIGIN ID RKWA (865) 291-3000
SAMPLE CONTROL
EUROFINS TESTAMERICA KNOXVILLE,TN
5815 MIDDLEBROOK PIKE

KNOXVILLE, TN 37921
UNITED STATES US

SHIP DATE: 29OCT24
ACTWGT: 18.40 LB
CAD: 0238739/CAFE3855
DIMS: 11x8x7 IN

BILL SENDER

TO SHIPPING/RECEIVING
EUROFINS ENVIRONMENT TESTING NORTHE
301 ALPHA DRIVE
RIDC PARK
PITTSBURGH PA 15238

(412) 963-7068 REF S140-14736
PO YES DEPT 140320

Uncorrected temp 0.6 °C
Thermometer ID 25
CF +0.1 Initials PM
PT-WI-SR-001 effective 11/8/18

FedEx Express

WED - 30 OCT 10:30A
PRIORITY OVERNIGHT

TRK# 0201 4191 4716 4092

NX AGCA

15238
PA-US PIT

140-39235 Waybill

FedEx

eurofins Testing

RT 198 1 10:30 A
FZ 197 4092 10.30

Part # 159469-434 MTN EXP 04/25

ORIGIN ID RKWA (865) 291-3000
SAMPLE CONTROL
EUROFINS TESTAMERICA KNOXVILLE,TN
5815 MIDDLEBROOK PIKE

KNOXVILLE, TN 37921
UNITED STATES US

SHIP DATE 29OCT24
ACTWGT 18.40 LB
CAD 0238739/CAFE3855
DIMS 11x8x7 IN

BILL SENDER

TO SHIPPING/RECEIVING
EUROFINS ENVIRONMENT TESTING NORTHE
301 ALPHA DRIVE
RIDC PARK
PITTSBURGH PA 15238

(412) 963-7058 REF S140-14736
PO:YES DEPT 140320

140-39235 Waybill

Uncorrected temp 0.6 C
Thermometer ID 25
CF +0.1 Initials RM
PT-WI-SR-001 effective 11/8/18

FedEx Express

WED - 30 OCT 10:30A
PRIORITY OVERNIGHT

TRK# 0201 4191 4716 4092

NX AGCA

15238
PA-US PIT

Eurofins Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Phone: 865-291-3000 Fax: 865-584-4315

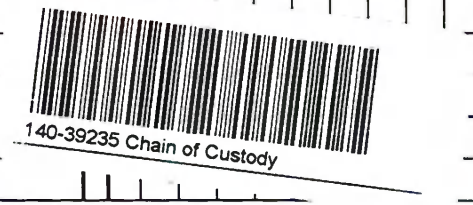
Chain of Custody Record

eurofins | Environment Testing

Client Information (Sub Contract Lab)	Sampler: N/A	Lab PM: Henry, Ryan	Carrier Tracking No(s): N/A	COC No: 140-17066.1
Client Contact: Shipping/Receiving	Phone: N/A	E-Mail: William.Henry@et.eurofinsus.com	State of Origin: Ohio	Page: Page 1 of 1
Company: Eurofins Environment Testing Northeast L		Accreditations Required (See note): N/A		Job #: 140-39235-1
Address: 301 Alpha Drive, RIDC Park,	Due Date Requested: 12/4/2024			Preservation Codes: -
City: Pittsburgh	TAT Requested (days): N/A			
State, Zip: PA, 15238				
Phone: 412-963-7058(Tel) 412-963-2468(Fax)	PO #: N/A			
Email: N/A	WO #: N/A			
Project Name: HEN W	Project #: 14006199			
Site: N/A	SSOW#: N/A			Other: N/A

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	D_2974/ LOI	Lloyd_Kahn_Mod/ Lloyd Kahn Duplicates	Total Number of containers	Special Instructions/Note:
			Preservation Code:							
HEN-B100-37-38 (140-39235-1)	10/28/24	15:40 Eastern	G	Solid			X	X	1	
HEN-B100-48-49 (140-39235-2)	10/28/24	16:00 Eastern	G	Solid			X	X	1	



Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte & accreditation compliance upon our subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins TestAmerica.

Possible Hazard Identification	*Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)*
Unconfirmed	☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* _____ *Months*
Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 4	Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
1	[signature]	10-29-24 1505	ET/KA	[signature]	10/30/24 0910	ET:HNE
2	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
3	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Eurofins Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Phone: 865-291-3000 Fax: 865-584-4315

Chain of Custody Record

eurofins | Environment Testing

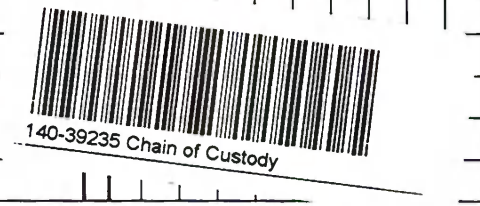
Client Information (Sub Contract Lab)	Sampler: N/A	Lab PM: Henry, Ryan	Carrier Tracking No(s): N/A	COC No: 140-17066.1
Client Contact: Shipping/Receiving	Phone: N/A	E-Mail: William.Henry@et.eurofinsus.com	State of Origin: Ohio	Page: Page 1 of 1
Company: Eurofins Environment Testing Northeast L		Accreditations Required (See note): N/A		Job #: 140-39235-1
Address: 301 Alpha Drive, RIDC Park,	Due Date Requested: 12/4/2024			
City: Pittsburgh	TAT Requested (days): N/A			
State, Zip: PA, 15238				
Phone: 412-963-7058(Tel) 412-963-2468(Fax)	PO #: N/A			
Email: N/A	WO #: N/A			
Project Name: HEN W	Project #: 14006199			
Site: N/A	SSOW#: N/A			

Analysis Requested

Preservation Codes: -

Other: N/A

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	D_2974/ LOI	Lloyd_Kahn_Mod/ Lloyd Kahn Duplicates	Total Number of containers	Special Instructions/Note:
			Preservation Code:							
HEN-B100-37-38 (140-39235-1)	10/28/24	15:40 Eastern	G	Solid			X	X	1	
HEN-B100-48-49 (140-39235-2)	10/28/24	16:00 Eastern	G	Solid			X	X	1	



Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte & accreditation compliance upon our subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins TestAmerica.

Possible Hazard Identification	*Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)*
Unconfirmed	☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* _____ *Months*
Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 4	Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
	10-29-24 1505	ET/KAO		10/30/24 0910	ET/HNE
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Login Sample Receipt Checklist

Client: Geosyntec Consultants Inc

Job Number: 140-39235-1

Login Number: 39235
List Number: 2
Creator: Mullins, Plumm A

List Source: Eurofins Pittsburgh
List Creation: 10/30/24 05:52 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Attachment D
X-Ray Diffraction Analytical Data

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Report for:

Reid Regelbruuge
Ramboll Americas Engineering Solutions, Inc
333 W. Wacker Drive, Suite 2700
Chicago, IL 60606

Regarding: Eurofins J3 Resources, Inc.
Project: GLP8078; HEN W
EML ID: 3833465

Approved by:

Business Unit Manager
Scott Ward

Dates of Analysis:
XRD Crystalline Silica NIOSH 7500/OSHA ID-142 mod - Bulk/ Dust/Wipe: 11-14-2024

All samples were received in acceptable condition unless noted in the Report Comments portion in the body of the report. Due to the nature of the analyses performed, field blank correction of results is not applied. The results relate only to the samples as received and tested.

Eurofins J3 Resources, Inc. ("the Company"), a member of the Eurofins Built Environment Testing group of companies, shall have no liability to the client or the client's customer with respect to decisions or recommendations made, actions taken or courses of conduct implemented by either the client or the client's customer as a result of or based upon the Test Results. In no event shall the Company be liable to the client with respect to the Test Results except for the Company's own willful misconduct or gross negligence nor shall the Company be liable for incidental or consequential damages or lost profits or revenues to the fullest extent such liability may be disclaimed by law, even if the Company has been advised of the possibility of such damages, lost profits or lost revenues. In no event shall the Company's liability with respect to the Test Results exceed the amount paid to the Company by the client therefor.

---

eurofins | Built Environment Testing

November 14, 2024

For:
Spencer Napiwocki
Geosyntec Consultants, Inc.
500 Wilson Bridge Rd Suite 250
Worthington, OH 43085

RE:
Eurofins Built Environment Testing – Pasadena, Texas
XRD Mineral Characterization of Soil by Full Mineral Scan
Project ID: HEN W
Project #: GLP8078
EMLab ID: 3833465

Approved By:

Scott M. Ward, Ph.D.

Analyst: Carlos Duane Salinas

Eurofins Built Environment Testing (EBET) is an analytical laboratory accredited for the analysis of asbestos in air and bulk samples by X-Ray Powder Diffraction (XRD), Analytical Transmission Electron Microscopy (ATEM), and Polarized Light Microscopy (PLM) by the National Voluntary Laboratory Accreditation Program (NVLAP) {Lab Code 200525 (Houston) and Lab Code 600120 (Pasadena)}, and the American Industrial Hygiene Association Lab Code 157714 (Pasadena)}.

All samples were received in acceptable condition unless noted in the Report Comments portion in the body of the report. The results relate only to the samples as received and tested. The results include an inherent uncertainty of measurement associated with estimating percentages by the analytical method utilized.

Eurofins Built Environement Testing located in Pasadena, TX, a member of the Eurofins Built Environment Testing group of companies, shall have no liability to the client or the client's customer with respect to decisions or recommendations made, actions taken or courses of conduct implemented by either the client or the client's customer as a result of or based upon the Test Results. In no event shall the Company be liable to the client with respect to the Test Results except for the Company's own willful misconduct or gross negligence nor

eurofins | Built Environment Testing

Report: 3833465

XRD Mineralogy of Soil Samples
Project Name: HEN W
Project #: GLP8078

For:

Spencer Napiwocki
Geosyntec Consultants, Inc.
500 W Wilson Bridge Rd Suite 250
Worthington, OH 43085

By:

Carlos Duane Salinas
Technical Expert
Eurofins Built Environmental Testing
3113 Red Bluff Road
Pasadena, Texas 77503

November 14, 2024

eurofins | Built Environment Testing

November 14, 2024

Spencer Napiwocki
Geosyntec Consultants, Inc.
500 W Wilson Bridge Rd Suite 250
Worthington, OH 43085

Dear Kristyn,

Eurofins Built Environmental Testing (EBET) is an analytical laboratory accredited for the analysis of asbestos in air and bulk samples by X-Ray Powder Diffraction (XRD), Analytical Transmission Electron Microscopy (ATEM), and Polarized Light Microscopy (PLM) by the National Voluntary Laboratory Accreditation Program (NVLAP) {Lab Code 200525 (Houston) and Lab Code 600120 (Pasadena)}, and the American Industrial Hygiene Association Laboratory Accreditation Program (AIHA LAP,LLC) {Lab Code 157714 (Pasadena)}.

EBET received two (2) samples on October 30, 2024, to determine their mineralogy by X-Ray Powder Diffraction (XRD). The samples were a gray colored sandy clay, and a tan sand contained in individually labeled and sealed 4 oz clear glass jars. The chain of custody matched the labeled sample ID's as follows:

Client Sample Number	EMLab ID Number
HEN-B100-37-38	3833465-1
HEN-B100-48-49	3833465-2

EBET prepped and analyzed the samples using X-Ray Powder Diffraction.

3833465 is the job number assigned to this study. This report is considered highly confidential and the sole property of the customer. EBET will not discuss any part of this study with personnel other than those authorized by the client. The results described in this report only apply to the samples analyzed. This report shall not be reproduced except in full, without written approval from EBET. The sample will be kept in our secure storage facility for a minimum of three (3) months from the report date.

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Full Mineral Scan Sample Preparation

A representative grab sample of the soil was dried overnight at 110 degrees Celsius in our drying oven. The dried sample was then crushed using a large mortar and pestle. The crushed sample was coned and quartered to acquire a representative sample to be further prepared. This sample was ground and homogenized by hand using a mortar and pestle, and then passed through a No. 35 Tyler Mesh (500 um) sieve. The sieved sample was then milled in a McCrone XRD Micro Mill for 15 minutes, utilizing agate grinding elements to produce a powder that was prepped and scanned in our Cubix3/Panalytical XRD using a mineral scan program.

The results of this study can be found in the attached documents. If you should have any questions about this report, please feel free to call us at 713-290-0223.

Sincerely,

Carlos Duane Salinas
Technical Expert
EBET – Pasadena, Texas

Mineralogy Report – November 2024.

This report was prepared at the request of Carlos Salinas, Technical Expert at Eurofins Built Environment Testing

I. Quantitative XRD analysis of powder samples

Table 1 - Scans of the following samples were evaluated.

Sample ID	
3465-1~1	Soil sample
3465-2~1	Soil sample

For QXRD analysis the software High score plus version 2.0.1 available from Malvern Panalytical was used.

II. Instrument and measurement conditions

Cubix3/PANalytical

Instrument settings:
Tube: Ceramic Cu long fine focus
Radiation: Copper (Cu)
Diffractometer radius: 200mm
Sample stage: Sample spinner stage

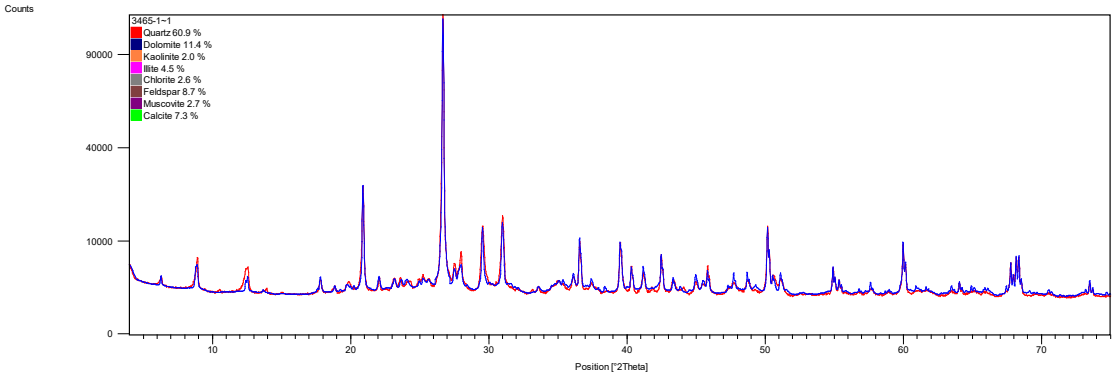
Incident optics:
BBHD
Divergence slit: Fixed 1/2 °
Soller slit: 0.04 radians
Mask: 10mm
Anti scatter slit: Fixed 2°

Diffracted optics:
Soller slit: 0.04 radians
Filter: Not present
Anti scatter slit: Fixed 5.5°
Detector: X'Celerator

Measurement conditions:
Applied power: 45KV, 40mA
Scan range: 4-75º 2Theta
Step size 0,016 º 2Theta
Time per step: 4.82sec
Scan type: continuous

III. QXRD analysis of samples:

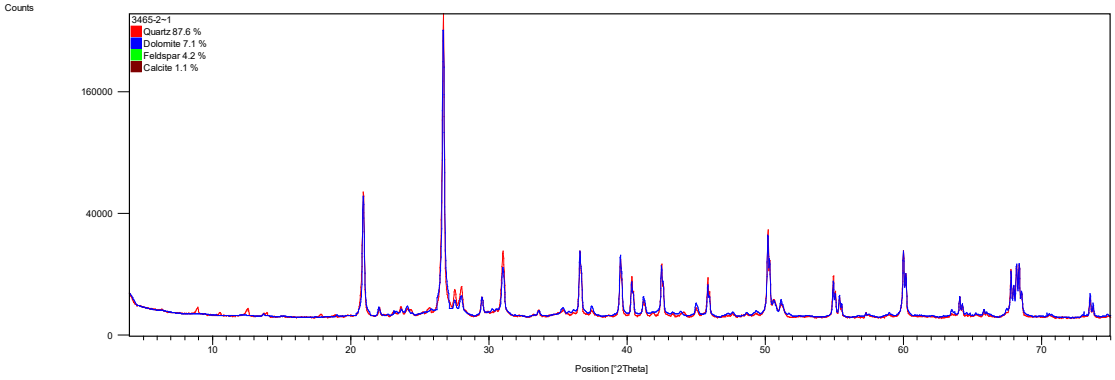
1) Sample 3465-1~1



Phase	Formula	%
Quartz	SiO2	60.9
Dolomite	CaMg(CO3)2	11.4
Feldspar	(Na,Ca)(Si,Al)4O8	8.7
Illite/Muscovite	(K,H3O)(Al,Mg,Fe)2(Si,Al)4O10[(OH)2,(H2O)	7.2
Chlorite/Vermiculite	(Mg,Fe)5Al(Si3Al)O10(OH)8	2.6
Kaolinite	Al2Si2O5(OH)4	2.0
Calcite	CaCO3	7.3

Figure 1 – Results of X-ray diffraction – 3465-1~1

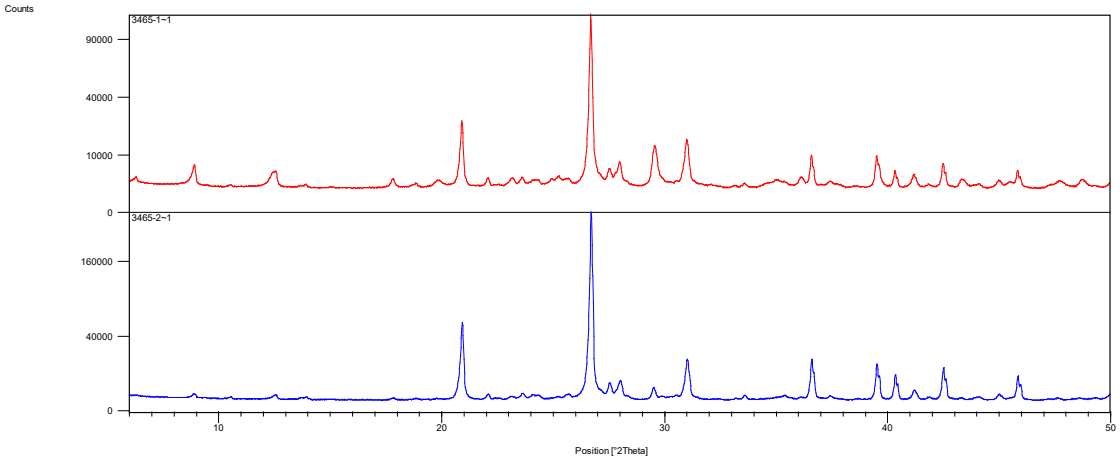
2) Sample 3465-2~1



Phase	Formula	%
Quartz	SiO2	87.6
Dolomite	CaMg(CO3)2	7.1
Feldspar	(Na,Ca)(Si,Al)4O8	4.2
Illite/Muscovite	(K,H3O)(Al,Mg,Fe)2(Si,Al)4O10[(OH)2,(H2O)	pp
Calcite	CaCO3	1.1

Figure 2 – Results of X-ray diffraction - 3465-2~1

3) All samples comparison



	Quartz	Dolomite	Kaolinite	Illite	Chlorite	Feldspar	Muscovite	Calcite
3465-1~1	60.9	11.4	2.0	4.5	2.6	8.7	2.7	7.3
3465-2~1	87.6	7.1	-	-	-	4.2	-	1.1

Figure 3 - The comparison of the x-ray diffraction (XRD) results

IV. Comments

Sample 1 showed the presence of quartz, dolomite, feldspar, calcite, mica, and clay. In sample 2, only quartz, dolomite, feldspar, and calcite were detected, with a possible presence of mica.
The term “possible presence” in XRD interpretation indicates that the mineral may be present in the sample, but its identification is not definitive due to factors such as low concentration, peak overlap, poor crystallinity, or ambiguities in the diffraction pattern. It is necessary to validate the quantification by XRD with other techniques, preferably chemical analysis. The orientation of clay mineral particles affects the XRD intensities of powdered samples. Clay mineral particles exhibit platy characteristics, and some preparation methods can often produce preferred orientation of clay minerals

Elaborated by:
Angela Nair Avelar
PhD, Geologist - Applied Mineralogy and Development Process

Márcia Mika Saito
MSC, Geologist – Geometallurgical and Applied Mineralogy

Attachment E
Illinois River Sampling Data

March 31, 2021

Allison Kreinberg
Geosyntec Consultants
1 McBride and Son Center Drive, Suite 202
Chesterfield, MO 63005
TEL: (614) 468-0421
FAX:

Illinois	100226
Kansas	E-10374
Louisiana	05002
Louisiana	05003
Oklahoma	9978

RE: Hennepin GW **WorkOrder:** 21030004

Dear Allison Kreinberg:

TEKLAB, INC received 4 samples on 3/1/2021 8:22:00 AM for the analysis presented in the following report.

Samples are analyzed on an as received basis unless otherwise requested and documented. The sample results contained in this report relate only to the requested analytes of interest as directed on the chain of custody. NELAP accredited fields of testing are indicated by the letters NELAP under the Certification column. Unless otherwise documented within this report, Teklab Inc. analyzes samples utilizing the most current methods in compliance with 40CFR. All tests are performed in the Collinsville, IL laboratory unless otherwise noted in the Case Narrative.

All quality control criteria applicable to the test methods employed for this project have been satisfactorily met and are in accordance with NELAP except where noted. The following report shall not be reproduced, except in full, without the written approval of Teklab, Inc.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Elizabeth A. Hurley

Elizabeth A. Hurley
Project Manager
(618)344-1004 ex 33
ehurley@teklabinc.com

Report Contents

Client: Geosyntec Consultants
Work Order: 21030004
Client Project: Hennepin GW
Report Date: 31-Mar-21

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Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

Abbr	Definition
*	Analytes on report marked with an asterisk are not NELAP accredited
CCV	Continuing calibration verification is a check of a standard to determine the state of calibration of an instrument between recalibration.
CRQL	A Client Requested Quantitation Limit is a reporting limit that varies according to customer request. The CRQL may not be less than the MDL.
DF	Dilution factor is the dilution performed during analysis only and does not take into account any dilutions made during sample preparation. The reported result is final and includes all dilution factors.
DNI	Did not ignite
DUP	Laboratory duplicate is a replicate aliquot prepared under the same laboratory conditions and independently analyzed to obtain a measure of precision.
ICV	Initial calibration verification is a check of a standard to determine the state of calibration of an instrument before sample analysis is initiated.
IDPH	IL Dept. of Public Health
LCS	Laboratory control sample is a sample matrix, free from the analytes of interest,spiked with verified known amounts of analytes and analyzed exactly like a sample to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.
LCSD	Laboratory control sample duplicate is a replicate laboratory control sample that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MBLK	Method blank is a sample of a matrix similar to the batch of associated sample (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences should present at concentrations that impact the analytical results for sample analyses.
MDL	"The method detection limit is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results."
MS	Matrix spike is an aliquot of matrix fortified (spiked) with known quantities of specific analytes that is subjected to the entire analytical procedures in order to determine the effect of the matrix on an approved test method's recovery system. The acceptable recovery range is listed in the QC Package (provided upon request).
MSD	Matrix spike duplicate means a replicate matrix spike that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MW	Molecular weight
NC	Data is not acceptable for compliance purposes
ND	Not Detected at the Reporting Limit
NELAP	NELAP Accredited
PQL	Practical quantitation limit means the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.
RL	The reporting limit the lowest level that the data is displayed in the final report. The reporting limit may vary according to customer request or sample dilution. The reporting limit may not be less than the MDL.
RPD	Relative percent difference is a calculated difference between two recoveries (ie. MS/MSD). The acceptable recovery limit is listed in the QC Package (provided upon request).
SPK	The spike is a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery deficiency or for other quality control purposes.
Surr	Surrogates are compounds which are similar to the analytes of interest in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.
TIC	Tentatively identified compound: Analytes tentatively identified in the sample by using a library search. Only results not in the calibration standard will be reported as tentatively identified compounds. Results for tentatively identified compounds that are not present in the calibration standard, but are assigned a specific chemical name based upon the library search, are calculated using total peak areas from reconstructed ion chromatograms and a response factor of one. The nearest Internal Standard is used for the calculation. The results of any TICs must be considered estimated, and are flagged with a "T". If the estimated result is above the calibration range it is flagged "ET"
TNTC	Too numerous to count (> 200 CFU)

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

Qualifiers

- # - Unknown hydrocarbon
- B - Analyte detected in associated Method Blank
- C - RL shown is a Client Requested Quantitation Limit
- E - Value above quantitation range
- H - Holding times exceeded
- I - Associated internal standard was outside method criteria
- J - Analyte detected below quantitation limits
- M - Manual Integration used to determine area response
- ND - Not Detected at the Reporting Limit
- R - RPD outside accepted recovery limits
- S - Spike Recovery outside recovery limits
- T - TIC(Tentatively identified compound)
- X - Value exceeds Maximum Contaminant Level

Case Narrative

http://www.teklabinc.com/

Client: Geosyntec Consultants
Client Project: Hennepin GW

Work Order: 21030004
Report Date: 31-Mar-21

Cooler Receipt Temp: 4.6 °C

An employee of Teklab, Inc. collected the sample(s).

Some Metals by ICP-MS analysis was performed by Pace Analytical Services, LLC. See attached report for results.

Locations

Collinsville

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
Email jhriley@teklabinc.com

Springfield

Address 3920 Pintail Dr
Springfield, IL 62711-9415
Phone (217) 698-1004
Fax (217) 698-1005
Email KKlostermann@teklabinc.com

Kansas City

Address 8421 Nieman Road
Lenexa, KS 66214
Phone (913) 541-1998
Fax (913) 541-1998
Email jhriley@teklabinc.com

Collinsville Air

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
Email EHurley@teklabinc.com

Chicago

Address 1319 Butterfield Rd.
Downers Grove, IL 60515
Phone (630) 324-6855
Fax
Email arenner@teklabinc.com

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

State	Dept	Cert #	NELAP	Exp Date	Lab
Illinois	IEPA	100226	NELAP	1/31/2022	Collinsville
Kansas	KDHE	E-10374	NELAP	4/30/2021	Collinsville
Louisiana	LDEQ	05002	NELAP	6/30/2021	Collinsville
Louisiana	LDEQ	05003	NELAP	6/30/2021	Collinsville
Oklahoma	ODEQ	9978	NELAP	8/31/2021	Collinsville
Arkansas	ADEQ	88-0966		3/14/2022	Collinsville
Illinois	IDPH	17584		5/31/2021	Collinsville
Kentucky	UST	0073		1/31/2022	Collinsville
Missouri	MDNR	00930		5/31/2021	Collinsville
Missouri	MDNR	930		1/31/2022	Collinsville

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

Lab ID: 21030004-001 **Client Sample ID:** MW-22-20210224

Matrix: GROUNDWATER **Collection Date:** 02/24/2021 15:18

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**230**	mg/L	1	03/04/2021 12:33	R288108
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/04/2021 12:33	R288108
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**674**	mg/L	1	03/02/2021 14:55	R287973
SW-846 9036 (TOTAL)								
Sulfate	NELAP	100		**182**	mg/L	10	03/03/2021 0:07	R287942
SW-846 9251 (TOTAL)								
Chloride	NELAP	10		**79**	mg/L	10	03/03/2021 0:07	R287943
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Antimony	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 18:19	174328
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 18:19	174328
Barium	NELAP	0.0010		**0.0613**	mg/L	5	03/10/2021 18:19	174328
Beryllium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 19:02	174328
Boron	NELAP	0.0250	S	**4.78**	mg/L	5	03/11/2021 19:02	174328
Cadmium	NELAP	0.0010		**0.0057**	mg/L	5	03/11/2021 19:02	174328
Chromium	NELAP	0.0015		**< 0.0015**	mg/L	5	03/10/2021 18:19	174328
Cobalt	NELAP	0.0010		**0.0027**	mg/L	5	03/10/2021 18:19	174328
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/10/2021 18:19	174328
Lead	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 18:19	174328
Lithium	*	0.0030		**0.0537**	mg/L	5	03/11/2021 19:02	174328
Magnesium	NELAP	0.0500		**30.1**	mg/L	5	03/11/2021 19:02	174328
Manganese	NELAP	0.0020		**0.0874**	mg/L	5	03/11/2021 19:02	174328
Molybdenum	NELAP	0.0015		**0.135**	mg/L	5	03/10/2021 18:19	174328
Potassium	NELAP	0.175		**11.8**	mg/L	5	03/10/2021 18:19	174328
Selenium	NELAP	0.0010		**0.0212**	mg/L	5	03/06/2021 21:15	174328
Thallium	NELAP	0.0020		**< 0.0020**	mg/L	5	03/10/2021 18:19	174328
Matrix spike control limits for B are not applicable due to high sample/spike ratio.								
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Antimony	NELAP	0.0010		**< 0.0010**	mg/L	5	03/06/2021 2:39	174329
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 16:42	174329
Barium	NELAP	0.0010		**0.0655**	mg/L	5	03/06/2021 2:39	174329
Beryllium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:34	174329
Cadmium	NELAP	0.0010		**0.0060**	mg/L	5	03/04/2021 4:34	174329
Chromium	NELAP	0.0015		**< 0.0015**	mg/L	5	03/10/2021 16:42	174329
Cobalt	NELAP	0.0010		**0.0028**	mg/L	5	03/04/2021 4:34	174329
Iron	NELAP	0.0250		**0.0377**	mg/L	5	03/10/2021 16:42	174329
Lead	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:34	174329
Molybdenum	NELAP	0.0015		**0.132**	mg/L	5	03/04/2021 4:34	174329
Potassium	NELAP	0.175		**12.4**	mg/L	5	03/10/2021 16:42	174329
Selenium	NELAP	0.0010		**0.0236**	mg/L	5	03/04/2021 4:34	174329
Thallium	NELAP	0.0020		**< 0.0020**	mg/L	5	03/04/2021 4:34	174329
SEE ATTACHED FOR SUBCONTRACTING ANALYSIS								
Subcontracted Analysis	*	0		**See Attached**		1	03/29/2021 0:00	R289136
Subcontracted Analysis	*	0		**See Attached**		1	03/29/2021 0:00	R289136

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

Lab ID: 21030004-002 **Client Sample ID:** MW-23-20210224

Matrix: GROUNDWATER **Collection Date:** 02/24/2021 16:54

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**166**	mg/L	1	03/04/2021 12:38	R288108
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/04/2021 12:38	R288108
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**884**	mg/L	1	03/02/2021 14:55	R287973
SW-846 9036 (TOTAL)								
Sulfate	NELAP	100		**407**	mg/L	10	03/03/2021 0:23	R287942
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**64**	mg/L	5	03/04/2021 13:15	R288111
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Antimony	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 19:57	174328
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 19:57	174328
Barium	NELAP	0.0010		**0.0351**	mg/L	5	03/10/2021 19:57	174328
Beryllium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 20:32	174328
Boron	NELAP	0.0250		**7.61**	mg/L	5	03/11/2021 20:32	174328
Cadmium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 20:32	174328
Chromium	NELAP	0.0015		**< 0.0015**	mg/L	5	03/10/2021 19:57	174328
Cobalt	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 19:57	174328
Iron	NELAP	0.0250		**0.0418**	mg/L	5	03/10/2021 19:57	174328
Lead	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 19:57	174328
Lithium	*	0.0030		**0.0047**	mg/L	5	03/11/2021 20:32	174328
Magnesium	NELAP	0.0500		**74.2**	mg/L	5	03/11/2021 20:32	174328
Manganese	NELAP	0.0020		**1.04**	mg/L	5	03/11/2021 20:32	174328
Molybdenum	NELAP	0.0015		**0.0144**	mg/L	5	03/10/2021 19:57	174328
Potassium	NELAP	0.175		**2.58**	mg/L	5	03/10/2021 19:57	174328
Selenium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/06/2021 22:53	174328
Thallium	NELAP	0.0020		**< 0.0020**	mg/L	5	03/10/2021 19:57	174328
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Antimony	NELAP	0.0010		**< 0.0010**	mg/L	5	03/06/2021 2:47	174329
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 17:55	174329
Barium	NELAP	0.0010		**0.0379**	mg/L	5	03/06/2021 2:47	174329
Beryllium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:42	174329
Cadmium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:42	174329
Chromium	NELAP	0.0015		**< 0.0015**	mg/L	5	03/10/2021 17:55	174329
Cobalt	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:42	174329
Iron	NELAP	0.0250		**0.167**	mg/L	5	03/10/2021 17:55	174329
Lead	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:42	174329
Molybdenum	NELAP	0.0015		**0.0149**	mg/L	5	03/04/2021 4:42	174329
Potassium	NELAP	0.175		**2.80**	mg/L	5	03/10/2021 17:55	174329
Selenium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:42	174329
Thallium	NELAP	0.0020		**< 0.0020**	mg/L	5	03/04/2021 4:42	174329
SEE ATTACHED FOR SUBCONTRACTING ANALYSIS								
Subcontracted Analysis	*	0		**See Attached**		1	03/29/2021 0:00	R289136
Subcontracted Analysis	*	0		**See Attached**		1	03/29/2021 0:00	R289136

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

Lab ID: 21030004-003 **Client Sample ID:** MW-51-20210225

Matrix: GROUNDWATER **Collection Date:** 02/25/2021 11:10

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**344**	mg/L	1	03/04/2021 12:47	R288108
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/04/2021 12:47	R288108
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**628**	mg/L	1	03/03/2021 18:37	R288088
SW-846 9036 (TOTAL)								
Sulfate	NELAP	100		**105**	mg/L	10	03/03/2021 0:52	R287942
SW-846 9251 (TOTAL)								
Chloride	NELAP	10		**97**	mg/L	10	03/03/2021 0:52	R287943
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Antimony	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 20:05	174328
Arsenic	NELAP	0.0010		**0.0136**	mg/L	5	03/10/2021 20:05	174328
Barium	NELAP	0.0010		**0.106**	mg/L	5	03/10/2021 20:05	174328
Beryllium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 20:40	174328
Boron	NELAP	0.0250		**2.18**	mg/L	5	03/11/2021 20:40	174328
Cadmium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 20:40	174328
Chromium	NELAP	0.0015		**< 0.0015**	mg/L	5	03/10/2021 20:05	174328
Cobalt	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 20:05	174328
Iron	NELAP	0.0250		**4.60**	mg/L	5	03/10/2021 20:05	174328
Lead	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 20:05	174328
Lithium	*	0.0030		**0.0207**	mg/L	5	03/11/2021 20:40	174328
Magnesium	NELAP	0.0500		**40.7**	mg/L	5	03/11/2021 20:40	174328
Manganese	NELAP	0.0020		**0.0965**	mg/L	5	03/11/2021 20:40	174328
Molybdenum	NELAP	0.0015		**0.0128**	mg/L	5	03/10/2021 20:05	174328
Potassium	NELAP	0.175		**3.57**	mg/L	5	03/10/2021 20:05	174328
Selenium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/06/2021 23:01	174328
Thallium	NELAP	0.0020		**< 0.0020**	mg/L	5	03/10/2021 20:05	174328
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Antimony	NELAP	0.0010		**< 0.0010**	mg/L	5	03/06/2021 2:55	174329
Arsenic	NELAP	0.0010		**0.0171**	mg/L	5	03/10/2021 18:03	174329
Barium	NELAP	0.0010		**0.118**	mg/L	5	03/06/2021 2:55	174329
Beryllium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:50	174329
Cadmium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:50	174329
Chromium	NELAP	0.0015		**0.0032**	mg/L	5	03/10/2021 18:03	174329
Cobalt	NELAP	0.0010		**0.0013**	mg/L	5	03/04/2021 4:50	174329
Iron	NELAP	0.0250		**8.30**	mg/L	5	03/10/2021 18:03	174329
Lead	NELAP	0.0010		**0.0028**	mg/L	5	03/04/2021 4:50	174329
Molybdenum	NELAP	0.0015		**0.0126**	mg/L	5	03/04/2021 4:50	174329
Potassium	NELAP	0.175		**4.05**	mg/L	5	03/10/2021 18:03	174329
Selenium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:50	174329
Thallium	NELAP	0.0020		**< 0.0020**	mg/L	5	03/04/2021 4:50	174329
SEE ATTACHED FOR SUBCONTRACTING ANALYSIS								
Subcontracted Analysis	*	0		**See Attached**		1	03/29/2021 0:00	R289136
Subcontracted Analysis	*	0		**See Attached**		1	03/29/2021 0:00	R289136

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

Lab ID: 21030004-004 **Client Sample ID:** HEN_IL_RIVER-20210225

Matrix: GROUNDWATER **Collection Date:** 02/25/2021 11:45

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**228**	mg/L	1	03/04/2021 12:53	R288108
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/04/2021 12:53	R288108
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**878**	mg/L	1	03/03/2021 18:38	R288088
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**94**	mg/L	4	03/04/2021 13:25	R288110
SW-846 9251 (TOTAL)								
Chloride	NELAP	10		**282**	mg/L	10	03/03/2021 1:00	R287943
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Antimony	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 20:14	174328
Arsenic	NELAP	0.0010		**0.0011**	mg/L	5	03/10/2021 20:14	174328
Barium	NELAP	0.0010		**0.0494**	mg/L	5	03/10/2021 20:14	174328
Beryllium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 20:48	174328
Boron	NELAP	0.0250		**0.208**	mg/L	5	03/11/2021 20:48	174328
Cadmium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 20:48	174328
Chromium	NELAP	0.0015		**< 0.0015**	mg/L	5	03/10/2021 20:14	174328
Cobalt	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 20:14	174328
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/10/2021 20:14	174328
Lead	NELAP	0.0010		**< 0.0010**	mg/L	5	03/10/2021 20:14	174328
Lithium	*	0.0030		**0.0082**	mg/L	5	03/11/2021 20:48	174328
Magnesium	NELAP	0.0500		**30.4**	mg/L	5	03/11/2021 20:48	174328
Manganese	NELAP	0.0020		**0.0410**	mg/L	5	03/11/2021 20:48	174328
Molybdenum	NELAP	0.0015		**0.0059**	mg/L	5	03/10/2021 20:14	174328
Potassium	NELAP	0.175		**6.31**	mg/L	5	03/10/2021 20:14	174328
Selenium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/06/2021 23:09	174328
Thallium	NELAP	0.0020		**< 0.0020**	mg/L	5	03/10/2021 20:14	174328
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Antimony	NELAP	0.0010		**< 0.0010**	mg/L	5	03/06/2021 3:04	174329
Arsenic	NELAP	0.0010		**0.0012**	mg/L	5	03/10/2021 18:11	174329
Barium	NELAP	0.0010		**0.0524**	mg/L	5	03/06/2021 3:04	174329
Beryllium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:58	174329
Cadmium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:58	174329
Chromium	NELAP	0.0015		**< 0.0015**	mg/L	5	03/10/2021 18:11	174329
Cobalt	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:58	174329
Iron	NELAP	0.0250		**0.239**	mg/L	5	03/10/2021 18:11	174329
Lead	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:58	174329
Molybdenum	NELAP	0.0015		**0.0061**	mg/L	5	03/04/2021 4:58	174329
Potassium	NELAP	0.175		**6.58**	mg/L	5	03/10/2021 18:11	174329
Selenium	NELAP	0.0010		**< 0.0010**	mg/L	5	03/04/2021 4:58	174329
Thallium	NELAP	0.0020		**< 0.0020**	mg/L	5	03/04/2021 4:58	174329
SEE ATTACHED FOR SUBCONTRACTING ANALYSIS								
Subcontracted Analysis	*	0		**See Attached**		1	03/29/2021 0:00	R289136
Subcontracted Analysis	*	0		**See Attached**		1	03/29/2021 0:00	R289136

Client: Geosyntec Consultants
Client Project: Hennepin GW

Work Order: 21030004
Report Date: 31-Mar-21

Lab Sample ID	Client Sample ID	Matrix	Fractions	Collection Date
21030004-001	MW-22-20210224	Groundwater	4	02/24/2021 15:18
21030004-002	MW-23-20210224	Groundwater	4	02/24/2021 16:54
21030004-003	MW-51-20210225	Groundwater	4	02/25/2021 11:10
21030004-004	HEN_IL_RIVER-20210225	Groundwater	5	02/25/2021 11:45

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			Prep Date/Time	Analysis Date/Time
21030004-001A	MW-22-20210224	02/24/2021 15:18	03/01/2021 8:22		
	Standard Methods 2320 B (Total) 1997				03/04/2021 12:33
	Standard Methods 2320 B 1997				03/04/2021 12:33
21030004-001B	MW-22-20210224	02/24/2021 15:18	03/01/2021 8:22		
	Standard Methods 2540 C (Total) 1997				03/02/2021 14:55
	SW-846 9036 (Total)				03/03/2021 0:07
	SW-846 9251 (Total)				03/03/2021 0:07
21030004-001C	MW-22-20210224	02/24/2021 15:18	03/01/2021 8:22		
	See Attached for Subcontracting Analysis				03/29/2021 0:00
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/04/2021 4:34
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/06/2021 2:39
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/10/2021 16:42
21030004-001D	MW-22-20210224	02/24/2021 15:18	03/01/2021 8:22		
	See Attached for Subcontracting Analysis				03/29/2021 0:00
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/06/2021 21:15
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/10/2021 18:19
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/11/2021 19:02
21030004-002A	MW-23-20210224	02/24/2021 16:54	03/01/2021 8:22		
	Standard Methods 2320 B (Total) 1997				03/04/2021 12:38
	Standard Methods 2320 B 1997				03/04/2021 12:38
21030004-002B	MW-23-20210224	02/24/2021 16:54	03/01/2021 8:22		
	Standard Methods 2540 C (Total) 1997				03/02/2021 14:55
	SW-846 9036 (Total)				03/03/2021 0:23
	SW-846 9251 (Total)				03/04/2021 13:15
21030004-002C	MW-23-20210224	02/24/2021 16:54	03/01/2021 8:22		
	See Attached for Subcontracting Analysis				03/29/2021 0:00
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/04/2021 4:42
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/06/2021 2:47
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/10/2021 17:55
21030004-002D	MW-23-20210224	02/24/2021 16:54	03/01/2021 8:22		
	See Attached for Subcontracting Analysis				03/29/2021 0:00
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/06/2021 22:53
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/10/2021 19:57
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/11/2021 20:32
21030004-003A	MW-51-20210225	02/25/2021 11:10	03/01/2021 8:22		
	Standard Methods 2320 B (Total) 1997				03/04/2021 12:47

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
	Standard Methods 2320 B 1997				03/04/2021 12:47
21030004-003B	MW-51-20210225	02/25/2021 11:10	03/01/2021 8:22		
	Standard Methods 2540 C (Total) 1997				03/03/2021 18:37
	SW-846 9036 (Total)				03/03/2021 0:52
	SW-846 9251 (Total)				03/03/2021 0:52
21030004-003C	MW-51-20210225	02/25/2021 11:10	03/01/2021 8:22		
	See Attached for Subcontracting Analysis				03/29/2021 0:00
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/04/2021 4:50
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/06/2021 2:55
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/10/2021 18:03
21030004-003D	MW-51-20210225	02/25/2021 11:10	03/01/2021 8:22		
	See Attached for Subcontracting Analysis				03/29/2021 0:00
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/06/2021 23:01
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/10/2021 20:05
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/11/2021 20:40
21030004-004A	HEN_IL_RIVER-20210225	02/25/2021 11:45	03/01/2021 8:22		
	Standard Methods 2320 B (Total) 1997				03/04/2021 12:53
	Standard Methods 2320 B 1997				03/04/2021 12:53
21030004-004B	HEN_IL_RIVER-20210225	02/25/2021 11:45	03/01/2021 8:22		
	Standard Methods 2540 C (Total) 1997				03/03/2021 18:38
	SW-846 9036 (Total)				03/04/2021 13:25
	SW-846 9251 (Total)				03/03/2021 1:00
21030004-004C	HEN_IL_RIVER-20210225	02/25/2021 11:45	03/01/2021 8:22		
	See Attached for Subcontracting Analysis				03/29/2021 0:00
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/04/2021 4:58
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/06/2021 3:04
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/02/2021 8:44	03/10/2021 18:11
21030004-004E	HEN_IL_RIVER-20210225	02/25/2021 11:45	03/01/2021 8:22		
	See Attached for Subcontracting Analysis				03/29/2021 0:00
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/06/2021 23:09
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/10/2021 20:14
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/02/2021 8:02	03/11/2021 20:48

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

STANDARD METHODS 2540 C (TOTAL) 1997

Batch R287973 **SampType:** MBLK Units **mg/L**
SampID: MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/01/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/02/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/01/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/02/2021

Batch R287973 **SampType:** LCS Units **mg/L**
SampID: LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**948**	1000	0	94.8	90	110	03/02/2021
Total Dissolved Solids		20		**948**	1000	0	94.8	90	110	03/01/2021
Total Dissolved Solids		20		**960**	1000	0	96.0	90	110	03/02/2021
Total Dissolved Solids		20		**960**	1000	0	96.0	90	110	03/01/2021

Batch R288088 **SampType:** MBLK Units **mg/L**
SampID: MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/03/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/03/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/03/2021

Batch R288088 **SampType:** LCS Units **mg/L**
SampID: LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**980**	1000	0	98.0	90	110	03/03/2021
Total Dissolved Solids		20		**974**	1000	0	97.4	90	110	03/03/2021
Total Dissolved Solids		20		**956**	1000	0	95.6	90	110	03/03/2021

Batch R288088 **SampType:** DUP Units **mg/L** RPD Limit **5**
SampID: 21030004-004BDUP

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Total Dissolved Solids		20		**868**				878.0	1.15	03/03/2021

Batch R288088 **SampType:** DUP Units **mg/L** RPD Limit
SampID: LCSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Total Dissolved Solids		20		**970**	1000	0	97.0	90	110	03/03/2021

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

SW-846 9036 (TOTAL)

Batch R287942 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	03/01/2021

Batch R287942 **SampType:** MBLK Units **mg/L**
SampID: MBLK/ICB

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	03/02/2021

Batch R287942 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**21**	20.00	0	104.0	90	110	03/01/2021

Batch R287942 **SampType:** LCS Units **mg/L**
SampID: LCS/ICV

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**21**	20.00	0	103.2	90	110	03/02/2021

Batch R287942 **SampType:** MS Units **mg/L**
SampID: 21030004-002BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		100	E	**600**	200.0	407.1	96.5	85	115	03/03/2021

Batch R287942 **SampType:** MSD Units **mg/L** RPD Limit **10**
SampID: 21030004-002BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Sulfate		100	E	**600**	200.0	407.1	96.6	600.0	0.04	03/03/2021

Batch R288110 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	03/04/2021

Batch R288110 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**20**	20.00	0	98.8	90	110	03/04/2021

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

SW-846 9251 (TOTAL)

Batch R287943 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	03/01/2021

Batch R287943 **SampType:** MBLK Units **mg/L**
SampID: MBLK/ICB

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	03/02/2021

Batch R287943 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**20**	20.00	0	101.5	90	110	03/01/2021

Batch R287943 **SampType:** LCS Units **mg/L**
SampID: LCS/ICV

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**19**	20.00	0	97.4	90	110	03/02/2021

Batch R288111 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	03/04/2021

Batch R288111 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**20**	20.00	0	101.3	90	110	03/04/2021

Batch R288111 **SampType:** MS Units **mg/L**
SampID: 21030004-002BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		5		**161**	100.0	63.62	97.3	85	115	03/04/2021

Batch R288111 **SampType:** MSD Units **mg/L** RPD Limit **15**
SampID: 21030004-002BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Chloride		5		**156**	100.0	63.62	92.1	160.9	3.26	03/04/2021

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 174328 **SampType:** MBLK Units **mg/L**

SampID: MBLK-174328

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Antimony		0.0010		**< 0.0010**	0.0004	0	0	-100	100	03/10/2021
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	03/10/2021
Barium		0.0010		**< 0.0010**	0.0007	0	0	-100	100	03/10/2021
Beryllium		0.0010		**< 0.0010**	0.0002	0	0	-100	100	03/11/2021
Boron		0.0250		**< 0.0250**	0.0093	0	0	-100	100	03/11/2021
Cadmium		0.0010		**< 0.0010**	0.0001	0	0	-100	100	03/11/2021
Chromium		0.0015		**< 0.0015**	0.0007	0	0	-100	100	03/10/2021
Cobalt		0.0010		**< 0.0010**	0.0001	0	0	-100	100	03/10/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	03/10/2021
Lead		0.0010		**< 0.0010**	0.0006	0	0	-100	100	03/10/2021
Lithium	*	0.0030		**< 0.0030**	0.0015	0	0	-100	100	03/11/2021
Magnesium		0.0500		**< 0.0500**	0.0175	0	0	-100	100	03/11/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	03/11/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	03/10/2021
Potassium		0.175		**< 0.175**	0.0800	0	0	-100	100	03/10/2021
Selenium		0.0010		**< 0.0010**	0.0006	0	0	-100	100	03/06/2021
Thallium		0.0020		**< 0.0020**	0.0010	0	0	-100	100	03/10/2021

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch **174328** **SampType:** **LCS** Units **mg/L**

SampID: LCS-174328

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Antimony		0.0010		**0.461**	0.5000	0	92.3	80	120	03/10/2021
Arsenic		0.0010		**0.498**	0.5000	0	99.7	80	120	03/10/2021
Barium		0.0010		**2.02**	2.000	0	100.9	80	120	03/10/2021
Beryllium		0.0010		**0.0474**	0.0500	0	94.8	80	120	03/11/2021
Boron		0.0250		**0.454**	0.5000	0	90.9	80	120	03/11/2021
Cadmium		0.0010		**0.0460**	0.0500	0	92.1	80	120	03/11/2021
Chromium		0.0015		**0.185**	0.2000	0	92.3	80	120	03/10/2021
Cobalt		0.0010		**0.463**	0.5000	0	92.5	80	120	03/10/2021
Iron		0.0250		**1.79**	2.000	0	89.3	80	120	03/10/2021
Lead		0.0010		**0.470**	0.5000	0	94.0	80	120	03/10/2021
Lithium	*	0.0030		**0.481**	0.5000	0	96.2	80	120	03/11/2021
Magnesium		0.0500		**2.19**	2.500	0	87.5	80	120	03/11/2021
Manganese		0.0020		**0.475**	0.5000	0	94.9	80	120	03/11/2021
Molybdenum		0.0015		**0.471**	0.5000	0	94.2	80	120	03/10/2021
Potassium		0.175		**2.32**	2.500	0	93.0	80	120	03/10/2021
Selenium		0.0010		**0.449**	0.5000	0	89.8	80	120	03/06/2021
Thallium		0.0020		**0.233**	0.2500	0	93.3	80	120	03/10/2021

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 174328 **SampType:** MS Units **mg/L**

SampID: 21030004-001DMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Antimony		0.0010		**0.484**	0.5000	0.0006644	96.7	75	125	03/10/2021
Arsenic		0.0010		**0.517**	0.5000	0.0007762	103.2	75	125	03/10/2021
Barium		0.0010		**2.08**	2.000	0.06129	100.8	75	125	03/10/2021
Beryllium		0.0010		**0.0465**	0.0500	0	93.1	75	125	03/11/2021
Boron		0.0250	S	**5.14**	0.5000	4.784	71.6	75	125	03/11/2021
Cadmium		0.0010		**0.0517**	0.0500	0.005666	92.0	75	125	03/11/2021
Chromium		0.0015		**0.185**	0.2000	0	92.5	75	125	03/10/2021
Cobalt		0.0010		**0.459**	0.5000	0.002696	91.4	75	125	03/10/2021
Iron		0.0250		**1.79**	2.000	0	89.5	75	125	03/10/2021
Lead		0.0010		**0.473**	0.5000	0	94.5	75	125	03/10/2021
Lithium	*	0.0030		**0.527**	0.5000	0.05369	94.7	75	125	03/11/2021
Magnesium		0.0500		**32.1**	2.500	30.15	78.6	75	125	03/11/2021
Manganese		0.0020		**0.565**	0.5000	0.08735	95.5	75	125	03/11/2021
Molybdenum		0.0015		**0.608**	0.5000	0.1348	94.6	75	125	03/10/2021
Potassium		0.175		**14.3**	2.500	11.81	101.3	75	125	03/10/2021
Selenium		0.0010		**0.467**	0.5000	0.02121	89.1	75	125	03/06/2021
Thallium		0.0020		**0.234**	0.2500	0	93.8	75	125	03/10/2021

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 174328 **SampType:** MSD Units **mg/L** RPD Limit **20**

SampID: 21030004-001DMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Antimony		0.0010		**0.486**	0.5000	0.0006644	97.1	0.4839	0.47	03/10/2021
Arsenic		0.0010		**0.515**	0.5000	0.0007762	102.8	0.5169	0.40	03/10/2021
Barium		0.0010		**2.08**	2.000	0.06129	101.1	2.078	0.22	03/10/2021
Beryllium		0.0010		**0.0484**	0.0500	0	96.9	0.04654	3.99	03/11/2021
Boron		0.0250		**5.27**	0.5000	4.784	97.6	5.141	2.50	03/11/2021
Cadmium		0.0010		**0.0523**	0.0500	0.005666	93.3	0.05168	1.19	03/11/2021
Chromium		0.0015		**0.186**	0.2000	0	92.8	0.1850	0.36	03/10/2021
Cobalt		0.0010		**0.464**	0.5000	0.002696	92.2	0.4595	0.88	03/10/2021
Iron		0.0250		**1.79**	2.000	0	89.6	1.789	0.15	03/10/2021
Lead		0.0010		**0.485**	0.5000	0	96.9	0.4725	2.52	03/10/2021
Lithium	*	0.0030		**0.539**	0.5000	0.05369	97.1	0.5274	2.19	03/11/2021
Magnesium		0.0500		**32.2**	2.500	30.15	81.6	32.11	0.24	03/11/2021
Manganese		0.0020		**0.568**	0.5000	0.08735	96.2	0.5650	0.62	03/11/2021
Molybdenum		0.0015		**0.610**	0.5000	0.1348	95.1	0.6079	0.36	03/10/2021
Potassium		0.175		**14.1**	2.500	11.81	89.8	14.34	2.02	03/10/2021
Selenium		0.0010		**0.490**	0.5000	0.02121	93.8	0.4668	4.90	03/06/2021
Thallium		0.0020		**0.240**	0.2500	0	96.0	0.2344	2.30	03/10/2021

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 174329 **SampType:** MBLK Units **mg/L**

SampID: MBLK-174329

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Antimony		0.0010		**< 0.0010**	0.0004	0	0	-100	100	03/05/2021
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	03/05/2021
Barium		0.0010		**< 0.0010**	0.0007	0	0	-100	100	03/05/2021
Beryllium		0.0010		**< 0.0010**	0.0002	0	0	-100	100	03/03/2021
Cadmium		0.0010		**< 0.0010**	0.0001	0	0	-100	100	03/03/2021
Chromium		0.0015		**< 0.0015**	0.0007	0	0	-100	100	03/05/2021
Cobalt		0.0010		**< 0.0010**	0.0001	0	0	-100	100	03/03/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	03/05/2021
Lead		0.0010		**< 0.0010**	0.0006	0	0	-100	100	03/03/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	03/03/2021
Potassium		0.175		**< 0.175**	0.0800	0	0	-100	100	03/05/2021
Selenium		0.0010		**< 0.0010**	0.0006	0	0	-100	100	03/03/2021
Thallium		0.0020		**< 0.0020**	0.0010	0	0	-100	100	03/03/2021

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 174329 **SampType:** LCS Units **mg/L**

SampID: LCS-174329

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Antimony		0.0010		**0.513**	0.5000	0	102.7	85	115	03/05/2021
Arsenic		0.0010		**0.537**	0.5000	0	107.4	85	115	03/05/2021
Barium		0.0010		**2.08**	2.000	0	103.9	85	115	03/05/2021
Beryllium		0.0010		**0.0524**	0.0500	0	104.8	85	115	03/04/2021
Cadmium		0.0010		**0.0519**	0.0500	0	103.8	85	115	03/04/2021
Chromium		0.0015		**0.207**	0.2000	0	103.5	85	115	03/05/2021
Cobalt		0.0010		**0.522**	0.5000	0	104.4	85	115	03/04/2021
Iron		0.0250		**1.97**	2.000	0	98.7	85	115	03/05/2021
Lead		0.0010		**0.521**	0.5000	0	104.2	85	115	03/04/2021
Molybdenum		0.0015		**0.498**	0.5000	0	99.6	85	115	03/04/2021
Potassium		0.175		**2.56**	2.500	0	102.5	85	115	03/05/2021
Selenium		0.0010		**0.523**	0.5000	0	104.6	85	115	03/04/2021
Thallium		0.0020		**0.255**	0.2500	0	102.1	85	115	03/04/2021

Batch 174329 **SampType:** MS Units **mg/L**

SampID: 21030004-001CMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Antimony		0.0010		**0.518**	0.5000	0.0006760	103.5	75	125	03/06/2021
Arsenic		0.0010		**0.537**	0.5000	0.0009090	107.2	75	125	03/10/2021
Barium		0.0010		**2.16**	2.000	0.06547	104.7	75	125	03/06/2021
Beryllium		0.0010		**0.0502**	0.0500	0	100.3	75	125	03/04/2021
Cadmium		0.0010		**0.0553**	0.0500	0.006021	98.5	75	125	03/04/2021
Chromium		0.0015		**0.200**	0.2000	0	100.1	75	125	03/10/2021
Cobalt		0.0010		**0.492**	0.5000	0.002835	97.9	75	125	03/04/2021
Iron		0.0250		**1.96**	2.000	0.03770	95.9	75	125	03/10/2021
Lead		0.0010		**0.510**	0.5000	0	101.9	75	125	03/04/2021
Molybdenum		0.0015		**0.625**	0.5000	0.1323	98.5	75	125	03/04/2021
Potassium		0.175		**15.0**	2.500	12.41	103.3	75	125	03/10/2021
Selenium		0.0010		**0.552**	0.5000	0.02356	105.7	75	125	03/04/2021
Thallium		0.0020		**0.251**	0.2500	0	100.6	75	125	03/04/2021

Client: Geosyntec Consultants **Work Order:** 21030004

Client Project: Hennepin GW **Report Date:** 31-Mar-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch **174329** **SampType:** **MSD** Units **mg/L** RPD Limit **20**

SampID: 21030004-001CMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Antimony		0.0010		**0.526**	0.5000	0.0006760	105.0	0.5183	1.39	03/06/2021
Arsenic		0.0010		**0.531**	0.5000	0.0009090	106.1	0.5369	1.01	03/10/2021
Barium		0.0010		**2.15**	2.000	0.06547	104.3	2.159	0.31	03/06/2021
Beryllium		0.0010		**0.0506**	0.0500	0	101.2	0.05016	0.89	03/04/2021
Cadmium		0.0010		**0.0558**	0.0500	0.006021	99.6	0.05528	1.01	03/04/2021
Chromium		0.0015		**0.192**	0.2000	0	96.0	0.2002	4.17	03/10/2021
Cobalt		0.0010		**0.486**	0.5000	0.002835	96.5	0.4924	1.41	03/04/2021
Iron		0.0250		**1.92**	2.000	0.03770	93.9	1.956	2.07	03/10/2021
Lead		0.0010		**0.519**	0.5000	0	103.7	0.5095	1.76	03/04/2021
Molybdenum		0.0015		**0.623**	0.5000	0.1323	98.2	0.6250	0.26	03/04/2021
Potassium		0.175		**15.1**	2.500	12.41	107.5	15.00	0.70	03/10/2021
Selenium		0.0010		**0.545**	0.5000	0.02356	104.3	0.5522	1.28	03/04/2021
Thallium		0.0020		**0.257**	0.2500	0	102.7	0.2514	2.11	03/04/2021

Receiving Check List

http://www.teklabinc.com/

Client: Geosyntec Consultants
Work Order: 21030004
Client Project: Hennepin GW
Report Date: 31-Mar-21

Carrier: Tim Mathis
Received By: MEK

Completed by: Mary E. Kemp
On: 01-Mar-21
Mary E. Kemp

Reviewed by: Elizabeth A. Hurley
On: 01-Mar-21
Elizabeth A. Hurley

Pages to follow: Chain of custody 1 Extra pages included 19

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	Temp °C 4.6
Type of thermal preservation?	None ☐	Ice ☑	Blue Ice ☐	Dry Ice ☐
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		
Reported field parameters measured:	Field ☐	Lab ☐	NA ☑	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐		
When thermal preservation is required, samples are compliant with a temperature between 0.1°C - 6.0°C, or when samples are received on ice the same day as collected.				
Water – at least one vial per sample has zero headspace?	Yes ☐	No ☐	No VOA vials ☑	
Water - TOX containers have zero headspace?	Yes ☐	No ☐	No TOX containers ☑	
Water - pH acceptable upon receipt?	Yes ☐	No ☑	NA ☐	
NPDES/CWA TCN interferences checked/treated in the field?	Yes ☐	No ☐	NA ☑	

Any No responses must be detailed below or on the COC.

pH strip #74534. - PRY/MKemp - 3/1/2021 10:52:05 AM

HEN_IL_RIVER-20210225 was split, filtered and preserved with nitric acid (75787) for the dissolved parameters upon arrival at the laboratory. - MKemp - 3/1/2021 10:52:30 AM

CHAIN OF CUSTODY

pg. ____ of ____ Work order # 21030004

TEKLAB, INC. 5445 Horseshoe Lake Road - Collinsville, IL 62234 - Phone: (618) 344-1004 - Fax: (618) 344-1005

Client:	Geosyntec Consultants		
Address:	1 McBride and Son Center Drive, Suite 202		
City / State / Zip	Chesterfield, MO 63005		
Contact:	Allison Kreinberg	**Phone:**	(636) 812-0809
E-Mail:	AKreinberg@Geosyntec.com	**Fax:**	

Samples on: ☑ ICE ☐ BLUE ICE ☐ NO ICE 4.0 °C LTG# 5

Preserved in: ☑ LAB ☐ FIELD **FOR LAB USE ONLY**

Lab Notes * per Doug run MS/MSD where sample permits

* FILTER IN LAB TM, PH 7.4534, Added H2SO4 75821 TM

Client Comments: SAMPLE HEN_IL_RIVER. PLT 3/1/21

* NO TEKLAB ANALYSIS, COLLECTED FOR STREAM ONLY TE

Are these samples known to be involved in litigation? If yes, a surcharge will apply ☐ Yes ☐ No

Are these samples known to be hazardous? ☐ Yes ☐ No

Are there any required reporting limits to be met on the requested analysis?. If yes, please provide limits in the comment section. ☐ Yes ☐ No

Project Name/Number: Hennepin GW

Sample Collector's Name: T. MATHIS / E. IVANS

Results Requested: ☐ Standard ☐ 1-2 Day (100% Surcharge) ☐ Other ____ ☐ 3 Day (50% Surcharge)

Billing Instructions:

Lab Use Only	Sample Identification	Date/Time Sampled	# and Type of Containers: UNPRES	HNO3	NaOH	H2SO4	HCL	MeOH	NaHSO4	OTHER	MATRIX: Aqueous	Drinking Water	Soil	Sludge	Special Waste	Groundwater	INDICATE ANALYSIS REQUESTED: Alkalinity B	Alkalinity C	Chloride	Dissolved Metals by ICP/MS	Sulfate	TDS	Total Metals by ICP/MS
21030004-001	MW-22-20210224	2-24-21 1518														X	X	X	X	X	X	X	X
-002	MW-23-20210224	2-24-21 1634														X							
-003	MW-34-20210225	2-25-21 0858														X							
-004	MW-51-20210225	2-25-21 1410														X							
-005 *	HEN_IL_RIVER-20210225	2-25-21 1145									X						X	X	X	X	X	X	X
TE 3/1/21	MEK																						

Relinquished By	Date/Time	Received By	Date/Time
	3/1/21 822	Mary Kemp	3/1/21 822

The individual signing this agreement on behalf of the client, acknowledges that he/she has read and understands the terms and conditions of this agreement, and that he/she has the authority to sign on behalf of the client. See www.teklabinc.com for terms and conditions.

BottleOrder: 63738

PLT 3/1/21

WELL DEVELOPMENT AND GROUNDWATER SAMPLING FIELD FORM

PROJECT INFORMATION

Site: HEALDSBURG — Client: GEOSTRATA

Project Number: _____ Task #: _____ Start Date: 2.24.21 Time: 1434

Field Personnel: _____ Finish Date: 2.24.21 Time: 1518

WELL INFORMATION

Well ID: 27

Casing ID: _____ inches

EVENT TYPE

☐ Well Development ☒ Low-Flow / Low Stress Sampling

☐ Well Volume Approach Sampling ☐ Other (Specify):

WATER QUALITY INDICATOR PARAMETERS (continued)

Sampling Stage	Time (military)	Volume Removed (gallons)	Depth to Water (Feet)	Drawdown (Feet)	Temp. (°C)	pH (SU)	SEC or Cond. (µs/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Visual Clarity
	1454		18.63	0							
	1458	.13			13.3	7.24	1012	0.96	5.12	116.1	CLEAR
	1502	.26			13.4	7.41	1043	0.33	3.25	104.1	
	1506	.39			13.6	7.52	1062	0.22	3.93	96.2	
	1510	.52			13.5	7.52	1064	0.16	3.22	92.2	
	1514	.65			13.5	7.56	1061	0.15	3.09	90.5	
	1518	.78			13.8	7.57	1062	0.13	3.09	89.1	

NOTES (continued)

ABBREVIATIONS

Cond. - Actual Conductivity
FT BTOC - Feet Below Top of Casing
na - Not Applicable
nm - Not Measured
ORP - Oxidation-Reduction Potential
SEC - Specific Electrical Conductance
SU - Standard Units
Temp - Temperature
°C - Degrees Celcius

WELL DEVELOPMENT AND GROUNDWATER SAMPLING FIELD FORM

PROJECT INFORMATION

Site: HENRIETTA 1 | Client: GEOSYNTEC

Project Number: | Task #: | Start Date: 2.24.21 | Time: 1630

Field Personnel: | Finish Date: 2.24.21 | Time: 1654

WELL INFORMATION

Well ID: MW 23

Casing ID: inches

EVENT TYPE

☐ Well Development ☒ Low-Flow / Low Stress Sampling

☐ Well Volume Approach Sampling ☐ Other (Specify):

WATER QUALITY INDICATOR PARAMETERS (continued)

Sampling Stage	Time (military)	Volume Removed (gallons)	Depth to Water (Feet)	Drawdown (Feet)	Temp. (°C)	pH (SU)	SEC or Cond. (µs/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Visual Clarity
	1630		17.29								
	1634	.13		0	9.9	7.48	1275	2.07	6.40	-107.5	CLEAR
	1638	.26	|		10.8	7.52	1273	0.65	3.20	-104.6	
	1642	.39	|	|	11.3	7.53	1275	0.42	3.73	-122.7	|
	1646	.52	|	|	11.6	7.52	1285	0.17	3.49	-119.8	|
	1650	.65	|	|	11.6	7.52	1281	0.13	3.09	-119.5	|
	1654	.78	↓	↓	11.6	7.52	1279	0.08	3.31	-120.4	↓

NOTES (continued)

ABBREVIATIONS

Cond. - Actual Conductivity	ORP - Oxidation-Reduction Potential
FT BTOC - Feet Below Top of Casing	SEC - Specific Electrical Conductance
na - Net Applicable	SU - Standard Units
nm - Not Measured	Temp - Temperature
	°C - Degrees Celcius

WELL DEVELOPMENT AND GROUNDWATER SAMPLING FIELD FORM

PROJECT INFORMATION

Site: HENNEPIN Client: GEOSYNTEC

Project Number: Task #: Start Date: 2.25.21 Time: 0830

Field Personnel: TW MATTIS Finish Date: 2-25-21 Time: 0856

WELL INFORMATION

Well ID: MW34

Casing ID: inches

EVENT TYPE

☐ Well Development ☒ Low-Flow / Low Stress Sampling

☐ Well Volume Approach Sampling ☐ Other (Specify):

WATER QUALITY INDICATOR PARAMETERS (continued)

Sampling Stage	Time (military)	Volume Removed (gallons)	Depth to Water (Feet)	Drawdown (Feet)	Temp. (°C)	pH (SU)	SEC or Cond. (µs/cm)	Dissolved Oxygen (mg/L)	~~Turbidity (NTU)~~ ORP MV	~~ORP (mV)~~ Turb NTU	Visual Clarity
	0830		7.13								
	0834	.13	7.13	0	11.4	7.10	1208	0.48	-96.0	21.24	CLEAR
	0838	.26	7.13	|	11.4	7.10	1218	0.33	-99.1	18.05	|
	0842	.39	7.13	|	11.5	7.10	1235	0.20	-96.1	18.60	|
	0846	.52	7.13	|	11.4	7.10	1242	0.16	-92.9	18.74	|
	0850	.65	7.13	|	11.3	7.11	1248	0.12	-91.6	14.07	|
	0854	.78	7.13	V	11.4	7.10	1249	0.12	-92.8	12.04	|
	0858	.91	7.13	0	11.4	7.11	1252	0.13	-93.4	9.52	V

NOTES (continued)

ABBREVIATIONS

Cond. - Actual Conductivity
FT BTOC - Feet Below Top of Casing
na - Not Applicable
nm - Not Measured
ORP - Oxidation-Reduction Potential
SEC - Specific Electrical Conductance
SU - Standard Units
Temp - Temperature
°C - Degrees Celcius

WELL DEVELOPMENT AND GROUNDWATER SAMPLING FIELD FORM

PROJECT INFORMATION

Site: HENDERSON Client: GEOSYNTEC

Project Number: _____ Task #: _____ Start Date: 2.25.21 Time: 1020

Field Personnel: _____ Finish Date: 2.25.21 Time: 1110

WELL INFORMATION

Well ID: MW-61

Casing ID: _____ inches

EVENT TYPE

☐ Well Development ☒ Low-Flow / Low Stress Sampling

☐ Well Volume Approach Sampling ☐ Other (Specify):

WATER QUALITY INDICATOR PARAMETERS (continued)

Sampling Stage	Time (military)	Volume Removed (gallons)	Depth to Water (Feet)	Drawdown (Feet)	Temp. (°C)	pH (SU)	SEC or Cond. (µs/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Visual Clarity
	1020 PRE		18.85								
	1025	.13		0	10.1	7.43	1136	2.05	53.00	-85.1	CLEAR
	1030	.26			10.5	7.47	1140	1.15	38.51	-120.5	
	1035	.39			10.8	7.51	1144	1.01	39.98	-138.5	
	1040	.52			11.0	7.54	1146	0.23	39.95	-152.1	
	1045	.65			10.8	7.54	1153	0.18	37.93	-157.1	
	1050	.78			10.8	7.54	1151	0.17	36.60	-154.0	
	1055	.91			8.9	7.55	1150	0.24	34.54	-145.3	
	1100	1.04			9.5	7.54	1140	0.27	34.93	-142.7	
	1105	1.17		"	9.9	7.54	1139	0.28	35.74	-142.6	
	1110	1.30	"	0	9.9	7.54	1140	0.28	36.04	-142.9	"

NOTES (continued)

ABBREVIATIONS

Cond. - Actual Conductivity	ORP - Oxidation-Reduction Potential
FT BTOC - Feet Below Top of Casing	SEC - Specific Electrical Conductance
na - Not Applicable	SU - Standard Units
nm - Not Measured	Temp - Temperature
	°C - Degrees Celcius

WELL DEVELOPMENT AND GROUNDWATER SAMPLING FIELD FORM

PROJECT INFORMATION

Site: HEADWATERS Client: CAPISTRANO

Project Number: _____ Task #: _____ Start Date: _____ Time: _____

Field Personnel: _____ Finish Date: _____ Time: _____

WELL INFORMATION

Well ID: IL RIVER2

Casing ID: _____ inches

EVENT TYPE

☐ Well Development ☐ Low-Flow / Low Stress Sampling

☐ Well Volume Approach Sampling ☐ Other (Specify):

WATER QUALITY INDICATOR PARAMETERS (continued)

Sampling Stage	Time (military)	Volume Removed (gallons)	Depth to Water (Feet)	Drawdown (Feet)	Temp. (°C)	pH (SU)	SEC or Cond. (µs/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Visual Clarity
	1145	—	—	—	0.9	8.06	1690	12.84	5.10	73.9	CLEAR

NOTES (continued)

FILTER IN LAB

GRAB SAMPLE FROM RIVER NEAR PUMP STATION

ABBREVIATIONS

Cond. - Actual Conductivity
FT BTOC - Feet Below Top of Casing
na - Not Applicable
nm - Not Measured
ORP - Oxidation-Reduction Potential
SEC - Specific Electrical Conductance
SU - Standard Units
Temp - Temperature
°C - Degrees Celcius

2-24-21 0830

4.00
7.00
10.00
14/12
98.7%
0

7.00
13x87
93.4%
0.8

2-24-20

1900

LELAP CERTIFICATE NUMBER: 01955
DOD-ELAP ACCREDITATION NUMBER: 74960

ANALYTICAL RESULTS

PERFORMED BY

Pace Analytical Gulf Coast
7979 Innovation Park Dr.
Baton Rouge, LA 70820
(225) 769-4900

Report Date 03/30/2021

Report # 221032623

Project 21030004

Deliver To	***Additional Recipients***
Elizabeth Hurley Teklab, Inc 5445 Horseshoe Lake Road Collinsville, IL 62234 618-344-1004	NONE

Laboratory Endorsement

Sample analysis was performed in accordance with approved methodologies provided by the Environmental Protection Agency or other recognized agencies. The samples and their corresponding extracts will be maintained for a period of 30 days unless otherwise arranged. Following this retention period the samples will be disposed in accordance with Pace Gulf Coast's Standard Operating Procedures.

Common Abbreviations that may be Utilized in this Report

ND	Indicates the result was Not Detected at the specified reporting limit
NO	Indicates the sample did not ignite when preliminary test performed for EPA Method 1030
DO	Indicates the result was Diluted Out
MI	Indicates the result was subject to Matrix Interference
TNTC	Indicates the result was Too Numerous To Count
SUBC	Indicates the analysis was Sub-Contracted
FLD	Indicates the analysis was performed in the Field
DL	Detection Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
RE	Re-analysis
CF	HPLC or GC Confirmation
00:01	Reported as a time equivalent to 12:00 AM

Reporting Flags that may be Utilized in this Report

J or I	Indicates the result is between the MDL and LOQ
J	DOD flag on analyte in the parent sample for MS/MSD outside acceptance criteria
U	Indicates the compound was analyzed for but not detected
B or V	Indicates the analyte was detected in the associated Method Blank
Q	Indicates a non-compliant QC Result (See Q Flag Application Report)
*****	Indicates a non-compliant or not applicable QC recovery or RPD – see narrative
E	Organics - The result is estimated because it exceeded the instrument calibration range
E	Metals - % diference for the serial dilution is > 10%
L	Reporting Limits adjusted to meet risk-based limit.
P	RPD between primary and confirmation result is greater than 40
DL	Diluted analysis – when appended to Client Sample ID

Sample receipt at Pace Gulf Coast is documented through the attached chain of custody. In accordance with NELAC, this report shall be reproduced only in full and with the written permission of Pace Gulf Coast. The results contained within this report relate only to the samples reported. The documented results are presented within this report.

This report pertains only to the samples listed in the Report Sample Summary and should be retained as a permanent record thereof. The results contained within this report are intended for the use of the client. Any unauthorized use of the information contained in this report is prohibited.

I certify that this data package is in compliance with The NELAC Institute (TNI) Standard 2009 and terms and conditions of the contract and Statement of Work both technically and for completeness, for other than the conditions in the case narrative. Release of the data contained in this hardcopy data package and in the computer readable data submitted has been authorized by the Quality Assurance Manager or his/her designee, as verified by the following signature.

Estimated uncertainty of measurement is available upon request. This report is in compliance with the DOD QSM as specified in the contract if applicable.

Authorized Signature
Pace Gulf Coast Report 221032623

Certifications

Certification	Certification Number
DOD ELAP	74960
Alabama	01955
Arkansas	88-0655
Colorado	01955
Delaware	01955
Florida	E87854
Georgia	01955
Hawaii	01955
Idaho	01955
Illinois	200048
Indiana	01955
Kansas	E-10354
Kentucky	95
Louisiana	01955
Maryland	01955
Massachusetts	01955
Michigan	01955
Mississippi	01955
Missouri	01955
Montana	N/A
Nebraska	01955
New Mexico	01955
North Carolina	618
North Dakota	R-195
Oklahoma	9403
South Carolina	73006001
South Dakota	01955
Tennessee	01955
Texas	T104704178
Vermont	01955
Virginia	460215
Washington	C929
USDA Soil Permit	P330-16-00234

Case Narrative

Client: Teklab Inc **Report:** 221032623

Pace Analytical Gulf Coast received and analyzed the sample(s) listed
on the Report Sample Summary page of this report. Receipt of the sample(s) is documented
by the attached chain of custody. This applies only to the sample(s) listed in this report.
No sample integrity or quality control exceptions were identified unless noted below.

No anomalies were found for the analyzed sample(s).

Sample Summary

LAB ID	Client ID	Matrix	Collect Date	Receive Date
22103252517	21030004-001C	Water	02/24/2021 15:18	03/24/2021 09:50
22103252518	21030004-001D	Water	02/24/2021 15:18	03/24/2021 09:50
22103252519	21030004-002C	Water	02/24/2021 16:54	03/24/2021 09:50
22103252520	21030004-002D	Water	02/24/2021 16:54	03/24/2021 09:50
22103252521	21030004-003C	Water	02/25/2021 11:10	03/24/2021 09:50
22103252522	21030004-003D	Water	02/25/2021 11:10	03/24/2021 09:50
22103252523	21030004-004C	Water	02/25/2021 11:45	03/24/2021 09:50
22103252524	21030004-004D	Water	02/25/2021 11:45	03/24/2021 09:50

Detect Summary

LAB ID	Client ID	Method	Parameter	Result	Units
22103252517	21030004-001C	EPA 6020B	Boron	4920	ug/L
22103252517	21030004-001C	EPA 6020B	Calcium	108000	ug/L
22103252517	21030004-001C	EPA 6020B	Lithium	52.9	ug/L
22103252517	21030004-001C	EPA 6020B	Magnesium	32400	ug/L
22103252517	21030004-001C	EPA 6020B	Manganese	142	ug/L
22103252517	21030004-001C	EPA 6020B	Sodium	55600	ug/L
22103252518	21030004-001D	EPA 6020B	Calcium	113000	ug/L
22103252518	21030004-001D	EPA 6020B	Sodium	57800	ug/L
22103252519	21030004-002C	EPA 6020B	Boron	8520	ug/L
22103252519	21030004-002C	EPA 6020B	Calcium	118000	ug/L
22103252519	21030004-002C	EPA 6020B	Magnesium	85500	ug/L
22103252519	21030004-002C	EPA 6020B	Manganese	1140	ug/L
22103252519	21030004-002C	EPA 6020B	Sodium	47900	ug/L
22103252520	21030004-002D	EPA 6020B	Calcium	116000	ug/L
22103252520	21030004-002D	EPA 6020B	Sodium	47100	ug/L
22103252521	21030004-003C	EPA 6020B	Boron	2410	ug/L
22103252521	21030004-003C	EPA 6020B	Calcium	129000	ug/L
22103252521	21030004-003C	EPA 6020B	Lithium	23.0	ug/L
22103252521	21030004-003C	EPA 6020B	Magnesium	47500	ug/L
22103252521	21030004-003C	EPA 6020B	Manganese	162	ug/L
22103252521	21030004-003C	EPA 6020B	Sodium	57200	ug/L
22103252522	21030004-003D	EPA 6020B	Calcium	125000	ug/L
22103252522	21030004-003D	EPA 6020B	Sodium	57900	ug/L
22103252523	21030004-004C	EPA 6020B	Boron	215	ug/L
22103252523	21030004-004C	EPA 6020B	Calcium	87700	ug/L
22103252523	21030004-004C	EPA 6020B	Lithium	8.00	ug/L
22103252523	21030004-004C	EPA 6020B	Magnesium	34600	ug/L
22103252523	21030004-004C	EPA 6020B	Manganese	59.9	ug/L
22103252523	21030004-004C	EPA 6020B	Sodium	227000	ug/L
22103252524	21030004-004D	EPA 6020B	Calcium	85000	ug/L
22103252524	21030004-004D	EPA 6020B	Sodium	222000	ug/L

Sample Results

21030004-001C

Collect Date	02/24/2021 15:18	**LAB ID**	22103252517
Receive Date	03/24/2021 09:50	**Matrix**	Water

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:15	706841	EPA 3010A	1	03/29/2021 18:06	LWZ	707162

CAS#	Parameter	Result	LOQ	Units
7440-70-2	Calcium	108000	500	ug/L
7439-93-2	Lithium	52.9	5.00	ug/L
7439-95-4	Magnesium	32400	100	ug/L
7439-96-5	Manganese	142	5.00	ug/L
7440-23-5	Sodium	55600	100	ug/L

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:15	706841	EPA 3010A	50	03/30/2021 14:37	LWZ	707239

CAS#	Parameter	Result	LOQ	Units
7440-42-8	Boron	4920	500	ug/L

21030004-001D

Collect Date	02/24/2021 15:18	**LAB ID**	22103252518
Receive Date	03/24/2021 09:50	**Matrix**	Water

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:15	706841	EPA 3010A	1	03/29/2021 18:10	LWZ	707162

CAS#	Parameter	Result	LOQ	Units
7440-70-2	Calcium	113000	500	ug/L
7440-23-5	Sodium	57800	100	ug/L

21030004-002C

Collect Date	02/24/2021 16:54	**LAB ID**	22103252519
Receive Date	03/24/2021 09:50	**Matrix**	Water

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:15	706841	EPA 3010A	1	03/29/2021 18:13	LWZ	707162

CAS#	Parameter	Result	LOQ	Units
7440-70-2	Calcium	118000	500	ug/L
7439-93-2	Lithium	5.00 U	5.00	ug/L
7439-95-4	Magnesium	85500	100	ug/L
7439-96-5	Manganese	1140	5.00	ug/L
7440-23-5	Sodium	47900	100	ug/L

Sample Results

21030004-002C

Collect Date	02/24/2021 16:54	**LAB ID**	22103252519
Receive Date	03/24/2021 09:50	**Matrix**	Water

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:15	706841	EPA 3010A	50	03/30/2021 14:44	LWZ	707239

CAS#	Parameter	Result	LOQ	Units
7440-42-8	Boron	8520	500	ug/L

21030004-002D

Collect Date	02/24/2021 16:54	**LAB ID**	22103252520
Receive Date	03/24/2021 09:50	**Matrix**	Water

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:15	706841	EPA 3010A	1	03/29/2021 18:17	LWZ	707162

CAS#	Parameter	Result	LOQ	Units
7440-70-2	Calcium	116000	500	ug/L
7440-23-5	Sodium	47100	100	ug/L

21030004-003C

Collect Date	02/25/2021 11:10	**LAB ID**	22103252521
Receive Date	03/24/2021 09:50	**Matrix**	Water

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:30	706842	EPA 3010A	1	03/29/2021 19:55	LWZ	707162

CAS#	Parameter	Result	LOQ	Units
7440-70-2	Calcium	129000	500	ug/L
7439-93-2	Lithium	23.0	5.00	ug/L
7439-95-4	Magnesium	47500	100	ug/L
7439-96-5	Manganese	162	5.00	ug/L
7440-23-5	Sodium	57200	100	ug/L

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:30	706842	EPA 3010A	10	03/30/2021 13:00	LWZ	707239

CAS#	Parameter	Result	LOQ	Units
7440-42-8	Boron	2410	100	ug/L

Sample Results

21030004-003D

Collect Date	02/25/2021 11:10	**LAB ID**	22103252522
Receive Date	03/24/2021 09:50	**Matrix**	Water

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:30	706842	EPA 3010A	1	03/29/2021 19:58	LWZ	707162

CAS#	Parameter	Result	LOQ	Units
7440-70-2	Calcium	125000	500	ug/L
7440-23-5	Sodium	57900	100	ug/L

21030004-004C

Collect Date	02/25/2021 11:45	**LAB ID**	22103252523
Receive Date	03/24/2021 09:50	**Matrix**	Water

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:30	706842	EPA 3010A	1	03/29/2021 20:02	LWZ	707162

CAS#	Parameter	Result	LOQ	Units
7440-70-2	Calcium	87700	500	ug/L
7439-93-2	Lithium	8.00	5.00	ug/L
7439-95-4	Magnesium	34600	100	ug/L
7439-96-5	Manganese	59.9	5.00	ug/L

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:30	706842	EPA 3010A	1	03/30/2021 13:10	LWZ	707239

CAS#	Parameter	Result	LOQ	Units
7440-42-8	Boron	215	10.0	ug/L

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:30	706842	EPA 3010A	10	03/30/2021 13:07	LWZ	707239

CAS#	Parameter	Result	LOQ	Units
7440-23-5	Sodium	227000	1000	ug/L

21030004-004D

Collect Date	02/25/2021 11:45	**LAB ID**	22103252524
Receive Date	03/24/2021 09:50	**Matrix**	Water

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:30	706842	EPA 3010A	1	03/29/2021 20:12	LWZ	707162

CAS#	Parameter	Result	LOQ	Units
7440-70-2	Calcium	85000	500	ug/L

Sample Results

21030004-004D				
	Collect Date	02/25/2021 11:45	LAB ID	22103252524
	Receive Date	03/24/2021 09:50	Matrix	Water

EPA 6020B

Prep Date	Prep Batch	Prep Method	Dilution	Analysis Date	By	Analytical Batch
03/25/2021 13:30	706842	EPA 3010A	10	03/30/2021 13:17	LWZ	707239

CAS#	Parameter	Result	LOQ	Units
7440-23-5	Sodium	222000	1000	ug/L

Inorganics QC Summary

Analytical Batch	Client ID	MB706841		LCS706841			
707162	LAB ID	2160971		2160972			
Prep Batch	Sample Type	MB		LCS			
706841	Prep Date	03/25/21 13:15		03/25/21 13:15			
Prep Method	Analysis Date	03/29/21 16:50		03/29/21 16:53			
EPA 3010A	Matrix	Water		Water			
EPA 6020B		Units Result	ug/L LOQ	Spike Added	Result	%R	Control Limits%R
Calcium	7440-70-2	500U	500	25000	25800	103	80 - 120
Lithium	7439-93-2	5.00U	5.00	250	250	100	80 - 120
Magnesium	7439-95-4	100U	100	5000	5190	104	80 - 120
Manganese	7439-96-5	5.00U	5.00	50.0	53.2	106	80 - 120
Sodium	7440-23-5	100U	100	5000	5160	103	80 - 120

Analytical Batch	Client ID	MB706841		LCS706841			
707239	LAB ID	2160971		2160972			
Prep Batch	Sample Type	MB		LCS			
706841	Prep Date	03/25/21 13:15		03/25/21 13:15			
Prep Method	Analysis Date	03/30/21 13:59		03/30/21 14:02			
EPA 3010A	Matrix	Water		Water			
EPA 6020B		Units Result	ug/L LOQ	Spike Added	Result	%R	Control Limits%R
Boron	7440-42-8	10.0U	10.0	250	256	103	80 - 120

Analytical Batch	Client ID	MB706842		LCS706842				LCSD706842				
707162	LAB ID	2160979		2160981				2160980				
Prep Batch	Sample Type	MB		LCS				LCSD				
706842	Prep Date	03/25/21 13:30		03/25/21 13:30				03/25/21 13:30				
Prep Method	Analysis Date	03/29/21 19:44		03/29/21 19:51				03/29/21 19:48				
EPA 3010A	Matrix	Water		Water				Water				
EPA 6020B		Units Result	ug/L LOQ	Spike Added	Result	%R	Control Limits%R	Spike Added	Result	%R	RPD	RPD Limit
Calcium	7440-70-2	500U	500	25000	26000	104	80 - 120	25000	24300	97	7	20
Lithium	7439-93-2	5.00U	5.00	250	244	97	80 - 120	250	228	91	7	20
Magnesium	7439-95-4	100U	100	5000	5240	105	80 - 120	5000	4980	100	5	20
Manganese	7439-96-5	5.00U	5.00	50.0	54.6	109	80 - 120	50.0	50.4	101	8	20
Sodium	7440-23-5	100U	100	5000	5230	105	80 - 120	5000	4950	99	5	20

Analytical Batch	Client ID	MB706842		LCS706842				LCSD706842				
707239	LAB ID	2160979		2160981				2160980				
Prep Batch	Sample Type	MB		LCS				LCSD				
706842	Prep Date	03/25/21 13:30		03/25/21 13:30				03/25/21 13:30				
Prep Method	Analysis Date	03/30/21 12:49		03/30/21 12:56				03/30/21 12:53				
EPA 3010A	Matrix	Water		Water				Water				
EPA 6020B		Units Result	ug/L LOQ	Spike Added	Result	%R	Control Limits%R	Spike Added	Result	%R	RPD	RPD Limit
Boron	7440-42-8	10.0U	10.0	250	252	101	80 - 120	250	232	93	9	20

Client ID: 5233 - Teklab Inc
SDG: 221032623
PM: RWe

TEKLAB, INC. Chain of Custody

5445 Horseshoe Lake Road, Collinsville, IL 62234 Phone (618) 344-1004 Fax

Are the samples chilled? YES ☐ NO ☑ With: ☐ Ice ☐ Blue Ice Preserved in: ☐ Lab ☐ Field

Teklab Inc
5445 Horseshoe Lake Road
Collinsville, IL 62234

Cooler Temp: Sampler: Teklab, Inc. QC Level: 3

Comments: **Please Issue reports and invoices via email only**
Any changes to analysis/methods must be approved by Teklab, Inc.
Please analyze by ICP/MS (6020). All are HNO3-preserved GW source. IL site
Batch QC is required for all analyses requested.

Project# 21030004

Contact: Elizabeth Hurley Email: ehurley@teklabinc.com
Requested Due Date: 5-day from receipt Billing/PO: 30924
Phone: (618) 344-1004 ext. 33

PLEASE NOTE:

NELAP accreditation is required on the requested analytes and must be documented as such on the final report. If your laboratory does not currently hold a NELAP accreditation for the requested method and/or analytes, please contact Teklab immediately. If your laboratory loses accreditation or is suspended for any analyte/method during the life of the contract, you must contact Teklab immediately.

Lab Use	Sample ID	Sample Date/Time	Preservative	Matrix	B Ca Li Mg Mn Na	Ca Na (field filtered)											*
	21030004-001C	2/24/2021 3:18:00 PM	HNO3	Groundwater	✓												17
	21030004-001D	2/24/2021 3:18:00 PM	HNO3	Groundwater		✓											18
	21030004-002C	2/24/2021 4:54:00 PM	HNO3	Groundwater	✓												19
	21030004-002D	2/24/2021 4:54:00 PM	HNO3	Groundwater		✓											20
	21030004-003C	2/25/2021 11:10:00 AM	HNO3	Groundwater	✓												21
	21030004-003D	2/25/2021 11:10:00 AM	HNO3	Groundwater		✓											22
	21030004-004C	2/25/2021 11:45:00 AM	HNO3	Groundwater	✓												23
	21030004-004D	2/25/2021 11:45:00 AM	HNO3	Groundwater		✓											24
			Unpres	Aqueous													
			Unpres	Aqueous													
			Unpres	Aqueous													

*Relinquished By	Date/Time	Received By	Date/Time
Mary Kemp FedEx	3/23/21 1700		
	3.24.21 950	Lauren Heller	3.24.21 950

*all samples MOVed FROM 221032525

Teklab maintains a strict policy of client confidentiality and as such does not provide client/sampler information without proper authorization. and proprietary rights, Teklab, Inc. protects clients' confidential information as directed by local, state or federal laws. (Teklab QAM Section 9.1, TNI V1 M2 Section 4.1.5 c)

SubCocRevA
3/2/2016

9450 9224 ~~18~~ DMLT 7862 18.3EZu 48Cpm

SAMPLE RECEIVING CHECKLIST

SAMPLE DELIVERY GROUP 221032623	
Client **PM** RWe 5233 - Teklab Inc	**Transport Method** FEDEX
Profile Number 290458	**Received By** McCune, Dodie N.
Line Item(s) 7 - Ca, Li, Mn, Mg, Na, B 8 - Ca, Na	**Receive Date(s)** 03/24/21

CHECKLIST	YES	NO
Samples received with proper thermal preservation?	☑	☐
Radioactivity is <1600 cpm? If no, record cpm value in notes section.	☑	☐
COC relinquished and complete (including sampleIDs, collect times, and sampler)?	☑	☐
All containers received in good condition and within hold time?	☑	☐
All sample labels and containers received match the chain of custody?	☑	☐
Preservative added to any containers?	☐	☑
If received, was headspace for VOC water containers < 6mm?	☑	☐
Samples collected in containers provided by Pace Gulf Coast?	☑	☐

COOLERS

Airbill	Thermometer ID: E26	Temp °C
945092247862		18.3

DISCREPANCIES

None

LAB PRESERVATIONS

None

NOTES

April 08, 2021

Allison Kreinberg
Geosyntec Consultants
1 McBride and Son Center Drive, Suite 202
Chesterfield, MO 63005
TEL: (614) 468-0421
FAX:

Illinois	100226
Kansas	E-10374
Louisiana	05002
Louisiana	05003
Oklahoma	9978

RE: GLP8020 **WorkOrder:** 21030443

Dear Allison Kreinberg:

TEKLAB, INC received 9 samples on 3/5/2021 1:55:00 PM for the analysis presented in the following report.

Samples are analyzed on an as received basis unless otherwise requested and documented. The sample results contained in this report relate only to the requested analytes of interest as directed on the chain of custody. NELAP accredited fields of testing are indicated by the letters NELAP under the Certification column. Unless otherwise documented within this report, Teklab Inc. analyzes samples utilizing the most current methods in compliance with 40CFR. All tests are performed in the Collinsville, IL laboratory unless otherwise noted in the Case Narrative.

All quality control criteria applicable to the test methods employed for this project have been satisfactorily met and are in accordance with NELAP except where noted. The following report shall not be reproduced, except in full, without the written approval of Teklab, Inc.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Aaron Renner
Project Manager
(630)324-6855
arenner@teklabinc.com

Report Contents

Client: Geosyntec Consultants
Work Order: 21030443
Client Project: GLP8020
Report Date: 08-Apr-21

This reporting package includes the following:

Cover Letter	1
Report Contents	2
Definitions	3
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Accreditations	6
Laboratory Results	7
Sample Summary	16
Dates Report	17
Quality Control Results	21
Receiving Check List	27
Chain of Custody	Appended

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Abbr	Definition
*	Analytes on report marked with an asterisk are not NELAP accredited
CCV	Continuing calibration verification is a check of a standard to determine the state of calibration of an instrument between recalibration.
CRQL	A Client Requested Quantitation Limit is a reporting limit that varies according to customer request. The CRQL may not be less than the MDL.
DF	Dilution factor is the dilution performed during analysis only and does not take into account any dilutions made during sample preparation. The reported result is final and includes all dilution factors.
DNI	Did not ignite
DUP	Laboratory duplicate is a replicate aliquot prepared under the same laboratory conditions and independently analyzed to obtain a measure of precision.
ICV	Initial calibration verification is a check of a standard to determine the state of calibration of an instrument before sample analysis is initiated.
IDPH	IL Dept. of Public Health
LCS	Laboratory control sample is a sample matrix, free from the analytes of interest,spiked with verified known amounts of analytes and analyzed exactly like a sample to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.
LCSD	Laboratory control sample duplicate is a replicate laboratory control sample that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MBLK	Method blank is a sample of a matrix similar to the batch of associated sample (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences should present at concentrations that impact the analytical results for sample analyses.
MDL	"The method detection limit is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results."
MS	Matrix spike is an aliquot of matrix fortified (spiked) with known quantities of specific analytes that is subjected to the entire analytical procedures in order to determine the effect of the matrix on an approved test method's recovery system. The acceptable recovery range is listed in the QC Package (provided upon request).
MSD	Matrix spike duplicate means a replicate matrix spike that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MW	Molecular weight
NC	Data is not acceptable for compliance purposes
ND	Not Detected at the Reporting Limit
NELAP	NELAP Accredited
PQL	Practical quantitation limit means the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.
RL	The reporting limit the lowest level that the data is displayed in the final report. The reporting limit may vary according to customer request or sample dilution. The reporting limit may not be less than the MDL.
RPD	Relative percent difference is a calculated difference between two recoveries (ie. MS/MSD). The acceptable recovery limit is listed in the QC Package (provided upon request).
SPK	The spike is a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery deficiency or for other quality control purposes.
Surr	Surrogates are compounds which are similar to the analytes of interest in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.
TIC	Tentatively identified compound: Analytes tentatively identified in the sample by using a library search. Only results not in the calibration standard will be reported as tentatively identified compounds. Results for tentatively identified compounds that are not present in the calibration standard, but are assigned a specific chemical name based upon the library search, are calculated using total peak areas from reconstructed ion chromatograms and a response factor of one. The nearest Internal Standard is used for the calculation. The results of any TICs must be considered estimated, and are flagged with a "T". If the estimated result is above the calibration range it is flagged "ET"
TNTC	Too numerous to count (> 200 CFU)

Client: Geosyntec Consultants
Work Order: 21030443
Client Project: GLP8020
Report Date: 08-Apr-21

Qualifiers

# - Unknown hydrocarbon	B - Analyte detected in associated Method Blank
C - RL shown is a Client Requested Quantitation Limit	E - Value above quantitation range
H - Holding times exceeded	I - Associated internal standard was outside method criteria
J - Analyte detected below quantitation limits	M - Manual Integration used to determine area response
ND - Not Detected at the Reporting Limit	R - RPD outside accepted recovery limits
S - Spike Recovery outside recovery limits	T - TIC(Tentatively identified compound)
X - Value exceeds Maximum Contaminant Level	

Case Narrative

http://www.teklabinc.com/

Client: Geosyntec Consultants
Work Order: 21030443
Client Project: GLP8020
Report Date: 08-Apr-21

Cooler Receipt Temp: 1.4 °C

Locations

Collinsville

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
Email jhriley@teklabinc.com

Springfield

Address 3920 Pintail Dr
Springfield, IL 62711-9415
Phone (217) 698-1004
Fax (217) 698-1005
Email KKlostermann@teklabinc.com

Kansas City

Address 8421 Nieman Road
Lenexa, KS 66214
Phone (913) 541-1998
Fax (913) 541-1998
Email jhriley@teklabinc.com

Collinsville Air

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
Email EHurley@teklabinc.com

Chicago

Address 1319 Butterfield Rd.
Downers Grove, IL 60515
Phone (630) 324-6855
Fax
Email arenner@teklabinc.com

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

State	Dept	Cert #	NELAP	Exp Date	Lab
Illinois	IEPA	100226	NELAP	1/31/2022	Collinsville
Kansas	KDHE	E-10374	NELAP	4/30/2021	Collinsville
Louisiana	LDEQ	05002	NELAP	6/30/2021	Collinsville
Louisiana	LDEQ	05003	NELAP	6/30/2021	Collinsville
Oklahoma	ODEQ	9978	NELAP	8/31/2021	Collinsville
Arkansas	ADEQ	88-0966		3/14/2022	Collinsville
Illinois	IDPH	17584		5/31/2021	Collinsville
Kentucky	UST	0073		1/31/2022	Collinsville
Missouri	MDNR	00930		5/31/2021	Collinsville
Missouri	MDNR	930		1/31/2022	Collinsville

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Lab ID: 21030443-001 **Client Sample ID:** MW-03R-20210304

Matrix: GROUNDWATER **Collection Date:** 03/04/2021 16:10

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**242**	mg/L	1	03/10/2021 11:24	R288336
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/10/2021 11:24	R288336
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**534**	mg/L	1	03/10/2021 17:22	R288381
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**98**	mg/L	5	03/08/2021 18:00	R288184
SW-846 9251 (TOTAL)								
Chloride	NELAP	20		**89**	mg/L	5	03/08/2021 18:01	R288218
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/11/2021 2:28	174514
Manganese	NELAP	0.0020		**0.0104**	mg/L	5	03/11/2021 16:52	174514
Molybdenum	NELAP	0.0015		**0.163**	mg/L	5	03/11/2021 2:28	174514
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**0.913**	mg/L	5	03/17/2021 15:31	174528
Calcium	NELAP	0.125	S	**94.9**	mg/L	5	03/27/2021 15:00	174528
Iron	NELAP	0.0250		**0.314**	mg/L	5	03/17/2021 15:31	174528
Lithium	*	0.0030		**0.0340**	mg/L	5	03/29/2021 17:55	174528
Magnesium	NELAP	0.0500		**25.0**	mg/L	5	03/17/2021 15:31	174528
Manganese	NELAP	0.0020		**0.341**	mg/L	5	03/27/2021 15:00	174528
Molybdenum	NELAP	0.0015		**0.184**	mg/L	5	03/17/2021 15:31	174528
Potassium	NELAP	0.175		**13.3**	mg/L	5	03/17/2021 15:31	174528
Sodium	NELAP	0.225	S	**56.7**	mg/L	5	04/06/2021 12:57	174528

Matrix spike control limits for Na are not applicable due to high sample/spike ratio.

Matrix spike control limits for Ca are not applicable due to high sample/spike ratio.

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Lab ID: 21030443-002 **Client Sample ID:** MW-18D-20210304

Matrix: GROUNDWATER **Collection Date:** 03/04/2021 14:55

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**267**	mg/L	1	03/10/2021 11:30	R288336
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/10/2021 11:30	R288336
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**556**	mg/L	1	03/10/2021 17:23	R288381
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**108**	mg/L	5	03/08/2021 18:08	R288184
SW-846 9251 (TOTAL)								
Chloride	NELAP	20		**79**	mg/L	5	03/08/2021 18:09	R288218
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/11/2021 2:36	174514
Manganese	NELAP	0.0020		**0.0730**	mg/L	5	03/11/2021 17:00	174514
Molybdenum	NELAP	0.0015		**0.0307**	mg/L	5	03/11/2021 2:36	174514
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**1.60**	mg/L	5	03/17/2021 15:39	174528
Calcium	NELAP	0.125		**99.4**	mg/L	5	03/27/2021 15:08	174528
Iron	NELAP	0.0250		**0.686**	mg/L	5	03/17/2021 15:39	174528
Lithium	*	0.0030		**0.0272**	mg/L	5	03/29/2021 18:04	174528
Magnesium	NELAP	0.0500		**29.2**	mg/L	5	03/17/2021 15:39	174528
Manganese	NELAP	0.0020		**0.0960**	mg/L	5	03/27/2021 15:08	174528
Molybdenum	NELAP	0.0015		**0.0330**	mg/L	5	03/17/2021 15:39	174528
Potassium	NELAP	0.175		**9.63**	mg/L	5	03/17/2021 15:39	174528
Sodium	NELAP	0.225		**56.3**	mg/L	5	04/06/2021 13:06	174528

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Lab ID: 21030443-003 **Client Sample ID:** MW-18S-20210304

Matrix: GROUNDWATER **Collection Date:** 03/04/2021 14:10

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**237**	mg/L	1	03/10/2021 11:36	R288336
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/10/2021 11:36	R288336
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**606**	mg/L	1	03/10/2021 17:23	R288381
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**166**	mg/L	5	03/08/2021 18:16	R288184
SW-846 9251 (TOTAL)								
Chloride	NELAP	20		**73**	mg/L	5	03/08/2021 18:17	R288218
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/11/2021 2:45	174514
Manganese	NELAP	0.0020		**0.0109**	mg/L	5	03/11/2021 17:08	174514
Molybdenum	NELAP	0.0015		**0.158**	mg/L	5	03/11/2021 2:45	174514
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**2.75**	mg/L	5	03/17/2021 15:48	174528
Calcium	NELAP	0.125		**103**	mg/L	5	03/27/2021 15:17	174528
Iron	NELAP	0.0250		**0.215**	mg/L	5	03/17/2021 15:48	174528
Lithium	*	0.0030		**0.0554**	mg/L	5	03/29/2021 18:13	174528
Magnesium	NELAP	0.0500		**24.8**	mg/L	5	03/17/2021 15:48	174528
Manganese	NELAP	0.0020		**0.0214**	mg/L	5	03/27/2021 15:17	174528
Molybdenum	NELAP	0.0015		**0.172**	mg/L	5	03/17/2021 15:48	174528
Potassium	NELAP	0.175		**12.2**	mg/L	5	03/17/2021 15:48	174528
Sodium	NELAP	0.225		**57.6**	mg/L	5	04/06/2021 13:14	174528

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Lab ID: 21030443-004 **Client Sample ID:** MW-22-20210304

Matrix: GROUNDWATER **Collection Date:** 03/04/2021 11:00

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**210**	mg/L	1	03/10/2021 11:43	R288336
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/10/2021 11:43	R288336
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**688**	mg/L	1	03/10/2021 17:24	R288381
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**205**	mg/L	5	03/08/2021 18:24	R288184
SW-846 9251 (TOTAL)								
Chloride	NELAP	20		**88**	mg/L	5	03/08/2021 18:25	R288218
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 2:54	174514
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/11/2021 2:54	174514
Manganese	NELAP	0.0020		**0.101**	mg/L	5	03/11/2021 17:17	174514
Molybdenum	NELAP	0.0015		**0.127**	mg/L	5	03/11/2021 2:54	174514
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0012**	mg/L	5	03/17/2021 15:57	174528
Boron	NELAP	0.0250		**5.10**	mg/L	5	03/17/2021 15:57	174528
Calcium	NELAP	0.125		**108**	mg/L	5	03/27/2021 15:26	174528
Iron	NELAP	0.0250		**0.0797**	mg/L	5	03/17/2021 15:57	174528
Lithium	*	0.0030		**0.0621**	mg/L	5	03/29/2021 18:21	174528
Magnesium	NELAP	0.0500		**30.4**	mg/L	5	03/17/2021 15:57	174528
Manganese	NELAP	0.0020		**0.126**	mg/L	5	03/27/2021 15:26	174528
Molybdenum	NELAP	0.0015		**0.137**	mg/L	5	03/17/2021 15:57	174528
Potassium	NELAP	0.175		**12.7**	mg/L	5	03/17/2021 15:57	174528
Sodium	NELAP	0.225		**61.1**	mg/L	5	04/06/2021 13:23	174528

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Lab ID: 21030443-005 **Client Sample ID:** MW-51-20210304

Matrix: GROUNDWATER **Collection Date:** 03/04/2021 15:20

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**347**	mg/L	1	03/10/2021 11:53	R288336
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/10/2021 11:53	R288336
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**630**	mg/L	1	03/10/2021 17:24	R288381
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**106**	mg/L	4	03/10/2021 17:15	R288338
SW-846 9251 (TOTAL)								
Chloride	NELAP	4		**100**	mg/L	4	03/10/2021 16:31	R288339
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0124**	mg/L	5	03/11/2021 4:30	174514
Iron	NELAP	0.0250		**4.39**	mg/L	5	03/11/2021 4:30	174514
Manganese	NELAP	0.0020		**0.117**	mg/L	5	03/11/2021 18:22	174514
Molybdenum	NELAP	0.0015		**0.0120**	mg/L	5	03/11/2021 4:30	174514
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0168**	mg/L	5	03/17/2021 16:05	174528
Boron	NELAP	0.0250		**2.32**	mg/L	5	03/17/2021 16:05	174528
Calcium	NELAP	0.125		**119**	mg/L	5	03/27/2021 15:35	174528
Iron	NELAP	0.0250		**9.08**	mg/L	5	03/17/2021 16:05	174528
Lithium	*	0.0030		**0.0244**	mg/L	5	03/29/2021 18:30	174528
Magnesium	NELAP	0.0500		**42.1**	mg/L	5	03/17/2021 16:05	174528
Manganese	NELAP	0.0020		**0.162**	mg/L	5	03/27/2021 15:35	174528
Molybdenum	NELAP	0.0015		**0.0130**	mg/L	5	03/17/2021 16:05	174528
Potassium	NELAP	0.175		**4.55**	mg/L	5	03/17/2021 16:05	174528
Sodium	NELAP	0.225		**59.2**	mg/L	5	04/06/2021 13:32	174528

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Lab ID: 21030443-006 **Client Sample ID:** MW-23-20210304

Matrix: GROUNDWATER **Collection Date:** 03/04/2021 13:25

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**164**	mg/L	1	03/10/2021 12:00	R288336
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/10/2021 12:00	R288336
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**880**	mg/L	1	03/10/2021 17:25	R288381
SW-846 9036 (TOTAL)								
Sulfate	NELAP	200		**404**	mg/L	20	03/10/2021 17:50	R288338
SW-846 9251 (TOTAL)								
Chloride	NELAP	20		**63**	mg/L	5	03/08/2021 19:15	R288218
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 4:38	174514
Iron	NELAP	0.0250		**0.0786**	mg/L	5	03/11/2021 4:38	174514
Manganese	NELAP	0.0020		**1.21**	mg/L	5	03/11/2021 18:30	174514
Molybdenum	NELAP	0.0015		**0.0140**	mg/L	5	03/11/2021 4:38	174514
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/17/2021 16:14	174528
Boron	NELAP	0.0250		**8.53**	mg/L	5	03/17/2021 16:14	174528
Calcium	NELAP	0.125		**109**	mg/L	5	03/27/2021 15:43	174528
Iron	NELAP	0.0250		**0.255**	mg/L	5	03/17/2021 16:14	174528
Lithium	*	0.0030		**0.0051**	mg/L	5	03/29/2021 18:39	174528
Magnesium	NELAP	0.0500		**76.3**	mg/L	5	03/17/2021 16:14	174528
Manganese	NELAP	0.0020		**1.08**	mg/L	5	03/27/2021 15:43	174528
Molybdenum	NELAP	0.0015		**0.0157**	mg/L	5	03/17/2021 16:14	174528
Potassium	NELAP	0.175		**2.92**	mg/L	5	03/17/2021 16:14	174528
Sodium	NELAP	0.225		**46.2**	mg/L	5	04/06/2021 13:40	174528

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Lab ID: 21030443-007 **Client Sample ID:** HEN-1-20210304

Matrix: AQUEOUS **Collection Date:** 03/04/2021 11:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**164**	mg/L	1	03/10/2021 12:05	R288336
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/10/2021 12:05	R288336
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**614**	mg/L	1	03/10/2021 17:25	R288381
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**57**	mg/L	5	03/08/2021 19:23	R288184
SW-846 9251 (TOTAL)								
Chloride	NELAP	20		**224**	mg/L	5	03/08/2021 19:23	R288218
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 5:05	174570
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/11/2021 5:05	174570
Manganese	NELAP	0.0020		**0.0217**	mg/L	5	03/15/2021 18:59	174514
Molybdenum	NELAP	0.0015		**0.0085**	mg/L	5	03/11/2021 5:05	174570
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0019**	mg/L	5	03/17/2021 18:25	174528
Boron	NELAP	0.0250		**0.0558**	mg/L	5	03/27/2021 17:45	174528
Calcium	NELAP	0.125		**63.2**	mg/L	5	03/27/2021 17:45	174528
Iron	NELAP	0.0250		**1.73**	mg/L	5	03/17/2021 18:25	174528
Lithium	*	0.0030		**0.0074**	mg/L	5	03/29/2021 18:47	174528
Magnesium	NELAP	0.0500		**24.7**	mg/L	5	03/17/2021 18:25	174528
Manganese	NELAP	0.0020		**0.0621**	mg/L	5	03/27/2021 17:45	174528
Molybdenum	NELAP	0.0015		**0.0035**	mg/L	5	03/17/2021 18:25	174528
Potassium	NELAP	0.175		**4.93**	mg/L	5	03/17/2021 18:25	174528
Sodium	NELAP	0.225		**127**	mg/L	5	04/06/2021 15:16	174528

Sample result for K exceeds 10 times the CCB. Data is reportable per the TNI Standard.

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Lab ID: 21030443-008 **Client Sample ID:** HEN-2-20210304

Matrix: AQUEOUS **Collection Date:** 03/04/2021 12:00

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**160**	mg/L	1	03/10/2021 12:36	R288336
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/10/2021 12:36	R288336
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**608**	mg/L	1	03/10/2021 17:26	R288381
SW-846 9036 (TOTAL)								
Sulfate	NELAP	10		**46**	mg/L	1	03/08/2021 19:42	R288184
SW-846 9251 (TOTAL)								
Chloride	NELAP	20		**222**	mg/L	5	03/08/2021 19:47	R288218
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/11/2021 5:13	174570
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/11/2021 5:13	174570
Manganese	NELAP	0.0020		**0.0174**	mg/L	5	03/11/2021 18:46	174514
Molybdenum	NELAP	0.0015		**0.0031**	mg/L	5	03/11/2021 5:13	174570
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0036**	mg/L	5	03/17/2021 18:34	174528
Boron	NELAP	0.0250		**0.0716**	mg/L	5	03/27/2021 17:54	174528
Calcium	NELAP	0.125		**72.3**	mg/L	5	03/27/2021 17:54	174528
Iron	NELAP	0.0250		**7.15**	mg/L	5	03/17/2021 18:34	174528
Lithium	*	0.0030		**0.0098**	mg/L	5	03/29/2021 18:56	174528
Magnesium	NELAP	0.0500		**27.2**	mg/L	5	03/17/2021 18:34	174528
Manganese	NELAP	0.0020		**0.201**	mg/L	5	03/27/2021 17:54	174528
Molybdenum	NELAP	0.0015		**0.0039**	mg/L	5	03/17/2021 18:34	174528
Potassium	NELAP	0.175		**6.19**	mg/L	5	03/17/2021 18:34	174528
Sodium	NELAP	0.225		**130**	mg/L	5	04/06/2021 15:25	174528

Sample result for K exceeds 10 times the CCB. Data is reportable per the TNI Standard.

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Lab ID: 21030443-009 **Client Sample ID:** EQB-20210304

Matrix: GROUNDWATER **Collection Date:** 03/04/2021 11:00

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/17/2021 18:43	174528
Boron	NELAP	0.0250		**0.0536**	mg/L	5	03/27/2021 18:03	174528
Calcium	NELAP	0.125		**0.143**	mg/L	5	03/27/2021 18:03	174528
Iron	NELAP	0.0250		**0.0329**	mg/L	5	03/17/2021 18:43	174528
Lithium	*	0.0030		**< 0.0030**	mg/L	5	03/29/2021 21:07	174528
Magnesium	NELAP	0.0500		**< 0.0500**	mg/L	5	03/17/2021 18:43	174528
Manganese	NELAP	0.0020		**0.0023**	mg/L	5	03/27/2021 18:03	174528
Molybdenum	NELAP	0.0015		**< 0.0015**	mg/L	5	03/17/2021 18:43	174528
Potassium	NELAP	0.175		**< 0.175**	mg/L	5	03/17/2021 18:43	174528
Sodium	NELAP	0.225		**< 0.225**	mg/L	5	04/06/2021 15:34	174528

Contamination present in the CCB for K. Sample results below the reporting limit are reportable per the TNI Standard.

Client: Geosyntec Consultants
Client Project: GLP8020

Work Order: 21030443
Report Date: 08-Apr-21

Lab Sample ID	Client Sample ID	Matrix	Fractions	Collection Date
21030443-001	MW-03R-20210304	Groundwater	4	03/04/2021 16:10
21030443-002	MW-18D-20210304	Groundwater	4	03/04/2021 14:55
21030443-003	MW-18S-20210304	Groundwater	4	03/04/2021 14:10
21030443-004	MW-22-20210304	Groundwater	4	03/04/2021 11:00
21030443-005	MW-51-20210304	Groundwater	4	03/04/2021 15:20
21030443-006	MW-23-20210304	Groundwater	4	03/04/2021 13:25
21030443-007	HEN-1-20210304	Aqueous	1	03/04/2021 11:30
21030443-007	HEN-1-20210304	Groundwater	3	03/04/2021 11:30
21030443-008	HEN-2-20210304	Aqueous	1	03/04/2021 12:00
21030443-008	HEN-2-20210304	Groundwater	3	03/04/2021 12:00
21030443-009	EQB-20210304	Groundwater	1	03/04/2021 11:00

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			Prep Date/Time	Analysis Date/Time
21030443-001A	MW-03R-20210304	03/04/2021 16:10	03/05/2021 13:55		
	Standard Methods 2320 B (Total) 1997				03/10/2021 11:24
	Standard Methods 2320 B 1997				03/10/2021 11:24
	Standard Methods 2540 C (Total) 1997				03/10/2021 17:22
21030443-001B	MW-03R-20210304	03/04/2021 16:10	03/05/2021 13:55		
	SW-846 9036 (Total)				03/08/2021 18:00
	SW-846 9251 (Total)				03/08/2021 18:01
21030443-001C	MW-03R-20210304	03/04/2021 16:10	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/17/2021 15:31
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/27/2021 15:00
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/29/2021 17:55
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	04/06/2021 12:57
21030443-001D	MW-03R-20210304	03/04/2021 16:10	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 2:28
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 16:52
21030443-002A	MW-18D-20210304	03/04/2021 14:55	03/05/2021 13:55		
	Standard Methods 2320 B (Total) 1997				03/10/2021 11:30
	Standard Methods 2320 B 1997				03/10/2021 11:30
	Standard Methods 2540 C (Total) 1997				03/10/2021 17:23
21030443-002B	MW-18D-20210304	03/04/2021 14:55	03/05/2021 13:55		
	SW-846 9036 (Total)				03/08/2021 18:08
	SW-846 9251 (Total)				03/08/2021 18:09
21030443-002C	MW-18D-20210304	03/04/2021 14:55	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/17/2021 15:39
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/27/2021 15:08
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/29/2021 18:04
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	04/06/2021 13:06
21030443-002D	MW-18D-20210304	03/04/2021 14:55	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 2:36
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 17:00
21030443-003A	MW-18S-20210304	03/04/2021 14:10	03/05/2021 13:55		
	Standard Methods 2320 B (Total) 1997				03/10/2021 11:36
	Standard Methods 2320 B 1997				03/10/2021 11:36
	Standard Methods 2540 C (Total) 1997				03/10/2021 17:23
21030443-003B	MW-18S-20210304	03/04/2021 14:10	03/05/2021 13:55		
	SW-846 9036 (Total)				03/08/2021 18:16

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
	SW-846 9251 (Total)				03/08/2021 18:17
21030443-003C	MW-18S-20210304	03/04/2021 14:10	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/17/2021 15:48
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/27/2021 15:17
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/29/2021 18:13
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	04/06/2021 13:14
21030443-003D	MW-18S-20210304	03/04/2021 14:10	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 2:45
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 17:08
21030443-004A	MW-22-20210304	03/04/2021 11:00	03/05/2021 13:55		
	Standard Methods 2320 B (Total) 1997				03/10/2021 11:43
	Standard Methods 2320 B 1997				03/10/2021 11:43
	Standard Methods 2540 C (Total) 1997				03/10/2021 17:24
21030443-004B	MW-22-20210304	03/04/2021 11:00	03/05/2021 13:55		
	SW-846 9036 (Total)				03/08/2021 18:24
	SW-846 9251 (Total)				03/08/2021 18:25
21030443-004C	MW-22-20210304	03/04/2021 11:00	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/17/2021 15:57
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/27/2021 15:26
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/29/2021 18:21
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	04/06/2021 13:23
21030443-004D	MW-22-20210304	03/04/2021 11:00	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 2:54
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 17:17
21030443-005A	MW-51-20210304	03/04/2021 15:20	03/05/2021 13:55		
	Standard Methods 2320 B (Total) 1997				03/10/2021 11:53
	Standard Methods 2320 B 1997				03/10/2021 11:53
	Standard Methods 2540 C (Total) 1997				03/10/2021 17:24
21030443-005B	MW-51-20210304	03/04/2021 15:20	03/05/2021 13:55		
	SW-846 9036 (Total)				03/10/2021 17:15
	SW-846 9251 (Total)				03/10/2021 16:31
21030443-005C	MW-51-20210304	03/04/2021 15:20	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/17/2021 16:05
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/27/2021 15:35
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/29/2021 18:30
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	04/06/2021 13:32

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			Prep Date/Time	Analysis Date/Time
21030443-005D	MW-51-20210304	03/04/2021 15:20	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 4:30
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 18:22
21030443-006A	MW-23-20210304	03/04/2021 13:25	03/05/2021 13:55		
	Standard Methods 2320 B (Total) 1997				03/10/2021 12:00
	Standard Methods 2320 B 1997				03/10/2021 12:00
	Standard Methods 2540 C (Total) 1997				03/10/2021 17:25
21030443-006B	MW-23-20210304	03/04/2021 13:25	03/05/2021 13:55		
	SW-846 9036 (Total)				03/10/2021 17:50
	SW-846 9251 (Total)				03/08/2021 19:15
21030443-006C	MW-23-20210304	03/04/2021 13:25	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/17/2021 16:14
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/27/2021 15:43
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/29/2021 18:39
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	04/06/2021 13:40
21030443-006D	MW-23-20210304	03/04/2021 13:25	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 4:38
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 18:30
21030443-007A	HEN-1-20210304	03/04/2021 11:30	03/05/2021 13:55		
	Standard Methods 2320 B (Total) 1997				03/10/2021 12:05
	Standard Methods 2320 B 1997				03/10/2021 12:05
	Standard Methods 2540 C (Total) 1997				03/10/2021 17:25
21030443-007B	HEN-1-20210304	03/04/2021 11:30	03/05/2021 13:55		
	SW-846 9036 (Total)				03/08/2021 19:23
	SW-846 9251 (Total)				03/08/2021 19:23
21030443-007C	HEN-1-20210304	03/04/2021 11:30	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/17/2021 18:25
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/27/2021 17:45
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/29/2021 18:47
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	04/06/2021 15:16
21030443-007D	HEN-1-20210304	03/04/2021 11:30	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/08/2021 19:39	03/11/2021 5:05
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/15/2021 18:59
21030443-008A	HEN-2-20210304	03/04/2021 12:00	03/05/2021 13:55		
	Standard Methods 2320 B (Total) 1997				03/10/2021 12:36
	Standard Methods 2320 B 1997				03/10/2021 12:36

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
	Standard Methods 2540 C (Total) 1997				03/10/2021 17:26
21030443-008B	HEN-2-20210304	03/04/2021 12:00	03/05/2021 13:55		
	SW-846 9036 (Total)				03/08/2021 19:42
	SW-846 9251 (Total)				03/08/2021 19:47
21030443-008C	HEN-2-20210304	03/04/2021 12:00	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/17/2021 18:34
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/27/2021 17:54
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/29/2021 18:56
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	04/06/2021 15:25
21030443-008D	HEN-2-20210304	03/04/2021 12:00	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/08/2021 19:39	03/11/2021 5:13
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/05/2021 17:52	03/11/2021 18:46
21030443-009A	EQB-20210304	03/04/2021 11:00	03/05/2021 13:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/17/2021 18:43
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/27/2021 18:03
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	03/29/2021 21:07
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/08/2021 9:09	04/06/2021 15:34

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

STANDARD METHODS 2540 C (TOTAL) 1997

Batch R288381 **SampType:** MBLK Units **mg/L**
SampID: MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/10/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/10/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/11/2021

Batch R288381 **SampType:** LCS Units **mg/L**
SampID: LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**946**	1000	0	94.6	90	110	03/10/2021
Total Dissolved Solids		20		**962**	1000	0	96.2	90	110	03/11/2021
Total Dissolved Solids		20		**942**	1000	0	94.2	90	110	03/10/2021

Batch R288381 **SampType:** DUP Units **mg/L** RPD Limit **5**
SampID: 21030443-004ADUP

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Total Dissolved Solids		20		**684**				688.0	0.58	03/10/2021

SW-846 9036 (TOTAL)

Batch R288184 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	03/08/2021

Batch R288184 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**19**	20.00	0	97.0	90	110	03/08/2021

Batch R288338 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	03/10/2021

Batch R288338 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**21**	20.00	0	103.2	90	110	03/10/2021

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

SW-846 9036 (TOTAL)

Batch R288338 **SampType:** MS Units **mg/L**

SampID: 21030443-005BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		40		**182**	80.00	106.0	95.4	85	115	03/10/2021

Batch R288338 **SampType:** MSD Units **mg/L** RPD Limit **10**

SampID: 21030443-005BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Sulfate		40		**176**	80.00	106.0	87.5	182.3	3.53	03/10/2021

SW-846 9251 (TOTAL)

Batch R288218 **SampType:** MBLK Units **mg/L**

SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		4		**< 4**	0.5000	0	0	-100	100	03/08/2021

Batch R288218 **SampType:** LCS Units **mg/L**

SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		4		**20**	20.00	0	101.8	90	110	03/08/2021

Batch R288339 **SampType:** MBLK Units **mg/L**

SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	03/10/2021

Batch R288339 **SampType:** LCS Units **mg/L**

SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**21**	20.00	0	103.5	90	110	03/10/2021

Batch R288339 **SampType:** MS Units **mg/L**

SampID: 21030443-005BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		4		**168**	80.00	99.69	85.8	85	115	03/10/2021

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

SW-846 9251 (TOTAL)

Batch R288339 **SampType:** MSD Units **mg/L** RPD Limit **15**

SampID: 21030443-005BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Chloride		4		**168**	80.00	99.69	85.5	168.3	0.15	03/10/2021

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 174514 **SampType:** MBLK Units **mg/L**

SampID: MBLK-174514

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	03/11/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	03/11/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	03/11/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	03/11/2021

Batch 174514 **SampType:** LCS Units **mg/L**

SampID: LCS-174514

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.502**	0.5000	0	100.3	80	120	03/11/2021
Iron		0.0250		**1.87**	2.000	0	93.7	80	120	03/11/2021
Manganese		0.0020		**0.477**	0.5000	0	95.3	80	120	03/15/2021
Molybdenum		0.0015		**0.484**	0.5000	0	96.8	80	120	03/11/2021

Batch 174514 **SampType:** MS Units **mg/L**

SampID: 21030443-001DMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Iron		0.0250		**1.82**	2.000	0	91.0	75	125	03/11/2021
Manganese		0.0020		**0.538**	0.5000	0.01039	105.6	75	125	03/11/2021
Molybdenum		0.0015		**0.629**	0.5000	0.1634	93.1	75	125	03/11/2021

Batch 174514 **SampType:** MSD Units **mg/L** RPD Limit **20**

SampID: 21030443-001DMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Iron		0.0250		**1.82**	2.000	0	91.2	1.821	0.14	03/11/2021
Manganese		0.0020		**0.551**	0.5000	0.01039	108.2	0.5384	2.35	03/11/2021
Molybdenum		0.0015		**0.642**	0.5000	0.1634	95.8	0.6288	2.13	03/11/2021

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 174514 **SampType:** MS Units **mg/L**

SampID: 21030443-007DMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Manganese		0.0020		**0.503**	0.5000	0.02166	96.3	75	125	03/15/2021

Batch 174514 **SampType:** MSD Units **mg/L** RPD Limit **20**

SampID: 21030443-007DMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Manganese		0.0020		**0.495**	0.5000	0.02166	94.8	0.5032	1.56	03/15/2021

Batch 174570 **SampType:** MBLK Units **mg/L**

SampID: MBLK-174570

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	03/11/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	03/11/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	03/11/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	03/11/2021

Batch 174570 **SampType:** LCS Units **mg/L**

SampID: LCS-174570

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.499**	0.5000	0	99.7	80	120	03/11/2021
Iron		0.0250		**1.84**	2.000	0	91.8	80	120	03/11/2021
Manganese		0.0020		**0.502**	0.5000	0	100.4	80	120	03/15/2021
Molybdenum		0.0015		**0.475**	0.5000	0	95.1	80	120	03/11/2021

Batch 174570 **SampType:** MS Units **mg/L**

SampID: 21030443-007DMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.490**	0.5000	0.0009309	97.9	75	125	03/11/2021
Iron		0.0250		**1.81**	2.000	0.01196	90.1	75	125	03/11/2021
Molybdenum		0.0015		**0.470**	0.5000	0.008459	92.3	75	125	03/11/2021

Batch 174570 **SampType:** MSD Units **mg/L** RPD Limit **20**

SampID: 21030443-007DMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Arsenic		0.0010		**0.493**	0.5000	0.0009309	98.4	0.4902	0.55	03/11/2021
Iron		0.0250		**1.82**	2.000	0.01196	90.6	1.813	0.58	03/11/2021
Molybdenum		0.0015		**0.479**	0.5000	0.008459	94.2	0.4702	1.92	03/11/2021

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 174528 **SampType:** MBLK Units **mg/L**

SampID: MBLK-174528

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	03/16/2021
Boron		0.0250		**< 0.0250**	0.0093	0	0	-100	100	03/16/2021
Calcium		0.125		**< 0.125**	0.0700	0	0	-100	100	03/27/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	03/16/2021
Lithium	*	0.0030		**< 0.0030**	0.0015	0	0	-100	100	03/16/2021
Magnesium		0.0500		**< 0.0500**	0.0175	0	0	-100	100	03/16/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	03/22/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	03/27/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	03/16/2021
Potassium		0.175		**< 0.175**	0.0800	0	0	-100	100	03/16/2021
Sodium		0.225		**< 0.225**	0.0750	0	0	-100	100	04/06/2021

Batch 174528 **SampType:** LCS Units **mg/L**

SampID: LCS-174528

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.534**	0.5000	0	106.8	80	120	03/16/2021
Boron		0.0250		**0.523**	0.5000	0	104.6	80	120	03/16/2021
Calcium		0.125		**2.49**	2.500	0	99.6	80	120	03/27/2021
Iron		0.0250		**1.91**	2.000	0	95.3	80	120	03/16/2021
Lithium	*	0.0030		**0.540**	0.5000	0	108.0	80	120	03/16/2021
Magnesium		0.0500		**2.52**	2.500	0	100.9	80	120	03/16/2021
Manganese		0.0020		**0.506**	0.5000	0	101.2	80	120	03/27/2021
Molybdenum		0.0015		**0.501**	0.5000	0	100.2	80	120	03/16/2021
Potassium		0.175		**2.63**	2.500	0	105.2	80	120	03/16/2021
Sodium		0.225		**2.60**	2.500	0	104.0	80	120	04/06/2021

Client: Geosyntec Consultants **Work Order:** 21030443

Client Project: GLP8020 **Report Date:** 08-Apr-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 174528 **SampType:** MS Units **mg/L**

SampID: 21030443-001CMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Boron		0.0250		**1.48**	0.5000	0.9133	113.8	75	125	03/17/2021
Calcium		0.125	S	**95.5**	2.500	94.90	22.3	75	125	03/27/2021
Iron		0.0250		**2.23**	2.000	0.3139	96.0	75	125	03/17/2021
Lithium	*	0.0030		**0.531**	0.5000	0.03402	99.5	75	125	03/29/2021
Magnesium		0.0500		**27.5**	2.500	24.96	102.1	75	125	03/17/2021
Manganese		0.0020		**0.841**	0.5000	0.3412	99.9	75	125	03/27/2021
Molybdenum		0.0015		**0.699**	0.5000	0.1836	103.1	75	125	03/17/2021
Potassium		0.175		**15.5**	2.500	13.29	86.9	75	125	03/17/2021
Sodium		0.225	S	**60.5**	2.500	56.68	152.1	75	125	04/06/2021

Batch 174528 **SampType:** MSD Units **mg/L** RPD Limit **20**

SampID: 21030443-001CMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Boron		0.0250		**1.49**	0.5000	0.9133	115.9	1.482	0.71	03/17/2021
Calcium		0.125	S	**95.2**	2.500	94.90	10.4	95.45	0.31	03/27/2021
Iron		0.0250		**2.23**	2.000	0.3139	95.8	2.234	0.23	03/17/2021
Lithium	*	0.0030		**0.547**	0.5000	0.03402	102.7	0.5315	2.95	03/29/2021
Magnesium		0.0500		**28.0**	2.500	24.96	121.0	27.51	1.70	03/17/2021
Manganese		0.0020		**0.853**	0.5000	0.3412	102.4	0.8407	1.48	03/27/2021
Molybdenum		0.0015		**0.711**	0.5000	0.1836	105.4	0.6994	1.59	03/17/2021
Potassium		0.175		**15.5**	2.500	13.29	90.3	15.46	0.54	03/17/2021
Sodium		0.225		**59.8**	2.500	56.68	124.6	60.48	1.14	04/06/2021

Receiving Check List

http://www.teklabinc.com/

Client: Geosyntec Consultants
Client Project: GLP8020

Work Order: 21030443
Report Date: 08-Apr-21

Carrier: Jacob Wilson

Completed by: Amanda R. Ham
On: 05-Mar-21

Received By: AH

Reviewed by: Marvin L. Darling
On: 05-Mar-21

Pages to follow: Chain of custody 1 Extra pages included 1

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	Temp °C 1.4
Type of thermal preservation?	None ☐	Ice ☑	Blue Ice ☐	Dry Ice ☐
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		
Reported field parameters measured:	Field ☐	Lab ☐	NA ☑	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐		

When thermal preservation is required, samples are compliant with a temperature between 0.1°C - 6.0°C, or when samples are received on ice the same day as collected.

Water – at least one vial per sample has zero headspace?	Yes ☐	No ☐	No VOA vials ☑
Water - TOX containers have zero headspace?	Yes ☐	No ☐	No TOX containers ☑
Water - pH acceptable upon receipt?	Yes ☑	No ☐	NA ☐
NPDES/CWA TCN interferences checked/treated in the field?	Yes ☐	No ☐	NA ☑

Any No responses must be detailed below or on the COC.

pH strip #74534. - aham - 3/5/2021 5:00:10 PM

CHAIN OF CUSTODY

pg. 1 of 1 Work order # 21030443

TEKLAB, INC. 5445 Horseshoe Lake Road - Collinsville, IL 62234 - Phone: (618) 344-1004 - Fax: (618) 344-1005

Client:	Geosyntec Consultants
Address:	1 McBride and Son Center Drive, Suite 202
City / State / Zip	Chesterfield, MO 63005
Contact:	Allison Kreinberg
Phone:	(636) 812-0809
E-Mail:	AKreinberg@Geosyntec.com
Fax:	

Samples on: [X] ICE [ ] BLUE ICE [ ] NO ICE 1.4 °C LTG# 1

Preserved in: [ ] LAB [X] FIELD AH 3/5/21 74534

FOR LAB USE ONLY

Lab Notes

Client Comments: Courier

*Client to specify metals prior to analysis
**Client to specify metals prior to analysis

Samples will be field-filtered

Are these samples known to be involved in litigation? If yes, a surcharge will apply [ ] Yes [X] No

Are these samples known to be hazardous? [ ] Yes [X] No

Are there any required reporting limits to be met on the requested analysis?. If yes, please provide limits in the comment section. [ ] Yes [X] No

Project Name/Number: GLP8020

Sample Collector's Name: Amanda Toye

Results Requested: [ ] Standard [ ] 1-2 Day (100% Surcharge) [ ] Other ____ [ ] 3 Day (50% Surcharge)

Billing Instructions:

Lab Use Only	Sample Identification	Date/Time Sampled	# and Type of Containers: UNPRES	HNO3	NaOH	H2SO4	HCL	MeOH	NaHSO4	OTHER	MATRIX: Aqueous	Drinking Water	Soil	Sludge	Special Waste	Groundwater	INDICATE ANALYSIS REQUESTED: Alkalinity	Chloride	Metals (Dissolved)**	Metals (Total)*	Sulfate	TDS
21030443-01	MW-03R-20210304	3-4-21 1610	1	3												X	X	X	X	X	X	X
002	MW-18D-20210304	3-4-21 1455	1	3												X	X	X	X	X	X	X
003	MW-18S-20210304	3-4-21 1410	1	3												X	X	X	X	X	X	X
004	MW-22-20210304	3-4-21 1100	1	3												X	X	X	X	X	X	X
005	MW-51-20210304	3-4-21 1520	1	3												X	X	X	X	X	X	X
006	MW-23-20210304	3-4-21 1825	1	3												X	X	X	X	X	X	X
007	HEN-1-20210304	3-4-21 1130	1	3							X						X	X	X	X	X	X
008	HEN-2-20210304	3-4-21 1200	1	3							X						X	X	X	X	X	X
009	EQB-20210304	3-4-21 1100		1							X									X		

Relinquished By	Date/Time	Received By	Date/Time
Crystal Luttrell	3/5/21 - 12:58PM		3/5/21 1258
	3/5/21 1353		3/5/21 1355

The individual signing this agreement on behalf of the client, acknowledges that he/she has read and understands the terms and conditions of this agreement, and that he/she has the authority to sign on behalf of the client. See www.teklabinc.com for terms and conditions.

BottleOrder: 64128

AH 21-1

Marvin L. Darling

From: Allison Kreinberg <AKreinberg@Geosyntec.com>
Sent: Friday, March 05, 2021 9:17 AM
To: Amanda Toye
Subject: Hennepin GW Sampling

West side: 22, 23, 24, surface water

Vistra - Hennepin WAPS MNA Evaluation

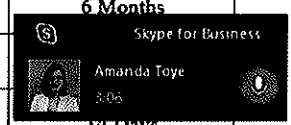
Analyte	Analytical Method	Container	Preservative	Hold Time
Na, Mg, K, Ca	USEPA Method 6020A	250-mL HDPE	HNO_3	6 Months
Boron				
Arsenic, Molybdenum, Lithium				
Total Fe and Mn				
Dissolved Fe, Mn, As, Mo	USEPA Method 6020A	250-mL HDPE	0.45 µm Field Filter HNO_3	6 Months
Cl, Sulfate	SW846 9056A	250-mL HDPE	N/A	6 Months
Bicarbonate and CarbonateAlkalinity	USEPA Method 2320B	250-mL HDPE	N/A	14 Days
Total Dissolved Solids	SW846 2540C	1-L HDPE	N/A	7 Days

Notes-
All samples will be submitted to an accredited contract laboratory for analyses

East side: 03R, 18S, 18D

Table 1 - Aqueous Samples Analytical Plan *Geosyntec Consultants, Inc*
Vistra - Hennepin Ash Pond No. 2 MNA Evaluation

Analyte	Analytical Method	Container	Preservative	Holil Time
Na, Mg, K, Ca	USEPA Method 6020A	250-mL HDPE	HNO_3	6 Months
Boron				
Molybdenum, Lithium				
Total Fe and Mn				
Dissolved Fe, Mn, Mo	USEPA Method 6020A	250-mL HDPE	0.45 µm Field Filter HNO_3	6 Months
Cl, Sulfate	SW846 9056A	250-mL HDPE	N/A	
Bicarbonate and Carbonate Alkalinity	USEPA Method 2320B	250-mL HDPE	N/A	14 Days
Total Dissolved Solids	SW846 2540C	1-L HDPE	N/A	7 Days



Notes-
All samples will be submitted to an accredited contract laboratory for analyses

April 07, 2021

Allison Kreinberg
Geosyntec Consultants
1 McBride and Son Center Drive, Suite 202
Chesterfield, MO 63005
TEL: (614) 468-0421
FAX:

Illinois	100226
Kansas	E-10374
Louisiana	05002
Louisiana	05003
Oklahoma	9978

RE: GLP8006\7 **WorkOrder:** 21030724

Dear Allison Kreinberg:

TEKLAB, INC received 9 samples on 3/10/2021 2:55:00 PM for the analysis presented in the following report.

Samples are analyzed on an as received basis unless otherwise requested and documented. The sample results contained in this report relate only to the requested analytes of interest as directed on the chain of custody. NELAP accredited fields of testing are indicated by the letters NELAP under the Certification column. Unless otherwise documented within this report, Teklab Inc. analyzes samples utilizing the most current methods in compliance with 40CFR. All tests are performed in the Collinsville, IL laboratory unless otherwise noted in the Case Narrative.

All quality control criteria applicable to the test methods employed for this project have been satisfactorily met and are in accordance with NELAP except where noted. The following report shall not be reproduced, except in full, without the written approval of Teklab, Inc.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Aaron Renner
Project Manager
(630)324-6855
arenner@teklabinc.com

Report Contents

Client: Geosyntec Consultants
Work Order: 21030724
Client Project: GLP8006\7
Report Date: 07-Apr-21

This reporting package includes the following:

Cover Letter	1
Report Contents	2
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Case Narrative	5
Accreditations	6
Laboratory Results	7
Sample Summary	16
Dates Report	17
Quality Control Results	21
Receiving Check List	26
Chain of Custody	Appended

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Abbr	Definition
*	Analytes on report marked with an asterisk are not NELAP accredited
CCV	Continuing calibration verification is a check of a standard to determine the state of calibration of an instrument between recalibration.
CRQL	A Client Requested Quantitation Limit is a reporting limit that varies according to customer request. The CRQL may not be less than the MDL.
DF	Dilution factor is the dilution performed during analysis only and does not take into account any dilutions made during sample preparation. The reported result is final and includes all dilution factors.
DNI	Did not ignite
DUP	Laboratory duplicate is a replicate aliquot prepared under the same laboratory conditions and independently analyzed to obtain a measure of precision.
ICV	Initial calibration verification is a check of a standard to determine the state of calibration of an instrument before sample analysis is initiated.
IDPH	IL Dept. of Public Health
LCS	Laboratory control sample is a sample matrix, free from the analytes of interest,spiked with verified known amounts of analytes and analyzed exactly like a sample to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.
LCSD	Laboratory control sample duplicate is a replicate laboratory control sample that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MBLK	Method blank is a sample of a matrix similar to the batch of associated sample (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences should present at concentrations that impact the analytical results for sample analyses.
MDL	"The method detection limit is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results."
MS	Matrix spike is an aliquot of matrix fortified (spiked) with known quantities of specific analytes that is subjected to the entire analytical procedures in order to determine the effect of the matrix on an approved test method's recovery system. The acceptable recovery range is listed in the QC Package (provided upon request).
MSD	Matrix spike duplicate means a replicate matrix spike that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MW	Molecular weight
NC	Data is not acceptable for compliance purposes
ND	Not Detected at the Reporting Limit
NELAP	NELAP Accredited
PQL	Practical quantitation limit means the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.
RL	The reporting limit the lowest level that the data is displayed in the final report. The reporting limit may vary according to customer request or sample dilution. The reporting limit may not be less than the MDL.
RPD	Relative percent difference is a calculated difference between two recoveries (ie. MS/MSD). The acceptable recovery limit is listed in the QC Package (provided upon request).
SPK	The spike is a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery deficiency or for other quality control purposes.
Surr	Surrogates are compounds which are similar to the analytes of interest in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.
TIC	Tentatively identified compound: Analytes tentatively identified in the sample by using a library search. Only results not in the calibration standard will be reported as tentatively identified compounds. Results for tentatively identified compounds that are not present in the calibration standard, but are assigned a specific chemical name based upon the library search, are calculated using total peak areas from reconstructed ion chromatograms and a response factor of one. The nearest Internal Standard is used for the calculation. The results of any TICs must be considered estimated, and are flagged with a "T". If the estimated result is above the calibration range it is flagged "ET"
TNTC	Too numerous to count (> 200 CFU)

Definitions

Client: Geosyntec Consultants
Work Order: 21030724
Client Project: GLP8006\7
Report Date: 07-Apr-21

Qualifiers

- Unknown hydrocarbon
B - Analyte detected in associated Method Blank
C - RL shown is a Client Requested Quantitation Limit
E - Value above quantitation range
H - Holding times exceeded
I - Associated internal standard was outside method criteria
J - Analyte detected below quantitation limits
M - Manual Integration used to determine area response
ND - Not Detected at the Reporting Limit
R - RPD outside accepted recovery limits
S - Spike Recovery outside recovery limits
T - TIC(Tentatively identified compound)
X - Value exceeds Maximum Contaminant Level

Case Narrative

http://www.teklabinc.com/

Client: Geosyntec Consultants
Client Project: GLP8006\7

Work Order: 21030724
Report Date: 07-Apr-21

Cooler Receipt Temp: 0.4 °C

Locations

Collinsville

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
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Springfield

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Address 1319 Butterfield Rd.
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Phone (630) 324-6855
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Email arenner@teklabinc.com

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

State	Dept	Cert #	NELAP	Exp Date	Lab
Illinois	IEPA	100226	NELAP	1/31/2022	Collinsville
Kansas	KDHE	E-10374	NELAP	4/30/2021	Collinsville
Louisiana	LDEQ	05002	NELAP	6/30/2021	Collinsville
Louisiana	LDEQ	05003	NELAP	6/30/2021	Collinsville
Oklahoma	ODEQ	9978	NELAP	8/31/2021	Collinsville
Arkansas	ADEQ	88-0966		3/14/2022	Collinsville
Illinois	IDPH	17584		5/31/2021	Collinsville
Kentucky	UST	0073		1/31/2022	Collinsville
Missouri	MDNR	00930		5/31/2021	Collinsville
Missouri	MDNR	930		1/31/2022	Collinsville

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Lab ID: 21030724-001 **Client Sample ID:** HEN-E-20210309

Matrix: AQUEOUS **Collection Date:** 03/09/2021 10:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**199**	mg/L	1	03/15/2021 10:44	R288483
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/15/2021 10:44	R288483
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**562**	mg/L	1	03/15/2021 15:58	R288554
SW-846 9036 (TOTAL)								
Sulfate	NELAP	20		**55**	mg/L	2	03/15/2021 14:25	R288474
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**190**	mg/L	5	03/15/2021 14:31	R288525
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/13/2021 8:12	174737
Manganese	NELAP	0.0020		**0.0257**	mg/L	5	03/13/2021 8:12	174737
Molybdenum	NELAP	0.0015		**0.0038**	mg/L	5	03/13/2021 8:12	174737
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**0.114**	mg/L	5	03/27/2021 20:31	174753
Calcium	NELAP	0.125	S	**75.8**	mg/L	5	03/27/2021 20:31	174753
Iron	NELAP	0.0250		**0.675**	mg/L	5	03/27/2021 20:31	174753
Lithium	*	0.0030		**0.0068**	mg/L	5	03/30/2021 13:39	174753
Magnesium	NELAP	0.0500	S	**32.5**	mg/L	5	04/01/2021 15:59	174753
Manganese	NELAP	0.0020		**0.0530**	mg/L	5	03/27/2021 20:31	174753
Molybdenum	NELAP	0.0015		**0.0074**	mg/L	5	03/27/2021 20:31	174753
Potassium	NELAP	0.175		**4.27**	mg/L	5	04/01/2021 15:59	174753
Sodium	NELAP	0.225	S	**108**	mg/L	5	04/05/2021 14:11	174753

Matrix spike control limits for Na are not applicable due to high sample/spike ratio.

Matrix spike control limits for Mg are not applicable due to high sample/spike ratio.

Matrix spike control limits for Ca are not applicable due to high sample/spike ratio.

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Lab ID: 21030724-002 **Client Sample ID:** HEN-W-20210309

Matrix: AQUEOUS **Collection Date:** 03/09/2021 16:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**196**	mg/L	1	03/15/2021 10:51	R288483
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/15/2021 10:51	R288483
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**562**	mg/L	1	03/15/2021 15:58	R288554
SW-846 9036 (TOTAL)								
Sulfate	NELAP	20		**49**	mg/L	2	03/15/2021 14:33	R288474
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**181**	mg/L	5	03/15/2021 14:39	R288525
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/17/2021 3:49	174737
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/13/2021 8:21	174737
Manganese	NELAP	0.0020		**0.0282**	mg/L	5	03/13/2021 8:21	174737
Molybdenum	NELAP	0.0015		**0.0031**	mg/L	5	03/13/2021 8:21	174737
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0014**	mg/L	5	03/27/2021 20:40	174753
Boron	NELAP	0.0250		**0.0714**	mg/L	5	03/27/2021 20:40	174753
Calcium	NELAP	0.125		**75.3**	mg/L	5	03/27/2021 20:40	174753
Iron	NELAP	0.0250		**1.22**	mg/L	5	03/19/2021 8:50	174753
Lithium	*	0.0030		**0.0059**	mg/L	5	03/30/2021 14:31	174753
Magnesium	NELAP	0.0500		**33.5**	mg/L	5	04/01/2021 17:09	174753
Manganese	NELAP	0.0020		**0.0664**	mg/L	5	03/27/2021 20:40	174753
Molybdenum	NELAP	0.0015		**0.0034**	mg/L	5	03/19/2021 8:50	174753
Potassium	NELAP	0.175		**3.98**	mg/L	5	04/01/2021 17:09	174753
Sodium	NELAP	0.225		**109**	mg/L	5	04/05/2021 14:20	174753

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Lab ID: 21030724-003 **Client Sample ID:** MW-22-20210309

Matrix: AQUEOUS **Collection Date:** 03/09/2021 14:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**327**	mg/L	1	03/15/2021 10:58	R288483
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/15/2021 10:58	R288483
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**646**	mg/L	1	03/15/2021 15:58	R288554
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**112**	mg/L	5	03/15/2021 14:41	R288474
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**97**	mg/L	5	03/15/2021 14:41	R288525
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0012**	mg/L	5	03/17/2021 3:58	174737
Iron	NELAP	0.0250		**2.21**	mg/L	5	03/13/2021 8:29	174737
Manganese	NELAP	0.0020		**0.0726**	mg/L	5	03/13/2021 8:29	174737
Molybdenum	NELAP	0.0015		**0.0062**	mg/L	5	03/13/2021 8:29	174737
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0013**	mg/L	5	03/27/2021 20:48	174753
Boron	NELAP	0.0250		**1.86**	mg/L	5	03/27/2021 20:48	174753
Calcium	NELAP	0.125		**122**	mg/L	5	03/27/2021 20:48	174753
Iron	NELAP	0.0250		**2.47**	mg/L	5	03/19/2021 8:59	174753
Lithium	*	0.0030		**0.0142**	mg/L	5	03/30/2021 14:40	174753
Magnesium	NELAP	0.0500		**51.2**	mg/L	5	04/01/2021 17:18	174753
Manganese	NELAP	0.0020		**0.0793**	mg/L	5	03/27/2021 20:48	174753
Molybdenum	NELAP	0.0015		**0.0066**	mg/L	5	03/19/2021 8:59	174753
Potassium	NELAP	0.175		**3.31**	mg/L	5	04/01/2021 17:18	174753
Sodium	NELAP	0.225		**40.9**	mg/L	5	04/05/2021 14:29	174753

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Lab ID: 21030724-004 **Client Sample ID:** MW-23-20210309

Matrix: AQUEOUS **Collection Date:** 03/09/2021 15:45

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**161**	mg/L	1	03/15/2021 11:12	R288483
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/15/2021 11:12	R288483
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**874**	mg/L	1	03/15/2021 16:54	R288554
SW-846 9036 (TOTAL)								
Sulfate	NELAP	200		**431**	mg/L	20	03/15/2021 14:52	R288474
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**61**	mg/L	5	03/15/2021 14:47	R288525
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/17/2021 4:06	174737
Iron	NELAP	0.0250		**0.0546**	mg/L	5	03/13/2021 8:38	174737
Manganese	NELAP	0.0020		**0.969**	mg/L	5	03/13/2021 8:38	174737
Molybdenum	NELAP	0.0015		**0.0138**	mg/L	5	03/13/2021 8:38	174737
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/27/2021 22:07	174753
Boron	NELAP	0.0250		**7.57**	mg/L	5	03/27/2021 22:07	174753
Calcium	NELAP	0.125		**112**	mg/L	5	03/27/2021 22:07	174753
Iron	NELAP	0.0250		**0.174**	mg/L	5	03/19/2021 9:07	174753
Lithium	*	0.0030		**0.0045**	mg/L	5	03/30/2021 14:49	174753
Magnesium	NELAP	0.0500		**78.7**	mg/L	5	04/01/2021 17:26	174753
Manganese	NELAP	0.0020		**1.02**	mg/L	5	03/27/2021 22:07	174753
Molybdenum	NELAP	0.0015		**0.0143**	mg/L	5	03/19/2021 9:07	174753
Potassium	NELAP	0.175		**2.61**	mg/L	5	04/01/2021 17:26	174753
Sodium	NELAP	0.225		**42.9**	mg/L	5	04/05/2021 14:38	174753

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Lab ID: 21030724-005 **Client Sample ID:** MW-51-20210309

Matrix: AQUEOUS **Collection Date:** 03/09/2021 16:50

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**335**	mg/L	1	03/15/2021 11:19	R288483
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/15/2021 11:19	R288483
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**632**	mg/L	1	03/15/2021 16:54	R288554
SW-846 9036 (TOTAL)								
Sulfate	NELAP	100		**127**	mg/L	10	03/15/2021 15:02	R288474
SW-846 9251 (TOTAL)								
Chloride	NELAP	10		**105**	mg/L	10	03/15/2021 15:02	R288525
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0149**	mg/L	5	03/17/2021 6:17	174737
Iron	NELAP	0.0250		**4.96**	mg/L	5	03/13/2021 8:47	174737
Manganese	NELAP	0.0020		**0.106**	mg/L	5	03/13/2021 8:47	174737
Molybdenum	NELAP	0.0015		**0.0114**	mg/L	5	03/13/2021 8:47	174737
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0185**	mg/L	5	03/27/2021 22:16	174753
Boron	NELAP	0.0250		**2.11**	mg/L	5	03/27/2021 22:16	174753
Calcium	NELAP	0.125		**124**	mg/L	5	03/27/2021 22:16	174753
Iron	NELAP	0.0250		**10.6**	mg/L	5	03/19/2021 9:16	174753
Lithium	*	0.0030		**0.0245**	mg/L	5	03/30/2021 14:57	174753
Magnesium	NELAP	0.0500		**43.5**	mg/L	5	04/01/2021 17:35	174753
Manganese	NELAP	0.0020		**0.188**	mg/L	5	03/27/2021 22:16	174753
Molybdenum	NELAP	0.0015		**0.0118**	mg/L	5	03/19/2021 9:16	174753
Potassium	NELAP	0.175		**4.23**	mg/L	5	04/01/2021 17:35	174753
Sodium	NELAP	0.225		**52.9**	mg/L	5	04/05/2021 14:46	174753

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Lab ID: 21030724-006 **Client Sample ID:** MW-18D-20210309

Matrix: AQUEOUS **Collection Date:** 03/09/2021 15:20

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**261**	mg/L	1	03/15/2021 12:39	R288483
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/15/2021 12:39	R288483
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**544**	mg/L	1	03/15/2021 16:55	R288554
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**101**	mg/L	4	03/15/2021 15:21	R288474
SW-846 9251 (TOTAL)								
Chloride	NELAP	4		**75**	mg/L	4	03/15/2021 15:21	R288525
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/13/2021 8:56	174737
Manganese	NELAP	0.0020		**0.0530**	mg/L	5	03/13/2021 8:56	174737
Molybdenum	NELAP	0.0015		**0.0313**	mg/L	5	03/13/2021 8:56	174737
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**1.38**	mg/L	5	03/27/2021 22:24	174753
Calcium	NELAP	0.125		**98.9**	mg/L	5	03/27/2021 22:24	174753
Iron	NELAP	0.0250		**0.333**	mg/L	5	03/19/2021 9:25	174753
Lithium	*	0.0030		**0.0253**	mg/L	5	03/30/2021 15:06	174753
Magnesium	NELAP	0.0500		**29.9**	mg/L	5	04/01/2021 17:44	174753
Manganese	NELAP	0.0020		**0.0679**	mg/L	5	03/27/2021 22:24	174753
Molybdenum	NELAP	0.0015		**0.0311**	mg/L	5	03/19/2021 9:25	174753
Potassium	NELAP	0.175		**8.70**	mg/L	5	04/01/2021 17:44	174753
Sodium	NELAP	0.225		**50.0**	mg/L	5	04/05/2021 15:56	174753

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Lab ID: 21030724-007 **Client Sample ID:** MW-18S-20210309

Matrix: AQUEOUS **Collection Date:** 03/09/2021 14:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**250**	mg/L	1	03/15/2021 12:45	R288483
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/15/2021 12:45	R288483
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**562**	mg/L	1	03/15/2021 16:56	R288554
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**122**	mg/L	5	03/15/2021 15:26	R288474
SW-846 9251 (TOTAL)								
Chloride	NELAP	10		**66**	mg/L	10	03/15/2021 15:37	R288525
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/13/2021 10:41	174737
Manganese	NELAP	0.0020		**0.0068**	mg/L	5	03/13/2021 10:41	174737
Molybdenum	NELAP	0.0015		**0.157**	mg/L	5	03/13/2021 10:41	174737
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**2.41**	mg/L	5	03/27/2021 22:33	174753
Calcium	NELAP	0.125		**102**	mg/L	5	03/27/2021 22:33	174753
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/19/2021 9:33	174753
Lithium	*	0.0030		**0.0514**	mg/L	5	03/30/2021 15:15	174753
Magnesium	NELAP	0.0500		**25.8**	mg/L	5	04/01/2021 17:52	174753
Manganese	NELAP	0.0020		**0.0079**	mg/L	5	03/27/2021 22:33	174753
Molybdenum	NELAP	0.0015		**0.156**	mg/L	5	03/19/2021 9:33	174753
Potassium	NELAP	0.175		**11.2**	mg/L	5	04/01/2021 17:52	174753
Sodium	NELAP	0.225		**52.5**	mg/L	5	04/05/2021 16:05	174753

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Lab ID: 21030724-008 **Client Sample ID:** EQB-20210309

Matrix: AQUEOUS **Collection Date:** 03/09/2021 14:40

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/27/2021 22:42	174753
Boron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/27/2021 22:42	174753
Calcium	NELAP	0.125		**< 0.125**	mg/L	5	03/27/2021 22:42	174753
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/19/2021 9:48	174753
Lithium	*	0.0030		**< 0.0030**	mg/L	5	03/30/2021 15:23	174753
Magnesium	NELAP	0.0500		**< 0.0500**	mg/L	5	04/01/2021 18:01	174753
Manganese	NELAP	0.0020		**< 0.0020**	mg/L	5	03/27/2021 22:42	174753
Molybdenum	NELAP	0.0015		**< 0.0015**	mg/L	5	03/19/2021 9:48	174753
Potassium	NELAP	0.175		**< 0.175**	mg/L	5	04/01/2021 18:01	174753
Sodium	NELAP	0.225		**0.249**	mg/L	5	04/05/2021 16:13	174753

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Lab ID: 21030724-009 **Client Sample ID:** MW-3R-20210309

Matrix: AQUEOUS **Collection Date:** 03/09/2021 13:40

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**226**	mg/L	1	03/15/2021 12:52	R288483
STANDARD METHODS 2320 B 1997								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/15/2021 12:52	R288483
STANDARD METHODS 2540 C (TOTAL) 1997								
Total Dissolved Solids	NELAP	20		**510**	mg/L	1	03/15/2021 16:57	R288554
SW-846 9036 (TOTAL)								
Sulfate	NELAP	100		**110**	mg/L	10	03/15/2021 15:53	R288474
SW-846 9251 (TOTAL)								
Chloride	NELAP	10		**85**	mg/L	10	03/15/2021 15:53	R288525
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/13/2021 10:49	174737
Manganese	NELAP	0.0020		**0.0158**	mg/L	5	03/13/2021 10:49	174737
Molybdenum	NELAP	0.0015		**0.174**	mg/L	5	03/13/2021 10:49	174737
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**0.863**	mg/L	5	03/27/2021 22:51	174753
Calcium	NELAP	0.125		**94.1**	mg/L	5	03/27/2021 22:51	174753
Iron	NELAP	0.0250		**0.0602**	mg/L	5	03/27/2021 22:51	174753
Lithium	*	0.0030		**0.0345**	mg/L	5	03/30/2021 15:32	174753
Magnesium	NELAP	0.0500		**31.0**	mg/L	5	04/01/2021 18:10	174753
Manganese	NELAP	0.0020		**0.0459**	mg/L	5	03/27/2021 22:51	174753
Molybdenum	NELAP	0.0015		**0.186**	mg/L	5	03/27/2021 22:51	174753
Potassium	NELAP	0.175		**13.9**	mg/L	5	04/01/2021 18:10	174753
Sodium	NELAP	0.225		**54.2**	mg/L	5	04/05/2021 16:22	174753

Client: Geosyntec Consultants
Client Project: GLP8006\7

Work Order: 21030724
Report Date: 07-Apr-21

Lab Sample ID	Client Sample ID	Matrix	Fractions	Collection Date
21030724-001	HEN-E-20210309	Aqueous	4	03/09/2021 10:30
21030724-002	HEN-W-20210309	Aqueous	4	03/09/2021 16:30
21030724-003	MW-22-20210309	Aqueous	4	03/09/2021 14:30
21030724-004	MW-23-20210309	Aqueous	4	03/09/2021 15:45
21030724-005	MW-51-20210309	Aqueous	4	03/09/2021 16:50
21030724-006	MW-18D-20210309	Aqueous	4	03/09/2021 15:20
21030724-007	MW-18S-20210309	Aqueous	4	03/09/2021 14:30
21030724-008	EQB-20210309	Aqueous	1	03/09/2021 14:40
21030724-009	MW-3R-20210309	Aqueous	4	03/09/2021 13:40

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
21030724-001A	HEN-E-20210309	03/09/2021 10:30	03/10/2021 14:55		
	Standard Methods 2320 B (Total) 1997				03/15/2021 10:44
	Standard Methods 2320 B 1997				03/15/2021 10:44
	Standard Methods 2540 C (Total) 1997				03/15/2021 15:58
21030724-001B	HEN-E-20210309	03/09/2021 10:30	03/10/2021 14:55		
	SW-846 9036 (Total)				03/15/2021 14:25
	SW-846 9251 (Total)				03/15/2021 14:31
21030724-001C	HEN-E-20210309	03/09/2021 10:30	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/27/2021 20:31
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/30/2021 13:39
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/01/2021 15:59
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/05/2021 14:11
21030724-001D	HEN-E-20210309	03/09/2021 10:30	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/13/2021 8:12
21030724-002A	HEN-W-20210309	03/09/2021 16:30	03/10/2021 14:55		
	Standard Methods 2320 B (Total) 1997				03/15/2021 10:51
	Standard Methods 2320 B 1997				03/15/2021 10:51
	Standard Methods 2540 C (Total) 1997				03/15/2021 15:58
21030724-002B	HEN-W-20210309	03/09/2021 16:30	03/10/2021 14:55		
	SW-846 9036 (Total)				03/15/2021 14:33
	SW-846 9251 (Total)				03/15/2021 14:39
21030724-002C	HEN-W-20210309	03/09/2021 16:30	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/19/2021 8:50
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/27/2021 20:40
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/30/2021 14:31
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/01/2021 17:09
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/05/2021 14:20
21030724-002D	HEN-W-20210309	03/09/2021 16:30	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/13/2021 8:21
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/17/2021 3:49
21030724-003A	MW-22-20210309	03/09/2021 14:30	03/10/2021 14:55		
	Standard Methods 2320 B (Total) 1997				03/15/2021 10:58
	Standard Methods 2320 B 1997				03/15/2021 10:58
	Standard Methods 2540 C (Total) 1997				03/15/2021 15:58
21030724-003B	MW-22-20210309	03/09/2021 14:30	03/10/2021 14:55		
	SW-846 9036 (Total)				03/15/2021 14:41

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
	SW-846 9251 (Total)				03/15/2021 14:41
21030724-003C	MW-22-20210309	03/09/2021 14:30	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/19/2021 8:59
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/27/2021 20:48
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/30/2021 14:40
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/01/2021 17:18
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/05/2021 14:29
21030724-003D	MW-22-20210309	03/09/2021 14:30	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/13/2021 8:29
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/17/2021 3:58
21030724-004A	MW-23-20210309	03/09/2021 15:45	03/10/2021 14:55		
	Standard Methods 2320 B (Total) 1997				03/15/2021 11:12
	Standard Methods 2320 B 1997				03/15/2021 11:12
	Standard Methods 2540 C (Total) 1997				03/15/2021 16:54
21030724-004B	MW-23-20210309	03/09/2021 15:45	03/10/2021 14:55		
	SW-846 9036 (Total)				03/15/2021 14:52
	SW-846 9251 (Total)				03/15/2021 14:47
21030724-004C	MW-23-20210309	03/09/2021 15:45	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/19/2021 9:07
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/27/2021 22:07
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/30/2021 14:49
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/01/2021 17:26
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/05/2021 14:38
21030724-004D	MW-23-20210309	03/09/2021 15:45	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/13/2021 8:38
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/17/2021 4:06
21030724-005A	MW-51-20210309	03/09/2021 16:50	03/10/2021 14:55		
	Standard Methods 2320 B (Total) 1997				03/15/2021 11:19
	Standard Methods 2320 B 1997				03/15/2021 11:19
	Standard Methods 2540 C (Total) 1997				03/15/2021 16:54
21030724-005B	MW-51-20210309	03/09/2021 16:50	03/10/2021 14:55		
	SW-846 9036 (Total)				03/15/2021 15:02
	SW-846 9251 (Total)				03/15/2021 15:02
21030724-005C	MW-51-20210309	03/09/2021 16:50	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/19/2021 9:16
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/27/2021 22:16

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/30/2021 14:57
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/01/2021 17:35
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/05/2021 14:46
21030724-005D	MW-51-20210309	03/09/2021 16:50	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/13/2021 8:47
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/17/2021 6:17
21030724-006A	MW-18D-20210309	03/09/2021 15:20	03/10/2021 14:55		
	Standard Methods 2320 B (Total) 1997				03/15/2021 12:39
	Standard Methods 2320 B 1997				03/15/2021 12:39
	Standard Methods 2540 C (Total) 1997				03/15/2021 16:55
21030724-006B	MW-18D-20210309	03/09/2021 15:20	03/10/2021 14:55		
	SW-846 9036 (Total)				03/15/2021 15:21
	SW-846 9251 (Total)				03/15/2021 15:21
21030724-006C	MW-18D-20210309	03/09/2021 15:20	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/19/2021 9:25
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/27/2021 22:24
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/30/2021 15:06
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/01/2021 17:44
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/05/2021 15:56
21030724-006D	MW-18D-20210309	03/09/2021 15:20	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/13/2021 8:56
21030724-007A	MW-18S-20210309	03/09/2021 14:30	03/10/2021 14:55		
	Standard Methods 2320 B (Total) 1997				03/15/2021 12:45
	Standard Methods 2320 B 1997				03/15/2021 12:45
	Standard Methods 2540 C (Total) 1997				03/15/2021 16:56
21030724-007B	MW-18S-20210309	03/09/2021 14:30	03/10/2021 14:55		
	SW-846 9036 (Total)				03/15/2021 15:26
	SW-846 9251 (Total)				03/15/2021 15:37
21030724-007C	MW-18S-20210309	03/09/2021 14:30	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/19/2021 9:33
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/27/2021 22:33
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/30/2021 15:15
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/01/2021 17:52
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/05/2021 16:05
21030724-007D	MW-18S-20210309	03/09/2021 14:30	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/13/2021 10:41

Client: Geosyntec Consultants
Work Order: 21030724
Client Project: GLP8006\7
Report Date: 07-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
21030724-008A	EQB-20210309	03/09/2021 14:40	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/19/2021 9:48
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/27/2021 22:42
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/30/2021 15:23
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/01/2021 18:01
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/05/2021 16:13
21030724-009A	MW-3R-20210309	03/09/2021 13:40	03/10/2021 14:55		
	Standard Methods 2320 B (Total) 1997				03/15/2021 12:52
	Standard Methods 2320 B 1997				03/15/2021 12:52
	Standard Methods 2540 C (Total) 1997				03/15/2021 16:57
21030724-009B	MW-3R-20210309	03/09/2021 13:40	03/10/2021 14:55		
	SW-846 9036 (Total)				03/15/2021 15:53
	SW-846 9251 (Total)				03/15/2021 15:53
21030724-009C	MW-3R-20210309	03/09/2021 13:40	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/27/2021 22:51
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	03/30/2021 15:32
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/01/2021 18:10
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/12/2021 15:35	04/05/2021 16:22
21030724-009D	MW-3R-20210309	03/09/2021 13:40	03/10/2021 14:55		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/12/2021 10:12	03/13/2021 10:49

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

STANDARD METHODS 2540 C (TOTAL) 1997

Batch R288554 **SampType:** MBLK Units **mg/L**
SampID: MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/15/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/15/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/15/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/16/2021

Batch R288554 **SampType:** LCS Units **mg/L**
SampID: LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**940**	1000	0	94.0	90	110	03/15/2021
Total Dissolved Solids		20		**942**	1000	0	94.2	90	110	03/15/2021
Total Dissolved Solids		20		**970**	1000	0	97.0	90	110	03/16/2021
Total Dissolved Solids		20		**956**	1000	0	95.6	90	110	03/15/2021

Batch R288554 **SampType:** DUP Units **mg/L** RPD Limit **5**
SampID: 21030724-007ADUP

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Total Dissolved Solids		20		**562**				562.0	0.00	03/15/2021

SW-846 9036 (TOTAL)

Batch R288474 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	03/15/2021

Batch R288474 **SampType:** MBLK Units **mg/L**
SampID: MB-R288474

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	7.620	0	0	-100	100	03/15/2021

Batch R288474 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**21**	20.00	0	105.2	90	110	03/15/2021

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

SW-846 9036 (TOTAL)

Batch R288474 **SampType:** LCS Units **mg/L**
SampID: LCS-R288474

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**21**	20.00	0	105.2	90	110	03/15/2021

Batch R288474 **SampType:** MS Units **mg/L**
SampID: 21030724-007BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		50		**224**	100.0	121.7	102.4	85	115	03/15/2021

Batch R288474 **SampType:** MSD Units **mg/L** RPD Limit **10**
SampID: 21030724-007BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Sulfate		50		**219**	100.0	121.7	97.6	224.1	2.17	03/15/2021

SW-846 9251 (TOTAL)

Batch R288525 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	03/15/2021

Batch R288525 **SampType:** MBLK Units **mg/L**
SampID: MB-R288525

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	03/15/2021

Batch R288525 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**20**	20.00	0	101.2	90	110	03/15/2021

Batch R288525 **SampType:** LCS Units **mg/L**
SampID: LCS-R288525

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**20**	20.00	0	101.2	90	110	03/15/2021

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

SW-846 9251 (TOTAL)

Batch R288525 **SampType:** MS Units **mg/L**

SampID: 21030724-007BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		10		**241**	200.0	65.63	87.9	85	115	03/15/2021

Batch R288525 **SampType:** MSD Units **mg/L** RPD Limit **15**

SampID: 21030724-007BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Chloride		10		**241**	200.0	65.63	87.8	241.4	0.07	03/15/2021

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 174737 **SampType:** MBLK Units **mg/L**

SampID: MBLK-174737

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	03/16/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	03/13/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	03/13/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	03/13/2021

Batch 174737 **SampType:** LCS Units **mg/L**

SampID: LCS-174737

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.506**	0.5000	0	101.3	80	120	03/16/2021
Iron		0.0250		**1.87**	2.000	0	93.6	80	120	03/13/2021
Manganese		0.0020		**0.490**	0.5000	0	98.0	80	120	03/13/2021
Molybdenum		0.0015		**0.473**	0.5000	0	94.5	80	120	03/13/2021

Batch 174737 **SampType:** MS Units **mg/L**

SampID: 21030724-002DMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.500**	0.5000	0.0009002	99.9	75	125	03/17/2021
Iron		0.0250		**1.83**	2.000	0	91.3	75	125	03/13/2021
Manganese		0.0020		**0.506**	0.5000	0.02820	95.6	75	125	03/13/2021
Molybdenum		0.0015		**0.476**	0.5000	0.003056	94.7	75	125	03/13/2021

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 174737 **SampType:** MSD Units **mg/L** RPD Limit **20**

SampID: 21030724-002DMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Arsenic		0.0010		**0.501**	0.5000	0.0009002	100.1	0.5002	0.21	03/17/2021
Iron		0.0250		**1.83**	2.000	0	91.7	1.827	0.36	03/13/2021
Manganese		0.0020		**0.512**	0.5000	0.02820	96.8	0.5064	1.18	03/13/2021
Molybdenum		0.0015		**0.479**	0.5000	0.003056	95.2	0.4764	0.50	03/13/2021

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 174753 **SampType:** MBLK Units **mg/L**

SampID: MBLK-174753

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	03/22/2021
Boron		0.0250		**< 0.0250**	0.0093	0	0	-100	100	03/22/2021
Calcium		0.125		**< 0.125**	0.0700	0	0	-100	100	03/27/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	03/18/2021
Lithium	*	0.0030		**< 0.0030**	0.0015	0	0	-100	100	03/30/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	03/18/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	03/18/2021
Potassium		0.175		**< 0.175**	0.0800	0	0	-100	100	04/01/2021
Sodium		0.225		**< 0.225**	0.0750	0	0	-100	100	04/05/2021

Batch 174753 **SampType:** LCS Units **mg/L**

SampID: LCS-174753

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.547**	0.5000	0	109.5	80	120	03/22/2021
Boron		0.0250		**0.526**	0.5000	0	105.2	80	120	03/22/2021
Calcium		0.125		**2.44**	2.500	0	97.6	80	120	03/27/2021
Iron		0.0250		**2.02**	2.000	0	101.0	80	120	03/18/2021
Lithium	*	0.0030		**0.512**	0.5000	0	102.5	80	120	03/30/2021
Manganese		0.0020		**0.513**	0.5000	0	102.6	80	120	03/18/2021
Molybdenum		0.0015		**0.515**	0.5000	0	103.1	80	120	03/18/2021
Potassium		0.175		**2.36**	2.500	0	94.3	80	120	04/01/2021
Sodium		0.225		**2.65**	2.500	0	106.1	80	120	04/05/2021

Client: Geosyntec Consultants **Work Order:** 21030724

Client Project: GLP8006\7 **Report Date:** 07-Apr-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch **174753** **SampType:** **MS** Units **mg/L**

SampID: 21030724-001CMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Boron		0.0250		**0.607**	0.5000	0.1138	98.5	75	125	03/27/2021
Calcium		0.125	S	**79.8**	2.500	75.75	163.3	75	125	03/27/2021
Iron		0.0250		**2.74**	2.000	0.6749	103.0	75	125	03/27/2021
Lithium	*	0.0030		**0.519**	0.5000	0.006838	102.5	75	125	03/30/2021
Magnesium		0.0500	S	**31.0**	2.500	32.51	-58.7	75	125	04/01/2021
Manganese		0.0020		**0.571**	0.5000	0.05302	103.7	75	125	03/27/2021
Molybdenum		0.0015		**0.519**	0.5000	0.007412	102.3	75	125	03/27/2021
Potassium		0.175		**6.22**	2.500	4.273	78.0	75	125	04/01/2021
Sodium		0.225		**110**	2.500	108.4	79.4	75	125	04/05/2021

Batch **174753** **SampType:** **MSD** Units **mg/L** RPD Limit **20**

SampID: 21030724-001CMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Boron		0.0250		**0.592**	0.5000	0.1138	95.7	0.6065	2.39	03/27/2021
Calcium		0.125		**78.5**	2.500	75.75	107.8	79.84	1.75	03/27/2021
Iron		0.0250		**2.65**	2.000	0.6749	98.8	2.735	3.12	03/27/2021
Lithium	*	0.0030		**0.517**	0.5000	0.006838	102.0	0.5194	0.50	03/30/2021
Magnesium		0.0500	S	**31.2**	2.500	32.51	-51.5	31.04	0.57	04/01/2021
Manganese		0.0020		**0.557**	0.5000	0.05302	100.8	0.5714	2.54	03/27/2021
Molybdenum		0.0015		**0.515**	0.5000	0.007412	101.5	0.5191	0.81	03/27/2021
Potassium		0.175		**6.26**	2.500	4.273	79.5	6.224	0.59	04/01/2021
Sodium		0.225	S	**108**	2.500	108.4	-7.7	110.4	1.99	04/05/2021

Receiving Check List

http://www.teklabinc.com/

Client: Geosyntec Consultants
Work Order: 21030724
Client Project: GLP8006\7
Report Date: 07-Apr-21

Carrier: Jacob Wilson
Received By: AH

Completed by: Marvin L. Darling II
On: 10-Mar-21
Marvin L. Darling

Reviewed by: Elizabeth A. Hurley
On: 11-Mar-21
Elizabeth A. Hurley

Pages to follow: Chain of custody 1 Extra pages included 3

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	Temp °C 0.4
Type of thermal preservation?	None ☐	Ice ☑	Blue Ice ☐	Dry Ice ☐
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☐	No ☑		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		
Reported field parameters measured:	Field ☐	Lab ☐	NA ☑	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐		
When thermal preservation is required, samples are compliant with a temperature between 0.1°C - 6.0°C, or when samples are received on ice the same day as collected.				
Water – at least one vial per sample has zero headspace?	Yes ☐	No ☐	No VOA vials ☑	
Water - TOX containers have zero headspace?	Yes ☐	No ☐	No TOX containers ☑	
Water - pH acceptable upon receipt?	Yes ☑	No ☐	NA ☐	
NPDES/CWA TCN interferences checked/treated in the field?	Yes ☐	No ☐	NA ☑	

Any No responses must be detailed below or on the COC.

MW-3R-20210309 was received but not listed on the chain of custody. The sample was added for the full suite of analyses. PRY/MLDII 3/10/21

pH strip# 74534. PRY 3/10/21

CHAIN OF CUSTODY

pg. 1 of 1 Work order # 21030724

TEKLAB, INC. 5445 Horseshoe Lake Road - Collinsville, IL 62234 - Phone: (618) 344-1004 - Fax: (618) 344-1005

Client:	Geosyntec Consultants
Address:	1 McBride and Son Center Drive, Suite 202
City / State / Zip	Chesterfield, MO 63005
Contact:	Allison Kreinberg
Phone:	(636) 812-0809
E-Mail:	AKreinberg@Geosyntec.com
Fax:	

Samples on: [X] ICE [ ] BLUE ICE [ ] NO ICE 0.4 °C LTG# 5

Preserved in: [ ] LAB [ ] FIELD

FOR LAB USE ONLY

Lab Notes: PW 74534, Sample MW-32 Not listed on chain. RAY 3/10/21

Are these samples known to be involved in litigation? If yes, a surcharge will apply [ ] Yes [X] No

Are these samples known to be hazardous? [ ] Yes [X] No

Are there any required reporting limits to be met on the requested analysis?. If yes, please provide limits in the comment section. [ ] Yes [X] No

Client Comments: Courier

#/er containers. mod 3/10/21

Project Name/Number	Sample Collector's Name
[redacted]	Amanda Taye

Results Requested: [X] Standard [ ] 1-2 Day (100% Surcharge) [ ] Other ____ [ ] 3 Day (50% Surcharge)

Billing Instructions:

Lab Use Only	Sample Identification	Date/Time Sampled	# and Type of Containers: UNPRES	HNO3	NaOH	H2SO4	HCL	MeOH	NaHSO4	OTHER	MATRIX: Aqueous	Drinking Water	Soil	Sludge	Special Waste	Groundwater	INDICATE ANALYSIS REQUESTED: Alkalinity	Chloride	Metals (Dissolved)**	Metals (Total)*	Sulfate	TDS
21030724-cc1	HEA-E-20210309	3-9-21 1030	1	3																		
-cc2	HEA-W-[redacted]	3-9-21 1620	1	3																		
-cc3	MW-22-[redacted]	3-9-21 1430	1	3																		
-cc4	MW-23-[redacted]	3-9-21 1545	1	3																		
-cc5	MW-[redacted]	3-9-21 1650	1	3																		
-cc6	MW-30-[redacted]	3-9-21 1520	1	3																		
-cc7	MW-[redacted]	3-9-21 1430	1	3																		
-cc8	EQB-[redacted]	3-9-21 1440		1																		
-cc9	MW3R-20210309	3/9/21 1340																				

Relinquished By	Date/Time	Received By	Date/Time
	3/10/21 1455		3/10/21 1240
			3/10/21 1455

The individual signing this agreement on behalf of the client, acknowledges that he/she has read and understands the terms and conditions of this agreement, and that he/she has the authority to sign on behalf of the client. See www.teklabinc.com for terms and conditions.

BottleOrder: 64185

RAY 3/10/21

Elizabeth A. Hurley

From: Marvin L. Darling
Sent: Thursday, March 11, 2021 9:20 AM
To: Emily Pohlman; Amanda Ham
Cc: Elizabeth A. Hurley
Subject: FW: GLP 8006/7 Metals

The paperwork for this one is in the trays by Mary's computer.

Thanks,

Marvin "Chip" Darling
Project Manager
TEKLAB, INC.
618-344-1004 X41
618-304-8198 Cell

From: Aaron Renner
Sent: Thursday, March 11, 2021 9:19 AM
To: Marvin L. Darling <MDarling@TekLabInc.com>
Subject: FW: GLP 8006/7 Metals

Chip,

This is for their Hennepin site and should be logged in the the same as 21030443:

Total ICPMS: B Ca Fe Li Mg Mn Mo K Na (Arsenic on -002)
Dissolved ICPMS: Fe Mn Mo (As on -002)

Also, do Alkalinity B and Alkalinity C rather than just Total Alkalinity.

Let me know if you have any other questions.

Thanks,

Aaron Renner
Project Manager

Teklab, Inc.
1319 Butterfield Road, Suite 502
Downers Grove, IL 60515
(630) 800-8638

www.teklabinc.com

From: Allison Kreinberg [mailto:AKreinberg@Geosyntec.com]
Sent: Thursday, March 11, 2021 8:49 AM
To: Aaron Renner
Subject: RE: GLP 8006/7 Metals

Hi Aaron-

I checked with the field samplers and arsenic should be included for the surface water sample with 'W' in the sample ID. I'd like to request that we get rush results for lithium, boron, and molybdenum for these samples. I think by Monday would be sufficient. I am hoping that we will have received results for the samples submitted on 3/5 by Monday as well. Please let me know if you have any questions.

Thanks
Allison

From: Allison Kreinberg
Sent: Wednesday, March 10, 2021 8:48 PM
To: Aaron Renner <arenner@TekLabInc.com>
Subject: RE: GLP 8006/7 Metals

Hi Aaron-

Yes, this is for the Hennepin project, GLP8006/8007 is actually the correct project number and they mislabeled it last week. Can you provide me with a copy of the COC and I'll identify which surface water sample gets arsenic and which should not be analyzed for arsenic?

Thanks,
Allison

From: Aaron Renner <arenner@TekLabInc.com>
Sent: Wednesday, March 10, 2021 8:09 PM
To: Allison Kreinberg <AKreinberg@Geosyntec.com>
Subject: GLP 8006/7 Metals

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe. If you have any suspicion, please confirm with the sender verbally that this email is authentic.

Hi Allison,

We received 8 aqueous samples today for project "GLP 8006/7". The COC requests Total Metals and Dissolved Metals, but doesn't specify which particular metals. I suspect that these are for the Hennepin site, but since the project number is different than what I'm used to seeing for that site I wanted to double check with you before we proceed.

Could you provide the required list of metals when you have a chance?

Thanks,

Aaron Renner
Project Manager

Teklab, Inc.
1319 Butterfield Road, Suite 502
Downers Grove, IL 60515
(630) 800-8638

April 12, 2021

Allison Kreinberg
Geosyntec Consultants
1 McBride and Son Center Drive, Suite 202
Chesterfield, MO 63005
TEL: (614) 468-0421
FAX:

Illinois	100226
Kansas	E-10374
Louisiana	05002
Louisiana	05003
Oklahoma	9978

RE: GLP8006/GLP8007 **WorkOrder:** 21031352

Dear Allison Kreinberg:

TEKLAB, INC received 8 samples on 3/19/2021 4:00:00 PM for the analysis presented in the following report.

Samples are analyzed on an as received basis unless otherwise requested and documented. The sample results contained in this report relate only to the requested analytes of interest as directed on the chain of custody. NELAP accredited fields of testing are indicated by the letters NELAP under the Certification column. Unless otherwise documented within this report, Teklab Inc. analyzes samples utilizing the most current methods in compliance with 40CFR. All tests are performed in the Collinsville, IL laboratory unless otherwise noted in the Case Narrative.

All quality control criteria applicable to the test methods employed for this project have been satisfactorily met and are in accordance with NELAP except where noted. The following report shall not be reproduced, except in full, without the written approval of Teklab, Inc.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Aaron Renner
Project Manager
(630)324-6855
arenner@teklabinc.com

Report Contents

Client: Geosyntec Consultants
Work Order: 21031352
Client Project: GLP8006/GLP8007
Report Date: 12-Apr-21

This reporting package includes the following:

Cover Letter	1
Report Contents	2
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Case Narrative	5
Accreditations	6
Laboratory Results	7
Sample Summary	15
Dates Report	16
Quality Control Results	19
Receiving Check List	24
Chain of Custody	Appended

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Abbr	Definition
*	Analytes on report marked with an asterisk are not NELAP accredited
CCV	Continuing calibration verification is a check of a standard to determine the state of calibration of an instrument between recalibration.
CRQL	A Client Requested Quantitation Limit is a reporting limit that varies according to customer request. The CRQL may not be less than the MDL.
DF	Dilution factor is the dilution performed during analysis only and does not take into account any dilutions made during sample preparation. The reported result is final and includes all dilution factors.
DNI	Did not ignite
DUP	Laboratory duplicate is a replicate aliquot prepared under the same laboratory conditions and independently analyzed to obtain a measure of precision.
ICV	Initial calibration verification is a check of a standard to determine the state of calibration of an instrument before sample analysis is initiated.
IDPH	IL Dept. of Public Health
LCS	Laboratory control sample is a sample matrix, free from the analytes of interest,spiked with verified known amounts of analytes and analyzed exactly like a sample to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.
LCSD	Laboratory control sample duplicate is a replicate laboratory control sample that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MBLK	Method blank is a sample of a matrix similar to the batch of associated sample (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences should present at concentrations that impact the analytical results for sample analyses.
MDL	"The method detection limit is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results."
MS	Matrix spike is an aliquot of matrix fortified (spiked) with known quantities of specific analytes that is subjected to the entire analytical procedures in order to determine the effect of the matrix on an approved test method's recovery system. The acceptable recovery range is listed in the QC Package (provided upon request).
MSD	Matrix spike duplicate means a replicate matrix spike that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MW	Molecular weight
NC	Data is not acceptable for compliance purposes
ND	Not Detected at the Reporting Limit
NELAP	NELAP Accredited
PQL	Practical quantitation limit means the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.
RL	The reporting limit the lowest level that the data is displayed in the final report. The reporting limit may vary according to customer request or sample dilution. The reporting limit may not be less than the MDL.
RPD	Relative percent difference is a calculated difference between two recoveries (ie. MS/MSD). The acceptable recovery limit is listed in the QC Package (provided upon request).
SPK	The spike is a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery deficiency or for other quality control purposes.
Surr	Surrogates are compounds which are similar to the analytes of interest in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.
TIC	Tentatively identified compound: Analytes tentatively identified in the sample by using a library search. Only results not in the calibration standard will be reported as tentatively identified compounds. Results for tentatively identified compounds that are not present in the calibration standard, but are assigned a specific chemical name based upon the library search, are calculated using total peak areas from reconstructed ion chromatograms and a response factor of one. The nearest Internal Standard is used for the calculation. The results of any TICs must be considered estimated, and are flagged with a "T". If the estimated result is above the calibration range it is flagged "ET"
TNTC	Too numerous to count (> 200 CFU)

Client: Geosyntec Consultants
Work Order: 21031352
Client Project: GLP8006/GLP8007
Report Date: 12-Apr-21

Qualifiers

- # - Unknown hydrocarbon
- B - Analyte detected in associated Method Blank
- C - RL shown is a Client Requested Quantitation Limit
- E - Value above quantitation range
- H - Holding times exceeded
- I - Associated internal standard was outside method criteria
- J - Analyte detected below quantitation limits
- M - Manual Integration used to determine area response
- ND - Not Detected at the Reporting Limit
- R - RPD outside accepted recovery limits
- S - Spike Recovery outside recovery limits
- T - TIC(Tentatively identified compound)
- X - Value exceeds Maximum Contaminant Level

Case Narrative

http://www.teklabinc.com/

Client: Geosyntec Consultants
Client Project: GLP8006/GLP8007

Work Order: 21031352
Report Date: 12-Apr-21

Cooler Receipt Temp: 5.0 °C

Locations

Collinsville

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
Email jhriley@teklabinc.com

Springfield

Address 3920 Pintail Dr
Springfield, IL 62711-9415
Phone (217) 698-1004
Fax (217) 698-1005
Email KKlostermann@teklabinc.com

Kansas City

Address 8421 Nieman Road
Lenexa, KS 66214
Phone (913) 541-1998
Fax (913) 541-1998
Email jhriley@teklabinc.com

Collinsville Air

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
Email EHurley@teklabinc.com

Chicago

Address 1319 Butterfield Rd.
Downers Grove, IL 60515
Phone (630) 324-6855
Fax
Email arenner@teklabinc.com

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

State	Dept	Cert #	NELAP	Exp Date	Lab
Illinois	IEPA	100226	NELAP	1/31/2022	Collinsville
Kansas	KDHE	E-10374	NELAP	4/30/2021	Collinsville
Louisiana	LDEQ	05002	NELAP	6/30/2021	Collinsville
Louisiana	LDEQ	05003	NELAP	6/30/2021	Collinsville
Oklahoma	ODEQ	9978	NELAP	8/31/2021	Collinsville
Arkansas	ADEQ	88-0966		3/14/2022	Collinsville
Illinois	IDPH	17584		5/31/2021	Collinsville
Kentucky	UST	0073		1/31/2022	Collinsville
Missouri	MDNR	00930		5/31/2021	Collinsville
Missouri	MDNR	930		1/31/2022	Collinsville

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Lab ID: 21031352-001 **Client Sample ID:** MW-18S-20210318

Matrix: GROUNDWATER **Collection Date:** 03/18/2021 0:00

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**240**	mg/L	1	03/24/2021 13:34	R288894
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/24/2021 13:34	R288894
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**598**	mg/L	1	03/24/2021 15:41	R288956
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**145**	mg/L	5	03/23/2021 0:42	R288761
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**68**	mg/L	5	03/23/2021 0:43	R288859
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/25/2021 0:25	174999
Manganese	NELAP	0.0020		**0.0051**	mg/L	5	03/25/2021 0:25	174999
Molybdenum	NELAP	0.0015		**0.150**	mg/L	5	03/25/2021 0:25	174999
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**2.94**	mg/L	5	04/04/2021 6:38	174995
Calcium	NELAP	0.125		**110**	mg/L	5	04/04/2021 6:38	174995
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/04/2021 6:38	174995
Lithium	*	0.0030		**0.0605**	mg/L	5	04/09/2021 4:18	174995
Magnesium	NELAP	0.0500		**28.2**	mg/L	5	04/07/2021 18:27	174995
Manganese	NELAP	0.0020		**0.0069**	mg/L	5	04/04/2021 6:38	174995
Molybdenum	NELAP	0.0015		**0.168**	mg/L	5	04/04/2021 6:38	174995
Potassium	NELAP	0.175		**13.5**	mg/L	5	04/07/2021 18:27	174995
Sodium	NELAP	0.225		**58.6**	mg/L	5	04/07/2021 18:27	174995

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Lab ID: 21031352-002 **Client Sample ID:** MW03R-20210318

Matrix: GROUNDWATER **Collection Date:** 03/18/2021 0:00

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**241**	mg/L	1	03/24/2021 13:41	R288894
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/24/2021 13:41	R288894
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**538**	mg/L	1	03/24/2021 15:41	R288956
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**95**	mg/L	5	03/23/2021 0:45	R288761
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**86**	mg/L	5	03/23/2021 0:45	R288859
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	03/25/2021 0:33	174999
Manganese	NELAP	0.0020		**0.0377**	mg/L	5	03/25/2021 0:33	174999
Molybdenum	NELAP	0.0015		**0.160**	mg/L	5	03/25/2021 0:33	174999
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**0.923**	mg/L	5	04/04/2021 6:55	174995
Calcium	NELAP	0.125		**97.7**	mg/L	5	04/04/2021 6:55	174995
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/04/2021 6:55	174995
Lithium	*	0.0030		**0.0340**	mg/L	5	04/09/2021 4:26	174995
Magnesium	NELAP	0.0500		**27.5**	mg/L	5	04/07/2021 18:35	174995
Manganese	NELAP	0.0020		**0.0478**	mg/L	5	04/04/2021 6:55	174995
Molybdenum	NELAP	0.0015		**0.173**	mg/L	5	04/04/2021 6:55	174995
Potassium	NELAP	0.175		**14.1**	mg/L	5	04/07/2021 18:35	174995
Sodium	NELAP	0.225		**56.8**	mg/L	5	04/07/2021 18:35	174995

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Lab ID: 21031352-003 **Client Sample ID:** HEN-E-20210317

Matrix: AQUEOUS **Collection Date:** 03/17/2021 8:15

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**223**	mg/L	1	03/24/2021 13:47	R288894
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/24/2021 13:47	R288894
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**592**	mg/L	1	03/23/2021 15:39	R288890
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**68**	mg/L	5	03/23/2021 1:14	R288761
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**155**	mg/L	5	03/23/2021 1:15	R288859
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**0.0397**	mg/L	5	03/25/2021 0:42	174999
Manganese	NELAP	0.0020		**0.0403**	mg/L	5	03/25/2021 0:42	174999
Molybdenum	NELAP	0.0015		**0.0102**	mg/L	5	03/25/2021 0:42	174999
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**0.116**	mg/L	5	04/04/2021 7:12	174995
Calcium	NELAP	0.125	S	**82.3**	mg/L	5	04/04/2021 7:12	174995
Iron	NELAP	0.0250		**0.814**	mg/L	5	04/04/2021 7:12	174995
Lithium	*	0.0030		**0.0072**	mg/L	5	04/09/2021 4:35	174995
Magnesium	NELAP	0.0500		**33.0**	mg/L	5	04/07/2021 18:44	174995
Manganese	NELAP	0.0020		**0.0772**	mg/L	5	04/04/2021 7:12	174995
Molybdenum	NELAP	0.0015		**0.0068**	mg/L	5	04/04/2021 7:12	174995
Potassium	NELAP	0.175		**4.91**	mg/L	5	04/07/2021 18:44	174995
Sodium	NELAP	0.225	S	**99.7**	mg/L	5	04/07/2021 18:44	174995

Matrix spike control limits for Na are not applicable due to high sample/spike ratio.

Matrix spike control limits for Ca are not applicable due to high sample/spike ratio.

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Lab ID: 21031352-004 **Client Sample ID:** MW-23-20210318

Matrix: GROUNDWATER **Collection Date:** 03/18/2021 17:35

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**169**	mg/L	1	03/24/2021 13:54	R288894
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/24/2021 13:54	R288894
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**912**	mg/L	1	03/24/2021 15:42	R288956
SW-846 9036 (TOTAL)								
Sulfate	NELAP	200		**423**	mg/L	20	03/23/2021 1:30	R288761
SW-846 9251 (TOTAL)								
Chloride	NELAP	2		**55**	mg/L	2	03/23/2021 1:25	R288859
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	03/25/2021 0:51	174999
Iron	NELAP	0.0250		**0.0278**	mg/L	5	03/25/2021 0:51	174999
Manganese	NELAP	0.0020		**0.955**	mg/L	5	03/25/2021 0:51	174999
Molybdenum	NELAP	0.0015		**0.0137**	mg/L	5	03/25/2021 0:51	174999
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	04/04/2021 7:30	174995
Boron	NELAP	0.0250		**8.30**	mg/L	5	04/04/2021 7:30	174995
Calcium	NELAP	0.125		**117**	mg/L	5	04/04/2021 7:30	174995
Iron	NELAP	0.0250		**0.102**	mg/L	5	04/04/2021 7:30	174995
Lithium	*	0.0030		**0.0050**	mg/L	5	04/09/2021 4:44	174995
Magnesium	NELAP	0.0500		**83.7**	mg/L	5	04/07/2021 18:53	174995
Manganese	NELAP	0.0020		**1.04**	mg/L	5	04/04/2021 7:30	174995
Molybdenum	NELAP	0.0015		**0.0150**	mg/L	5	04/04/2021 7:30	174995
Potassium	NELAP	0.175		**3.25**	mg/L	5	04/07/2021 18:53	174995
Sodium	NELAP	0.225		**46.6**	mg/L	5	04/07/2021 18:53	174995

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Lab ID: 21031352-005 **Client Sample ID:** MW-22-20210317

Matrix: GROUNDWATER **Collection Date:** 03/17/2021 10:15

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**332**	mg/L	1	03/24/2021 14:07	R288894
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/24/2021 14:07	R288894
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**712**	mg/L	1	03/23/2021 15:40	R288890
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**101**	mg/L	4	03/23/2021 1:33	R288761
SW-846 9251 (TOTAL)								
Chloride	NELAP	4		**92**	mg/L	4	03/23/2021 1:33	R288859
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0010**	mg/L	5	03/25/2021 1:00	174999
Iron	NELAP	0.0250		**2.23**	mg/L	5	03/25/2021 1:00	174999
Manganese	NELAP	0.0020		**0.0726**	mg/L	5	03/25/2021 1:00	174999
Molybdenum	NELAP	0.0015		**0.0064**	mg/L	5	03/25/2021 1:00	174999
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0015**	mg/L	5	04/04/2021 7:47	174995
Boron	NELAP	0.0250		**2.00**	mg/L	5	04/04/2021 7:47	174995
Calcium	NELAP	0.125		**133**	mg/L	5	04/04/2021 7:47	174995
Iron	NELAP	0.0250		**2.94**	mg/L	5	04/04/2021 7:47	174995
Lithium	*	0.0030		**0.0160**	mg/L	5	04/09/2021 4:52	174995
Magnesium	NELAP	0.0500		**44.9**	mg/L	5	04/07/2021 19:01	174995
Manganese	NELAP	0.0020		**0.0870**	mg/L	5	04/04/2021 7:47	174995
Molybdenum	NELAP	0.0015		**0.0070**	mg/L	5	04/04/2021 7:47	174995
Potassium	NELAP	0.175		**3.50**	mg/L	5	04/07/2021 19:01	174995
Sodium	NELAP	0.225		**43.9**	mg/L	5	04/07/2021 19:01	174995

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Lab ID: 21031352-006 **Client Sample ID:** HEN-W-20210318

Matrix: AQUEOUS **Collection Date:** 03/18/2021 11:15

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**244**	mg/L	1	03/24/2021 14:15	R288894
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/24/2021 14:15	R288894
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**568**	mg/L	1	03/24/2021 15:42	R288956
SW-846 9036 (TOTAL)								
Sulfate	NELAP	20		**70**	mg/L	2	03/23/2021 1:36	R288761
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**132**	mg/L	5	03/23/2021 1:55	R288859
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0027**	mg/L	5	03/25/2021 1:08	174999
Iron	NELAP	0.0250		**2.23**	mg/L	5	03/25/2021 1:08	174999
Manganese	NELAP	0.0020		**0.927**	mg/L	5	03/25/2021 1:08	174999
Molybdenum	NELAP	0.0015		**0.0130**	mg/L	5	03/25/2021 1:08	174999
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0092**	mg/L	5	04/04/2021 8:05	174995
Boron	NELAP	0.0250		**0.599**	mg/L	5	04/04/2021 8:05	174995
Calcium	NELAP	0.125		**120**	mg/L	5	04/04/2021 8:05	174995
Iron	NELAP	0.0250		**24.2**	mg/L	5	04/04/2021 8:05	174995
Lithium	*	0.0030		**0.0253**	mg/L	5	04/09/2021 5:01	174995
Magnesium	NELAP	0.0500		**40.3**	mg/L	5	04/07/2021 19:10	174995
Manganese	NELAP	0.0020		**1.17**	mg/L	5	04/04/2021 8:05	174995
Molybdenum	NELAP	0.0015		**0.0310**	mg/L	5	04/04/2021 8:05	174995
Potassium	NELAP	0.175		**7.85**	mg/L	5	04/07/2021 19:10	174995
Sodium	NELAP	0.225		**80.1**	mg/L	5	04/07/2021 19:10	174995

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Lab ID: 21031352-007 **Client Sample ID:** EQB-20210317

Matrix: AQUEOUS **Collection Date:** 03/17/2021 10:15

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	04/04/2021 10:51	174995
Boron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/04/2021 10:51	174995
Calcium	NELAP	0.125		**< 0.125**	mg/L	5	04/04/2021 10:51	174995
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/04/2021 10:51	174995
Lithium	*	0.0030		**< 0.0030**	mg/L	5	04/09/2021 6:37	174995
Magnesium	NELAP	0.0500		**< 0.0500**	mg/L	5	04/07/2021 19:19	174995
Manganese	NELAP	0.0020		**< 0.0020**	mg/L	5	04/04/2021 10:51	174995
Molybdenum	NELAP	0.0015		**< 0.0015**	mg/L	5	04/04/2021 10:51	174995
Potassium	NELAP	0.175		**< 0.175**	mg/L	5	04/07/2021 19:19	174995
Sodium	NELAP	0.225		**0.296**	mg/L	5	04/07/2021 19:19	174995

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Lab ID: 21031352-008 **Client Sample ID:** MW-51-20210318

Matrix: GROUNDWATER **Collection Date:** 03/18/2021 0:00

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**339**	mg/L	1	03/24/2021 14:22	R288894
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	03/24/2021 14:22	R288894
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**624**	mg/L	1	03/24/2021 15:43	R288956
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**106**	mg/L	5	03/23/2021 1:57	R288761
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**97**	mg/L	5	03/23/2021 1:57	R288859
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0156**	mg/L	5	03/25/2021 3:10	174999
Iron	NELAP	0.0250		**5.17**	mg/L	5	03/25/2021 3:10	174999
Manganese	NELAP	0.0020		**0.109**	mg/L	5	03/25/2021 3:10	174999
Molybdenum	NELAP	0.0015		**0.0124**	mg/L	5	03/25/2021 3:10	174999
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0180**	mg/L	5	04/04/2021 11:08	174995
Boron	NELAP	0.0250		**2.37**	mg/L	5	04/04/2021 11:08	174995
Calcium	NELAP	0.125		**128**	mg/L	5	04/04/2021 11:08	174995
Iron	NELAP	0.0250		**9.28**	mg/L	5	04/04/2021 11:08	174995
Lithium	*	0.0030		**0.0214**	mg/L	5	04/09/2021 6:46	174995
Magnesium	NELAP	0.0500		**45.5**	mg/L	5	04/07/2021 19:28	174995
Manganese	NELAP	0.0020		**0.178**	mg/L	5	04/04/2021 11:08	174995
Molybdenum	NELAP	0.0015		**0.0131**	mg/L	5	04/04/2021 11:08	174995
Potassium	NELAP	0.175		**4.78**	mg/L	5	04/07/2021 19:28	174995
Sodium	NELAP	0.225		**55.6**	mg/L	5	04/07/2021 19:28	174995

Client: Geosyntec Consultants
Client Project: GLP8006/GLP8007

Work Order: 21031352
Report Date: 12-Apr-21

Lab Sample ID	Client Sample ID	Matrix	Fractions	Collection Date
21031352-001	MW-18S-20210318	Groundwater	4	03/18/2021 0:00
21031352-002	MW03R-20210318	Groundwater	4	03/18/2021 0:00
21031352-003	HEN-E-20210317	Aqueous	4	03/17/2021 8:15
21031352-004	MW-23-20210318	Groundwater	4	03/18/2021 17:35
21031352-005	MW-22-20210317	Groundwater	4	03/17/2021 10:15
21031352-006	HEN-W-20210318	Aqueous	4	03/18/2021 11:15
21031352-007	EQB-20210317	Aqueous	1	03/17/2021 10:15
21031352-008	MW-51-20210318	Groundwater	4	03/18/2021 0:00

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			Prep Date/Time	Analysis Date/Time
21031352-001A	MW-18S-20210318	03/18/2021 0:00	03/19/2021 16:00		
	Standard Methods 2320 B (Total) 1997, 2011				03/24/2021 13:34
	Standard Methods 2320 B 1997, 2011				03/24/2021 13:34
	Standard Methods 2540 C (Total) 1997, 2011				03/24/2021 15:41
21031352-001B	MW-18S-20210318	03/18/2021 0:00	03/19/2021 16:00		
	SW-846 9036 (Total)				03/23/2021 0:42
	SW-846 9251 (Total)				03/23/2021 0:43
21031352-001C	MW-18S-20210318	03/18/2021 0:00	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/04/2021 6:38
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/07/2021 18:27
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/09/2021 4:18
21031352-001D	MW-18S-20210318	03/18/2021 0:00	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/22/2021 16:30	03/25/2021 0:25
21031352-002A	MW03R-20210318	03/18/2021 0:00	03/19/2021 16:00		
	Standard Methods 2320 B (Total) 1997, 2011				03/24/2021 13:41
	Standard Methods 2320 B 1997, 2011				03/24/2021 13:41
	Standard Methods 2540 C (Total) 1997, 2011				03/24/2021 15:41
21031352-002B	MW03R-20210318	03/18/2021 0:00	03/19/2021 16:00		
	SW-846 9036 (Total)				03/23/2021 0:45
	SW-846 9251 (Total)				03/23/2021 0:45
21031352-002C	MW03R-20210318	03/18/2021 0:00	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/04/2021 6:55
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/07/2021 18:35
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/09/2021 4:26
21031352-002D	MW03R-20210318	03/18/2021 0:00	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/22/2021 16:30	03/25/2021 0:33
21031352-003A	HEN-E-20210317	03/17/2021 8:15	03/19/2021 16:00		
	Standard Methods 2320 B (Total) 1997, 2011				03/24/2021 13:47
	Standard Methods 2320 B 1997, 2011				03/24/2021 13:47
	Standard Methods 2540 C (Total) 1997, 2011				03/23/2021 15:39
21031352-003B	HEN-E-20210317	03/17/2021 8:15	03/19/2021 16:00		
	SW-846 9036 (Total)				03/23/2021 1:14
	SW-846 9251 (Total)				03/23/2021 1:15
21031352-003C	HEN-E-20210317	03/17/2021 8:15	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/04/2021 7:12
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/07/2021 18:44

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/09/2021 4:35
21031352-003D	HEN-E-20210317	03/17/2021 8:15	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/22/2021 16:30	03/25/2021 0:42
21031352-004A	MW-23-20210318	03/18/2021 17:35	03/19/2021 16:00		
	Standard Methods 2320 B (Total) 1997, 2011				03/24/2021 13:54
	Standard Methods 2320 B 1997, 2011				03/24/2021 13:54
	Standard Methods 2540 C (Total) 1997, 2011				03/24/2021 15:42
21031352-004B	MW-23-20210318	03/18/2021 17:35	03/19/2021 16:00		
	SW-846 9036 (Total)				03/23/2021 1:30
	SW-846 9251 (Total)				03/23/2021 1:25
21031352-004C	MW-23-20210318	03/18/2021 17:35	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/04/2021 7:30
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/07/2021 18:53
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/09/2021 4:44
21031352-004D	MW-23-20210318	03/18/2021 17:35	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/22/2021 16:30	03/25/2021 0:51
21031352-005A	MW-22-20210317	03/17/2021 10:15	03/19/2021 16:00		
	Standard Methods 2320 B (Total) 1997, 2011				03/24/2021 14:07
	Standard Methods 2320 B 1997, 2011				03/24/2021 14:07
	Standard Methods 2540 C (Total) 1997, 2011				03/23/2021 15:40
21031352-005B	MW-22-20210317	03/17/2021 10:15	03/19/2021 16:00		
	SW-846 9036 (Total)				03/23/2021 1:33
	SW-846 9251 (Total)				03/23/2021 1:33
21031352-005C	MW-22-20210317	03/17/2021 10:15	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/04/2021 7:47
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/07/2021 19:01
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/09/2021 4:52
21031352-005D	MW-22-20210317	03/17/2021 10:15	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/22/2021 16:30	03/25/2021 1:00
21031352-006A	HEN-W-20210318	03/18/2021 11:15	03/19/2021 16:00		
	Standard Methods 2320 B (Total) 1997, 2011				03/24/2021 14:15
	Standard Methods 2320 B 1997, 2011				03/24/2021 14:15
	Standard Methods 2540 C (Total) 1997, 2011				03/24/2021 15:42
21031352-006B	HEN-W-20210318	03/18/2021 11:15	03/19/2021 16:00		
	SW-846 9036 (Total)				03/23/2021 1:36
	SW-846 9251 (Total)				03/23/2021 1:55

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
21031352-006C	HEN-W-20210318	03/18/2021 11:15	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/04/2021 8:05
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/07/2021 19:10
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/09/2021 5:01
21031352-006D	HEN-W-20210318	03/18/2021 11:15	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/22/2021 16:30	03/25/2021 1:08
21031352-007A	EQB-20210317	03/17/2021 10:15	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/04/2021 10:51
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/07/2021 19:19
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/09/2021 6:37
21031352-008A	MW-51-20210318	03/18/2021 0:00	03/19/2021 16:00		
	Standard Methods 2320 B (Total) 1997, 2011				03/24/2021 14:22
	Standard Methods 2320 B 1997, 2011				03/24/2021 14:22
	Standard Methods 2540 C (Total) 1997, 2011				03/24/2021 15:43
21031352-008B	MW-51-20210318	03/18/2021 0:00	03/19/2021 16:00		
	SW-846 9036 (Total)				03/23/2021 1:57
	SW-846 9251 (Total)				03/23/2021 1:57
21031352-008C	MW-51-20210318	03/18/2021 0:00	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/04/2021 11:08
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/07/2021 19:28
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/19/2021 20:58	04/09/2021 6:46
21031352-008D	MW-51-20210318	03/18/2021 0:00	03/19/2021 16:00		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/22/2021 16:30	03/25/2021 3:10

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

STANDARD METHODS 2540 C (TOTAL) 1997, 2011

Batch R288890 **SampType:** MBLK Units **mg/L**
SampID: MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/22/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/23/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/22/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/23/2021
Total Dissolved Solids		20		**< 20**	16.00	0	100.0	-100	100	03/22/2021

Batch R288890 **SampType:** LCS Units **mg/L**
SampID: LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**950**	1000	0	95.0	90	110	03/22/2021
Total Dissolved Solids		20		**968**	1000	0	96.8	90	110	03/22/2021
Total Dissolved Solids		20		**946**	1000	0	94.6	90	110	03/23/2021
Total Dissolved Solids		20		**942**	1000	0	94.2	90	110	03/23/2021
Total Dissolved Solids		20		**962**	1000	0	96.2	90	110	03/22/2021

Batch R288956 **SampType:** MBLK Units **mg/L**
SampID: MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**< 20**	16.00	0	100.0	-100	100	03/24/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/25/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/24/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	03/24/2021

Batch R288956 **SampType:** LCS Units **mg/L**
SampID: LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**960**	1000	0	96.0	90	110	03/25/2021
Total Dissolved Solids		20		**948**	1000	0	94.8	90	110	03/24/2021
Total Dissolved Solids		20		**966**	1000	0	96.6	90	110	03/24/2021
Total Dissolved Solids		20		**968**	1000	0	96.8	90	110	03/24/2021

Batch R288956 **SampType:** DUP Units **mg/L** RPD Limit **5**
SampID: 21031352-006ADUP

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Total Dissolved Solids		20		**580**				568.0	2.09	03/24/2021

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

SW-846 9036 (TOTAL)

Batch R288761 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	03/22/2021

Batch R288761 **SampType:** MBLK Units **mg/L**
SampID: MB-R288761

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	7.620	0	0	-100	100	03/22/2021

Batch R288761 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**21**	20.00	0	106.1	90	110	03/22/2021

Batch R288761 **SampType:** LCS Units **mg/L**
SampID: LCS-R288761

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**21**	20.00	0	106.1	90	110	03/22/2021

Batch R288761 **SampType:** MS Units **mg/L**
SampID: 21031352-003BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		50		**160**	100.0	68.22	92.3	85	115	03/23/2021

Batch R288761 **SampType:** MSD Units **mg/L** RPD Limit **10**
SampID: 21031352-003BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Sulfate		50		**163**	100.0	68.22	94.7	160.5	1.51	03/23/2021

SW-846 9251 (TOTAL)

Batch R288859 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	03/22/2021

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

SW-846 9251 (TOTAL)

Batch R288859 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**21**	20.00	0	104.4	90	110	03/22/2021

Batch R288859 **SampType:** MS Units **mg/L**
SampID: 21031352-003BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		5	E	**255**	100.0	155.3	100.0	85	115	03/23/2021

Batch R288859 **SampType:** MSD Units **mg/L** RPD Limit **15**
SampID: 21031352-003BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Chloride		5	E	**266**	100.0	155.3	110.4	255.3	3.99	03/23/2021

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 174999 **SampType:** MBLK Units **mg/L**
SampID: MBLK-174999

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	03/24/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	03/24/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	03/24/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	03/24/2021

Batch 174999 **SampType:** LCS Units **mg/L**
SampID: LCS-174999

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.546**	0.5000	0	109.2	80	120	03/24/2021
Iron		0.0250		**2.09**	2.000	0	104.4	80	120	03/24/2021
Manganese		0.0020		**0.545**	0.5000	0	108.9	80	120	03/24/2021
Molybdenum		0.0015		**0.521**	0.5000	0	104.1	80	120	03/24/2021

Batch 174999 **SampType:** MS Units **mg/L**
SampID: 21031352-001DMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Iron		0.0250		**1.79**	2.000	0.01338	89.0	75	125	03/25/2021
Manganese		0.0020		**0.478**	0.5000	0.005124	94.5	75	125	03/25/2021
Molybdenum		0.0015		**0.607**	0.5000	0.1504	91.3	75	125	03/25/2021

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 174999 **SampType:** MSD Units **mg/L** RPD Limit **20**

SampID: 21031352-001DMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Iron		0.0250		**1.81**	2.000	0.01338	89.9	1.793	1.01	03/25/2021
Manganese		0.0020		**0.479**	0.5000	0.005124	94.9	0.4776	0.40	03/25/2021
Molybdenum		0.0015		**0.617**	0.5000	0.1504	93.2	0.6070	1.55	03/25/2021

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 174995 **SampType:** MBLK Units **mg/L**

SampID: MBLK-174995

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	04/04/2021
Boron		0.0250		**< 0.0250**	0.0093	0	0	-100	100	04/04/2021
Calcium		0.125		**< 0.125**	0.0700	0	0	-100	100	04/04/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	04/04/2021
Lithium	*	0.0030		**< 0.0030**	0.0015	0	0	-100	100	04/07/2021
Magnesium		0.0500		**< 0.0500**	0.0175	0	0	-100	100	04/07/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	04/04/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	04/04/2021
Potassium		0.175		**< 0.175**	0.0800	0	0	-100	100	04/07/2021
Sodium		0.225		**< 0.225**	0.0750	0	0	-100	100	04/07/2021

Batch 174995 **SampType:** LCS Units **mg/L**

SampID: LCS-174995

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.559**	0.5000	0	111.8	80	120	04/04/2021
Boron		0.0250		**0.536**	0.5000	0	107.3	80	120	04/04/2021
Calcium		0.125		**2.61**	2.500	0	104.4	80	120	04/04/2021
Iron		0.0250		**2.08**	2.000	0	104.1	80	120	04/04/2021
Lithium	*	0.0030		**0.536**	0.5000	0	107.2	80	120	04/07/2021
Magnesium		0.0500		**2.55**	2.500	0	101.9	80	120	04/07/2021
Manganese		0.0020		**0.539**	0.5000	0	107.7	80	120	04/04/2021
Molybdenum		0.0015		**0.504**	0.5000	0	100.9	80	120	04/04/2021
Potassium		0.175		**2.69**	2.500	0	107.8	80	120	04/07/2021
Sodium		0.225		**2.41**	2.500	0	96.2	80	120	04/07/2021

Client: Geosyntec Consultants **Work Order:** 21031352

Client Project: GLP8006/GLP8007 **Report Date:** 12-Apr-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch **174995** **SampType:** **MS** Units **mg/L**

SampID: 21031352-003CMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Boron		0.0250		**0.642**	0.5000	0.1164	105.1	75	125	04/04/2021
Calcium		0.125	S	**87.2**	2.500	82.34	193.1	75	125	04/04/2021
Iron		0.0250		**3.12**	2.000	0.8142	115.4	75	125	04/04/2021
Lithium	*	0.0030		**0.574**	0.5000	0.007190	113.3	75	125	04/09/2021
Magnesium		0.0500		**35.1**	2.500	33.04	83.7	75	125	04/07/2021
Manganese		0.0020		**0.612**	0.5000	0.07716	106.9	75	125	04/04/2021
Molybdenum		0.0015		**0.528**	0.5000	0.006835	104.2	75	125	04/04/2021
Potassium		0.175		**7.55**	2.500	4.915	105.6	75	125	04/07/2021
Sodium		0.225	S	**101**	2.500	99.70	50.3	75	125	04/07/2021

Batch **174995** **SampType:** **MSD** Units **mg/L** RPD Limit **20**

SampID: 21031352-003CMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Boron		0.0250		**0.638**	0.5000	0.1164	104.2	0.6421	0.70	04/04/2021
Calcium		0.125	S	**86.6**	2.500	82.34	169.4	87.17	0.68	04/04/2021
Iron		0.0250		**3.07**	2.000	0.8142	112.9	3.122	1.62	04/04/2021
Lithium	*	0.0030		**0.566**	0.5000	0.007190	111.8	0.5736	1.33	04/09/2021
Magnesium		0.0500		**35.5**	2.500	33.04	100.1	35.13	1.15	04/07/2021
Manganese		0.0020		**0.603**	0.5000	0.07716	105.2	0.6116	1.43	04/04/2021
Molybdenum		0.0015		**0.526**	0.5000	0.006835	103.9	0.5277	0.24	04/04/2021
Potassium		0.175		**7.50**	2.500	4.915	103.5	7.554	0.70	04/07/2021
Sodium		0.225	S	**101**	2.500	99.70	41.0	101.0	0.23	04/07/2021

Receiving Check List

http://www.teklabinc.com/

Client: Geosyntec Consultants
Client Project: GLP8006/GLP8007

Work Order: 21031352
Report Date: 12-Apr-21

Carrier: Jacob Wilson

Completed by: Marvin L. Darling II
On: 19-Mar-21
Marvin L. Darling

Received By: AH

Reviewed by: Elizabeth A. Hurley
On: 19-Mar-21
Elizabeth A. Hurley

Pages to follow: Chain of custody 1 Extra pages included 0

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	Temp °C 5.0
Type of thermal preservation?	None ☐	Ice ☑	Blue Ice ☐	Dry Ice ☐
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		
Reported field parameters measured:	Field ☐	Lab ☐	NA ☑	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐		

When thermal preservation is required, samples are compliant with a temperature between 0.1°C - 6.0°C, or when samples are received on ice the same day as collected.

Water – at least one vial per sample has zero headspace?	Yes ☐	No ☐	No VOA vials ☑
Water - TOX containers have zero headspace?	Yes ☐	No ☐	No TOX containers ☑
Water - pH acceptable upon receipt?	Yes ☑	No ☐	NA ☐
NPDES/CWA TCN interferences checked/treated in the field?	Yes ☐	No ☐	NA ☑

Any No responses must be detailed below or on the COC.

pH strip# 75226. PRY 3/19/21

CHAIN OF CUSTODY pg. ___ of ___ Work order # 21031352

TEKLAB, INC. 5445 Horseshoe Lake Road - Collinsville, IL 62234 - Phone: (618) 344-1004 - Fax: (618) 344-1005

Client:	Geosyntec Consultants		
Address:	1 McBride and Son Center Drive, Suite 202		
City / State / Zip	Chesterfield, MO 63005		
Contact:	Allison Kreinberg	**Phone:**	(636) 812-0809
E-Mail:	AKreinberg@Geosyntec.com	**Fax:**	

Samples on: ☑ ICE ☐ BLUE ICE ☐ NO ICE 5.0 °C LTG# 5

Preserved in: ☐ LAB ☑ FIELD

FOR LAB USE ONLY

Lab Notes PHV 75226. PM 3/19/21

Client Comments: */** Client to provide metals list

Total metals: B Ca Fe Li Mg Mn Mo K Na
Dis metals: Fe Mn Mo All B/C per Allison Kreinberg email. mwoll 3/18/21

Courier

Are these samples known to be involved in litigation? If yes, a surcharge will apply ☐ Yes ☐ No

Are these samples known to be hazardous? ☐ Yes ☐ No

Are there any required reporting limits to be met on the requested analysis?. If yes, please provide limits in the comment section. ☐ Yes ☐ No

Project Name/Number: GLP8006/GLP8007

Sample Collector's Name:

Results Requested: ☐ Standard ☐ 1-2 Day (100% Surcharge) ☐ Other ___ ☐ 3 Day (50% Surcharge)

Billing Instructions:

Lab Use Only	Sample Identification	Date/Time Sampled	# and Type of Containers: UNPRES	HNO3	NaOH	H2SO4	HCL	MeOH	NaHSO4	OTHER	MATRIX: Aqueous	Drinking Water	Soil	Sludge	Special Waste	Groundwater	INDICATE ANALYSIS REQUESTED: Alkalinity	Chloride	Metals (Dissolved)**	Metals (Total)*	Sulfate	TDS
21031352-01	MW-18S-20210318	3-19-21	1	3												\	\	\	\	\	\	\
-02	MW-07R-20210318	3-18-21	1	3												\	\	\	\	\	\	\
-03	HEN-E-20210318	3-17-21 0915	1	3							\						\	\	\	\	\	\
-04	MW-23-20210318	3-18-21 1735	1	3												\	\	\	\	\	\	\
-05	MW-22-20210317	3-17-21 1015	1	3												\	\	\	\	\	\	\
-06	HEN-W-20210318	3-18-21 1115	1	3							\						\	\	\	\	\	\
-07	EQB-20210317	3-17-21 1015		1							\									\		
-08	MW-51-20210318	3-18-21	1	3												\	\	\	\	\	\	\

Relinquished By	Date/Time	Received By	Date/Time
	3-19-21 1320		3/19/21 1320
	3/19/21 1600		3/19/21 1600

The individual signing this agreement on behalf of the client, acknowledges that he/she has read and understands the terms and conditions of this agreement, and that he/she has the authority to sign on behalf of the client. See www.teklabinc.com for terms and conditions.

BottleOrder: 64325

PM 3/19/21

April 23, 2021

Allison Kreinberg
Geosyntec Consultants
1 McBride and Son Center Drive, Suite 202
Chesterfield, MO 63005
TEL: (614) 468-0421
FAX:

Illinois	100226
Kansas	E-10374
Louisiana	05002
Louisiana	05003
Oklahoma	9978

RE: GLP8006/GLP8007 **WorkOrder:** 21032011

Dear Allison Kreinberg:

TEKLAB, INC received 9 samples on 3/31/2021 2:40:00 PM for the analysis presented in the following report.

Samples are analyzed on an as received basis unless otherwise requested and documented. The sample results contained in this report relate only to the requested analytes of interest as directed on the chain of custody. NELAP accredited fields of testing are indicated by the letters NELAP under the Certification column. Unless otherwise documented within this report, Teklab Inc. analyzes samples utilizing the most current methods in compliance with 40CFR. All tests are performed in the Collinsville, IL laboratory unless otherwise noted in the Case Narrative.

All quality control criteria applicable to the test methods employed for this project have been satisfactorily met and are in accordance with NELAP except where noted. The following report shall not be reproduced, except in full, without the written approval of Teklab, Inc.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Aaron Renner
Project Manager
(630)324-6855
arenner@teklabinc.com

Report Contents

Client: Geosyntec Consultants
Work Order: 21032011
Client Project: GLP8006/GLP8007
Report Date: 23-Apr-21

This reporting package includes the following:

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Sample Summary	16
Dates Report	17
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Receiving Check List	26
Chain of Custody	Appended

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Abbr	Definition
*	Analytes on report marked with an asterisk are not NELAP accredited
CCV	Continuing calibration verification is a check of a standard to determine the state of calibration of an instrument between recalibration.
CRQL	A Client Requested Quantitation Limit is a reporting limit that varies according to customer request. The CRQL may not be less than the MDL.
DF	Dilution factor is the dilution performed during analysis only and does not take into account any dilutions made during sample preparation. The reported result is final and includes all dilution factors.
DNI	Did not ignite
DUP	Laboratory duplicate is a replicate aliquot prepared under the same laboratory conditions and independently analyzed to obtain a measure of precision.
ICV	Initial calibration verification is a check of a standard to determine the state of calibration of an instrument before sample analysis is initiated.
IDPH	IL Dept. of Public Health
LCS	Laboratory control sample is a sample matrix, free from the analytes of interest,spiked with verified known amounts of analytes and analyzed exactly like a sample to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.
LCSD	Laboratory control sample duplicate is a replicate laboratory control sample that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MBLK	Method blank is a sample of a matrix similar to the batch of associated sample (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences should present at concentrations that impact the analytical results for sample analyses.
MDL	"The method detection limit is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results."
MS	Matrix spike is an aliquot of matrix fortified (spiked) with known quantities of specific analytes that is subjected to the entire analytical procedures in order to determine the effect of the matrix on an approved test method's recovery system. The acceptable recovery range is listed in the QC Package (provided upon request).
MSD	Matrix spike duplicate means a replicate matrix spike that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MW	Molecular weight
NC	Data is not acceptable for compliance purposes
ND	Not Detected at the Reporting Limit
NELAP	NELAP Accredited
PQL	Practical quantitation limit means the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.
RL	The reporting limit the lowest level that the data is displayed in the final report. The reporting limit may vary according to customer request or sample dilution. The reporting limit may not be less than the MDL.
RPD	Relative percent difference is a calculated difference between two recoveries (ie. MS/MSD). The acceptable recovery limit is listed in the QC Package (provided upon request).
SPK	The spike is a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery deficiency or for other quality control purposes.
Surr	Surrogates are compounds which are similar to the analytes of interest in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.
TIC	Tentatively identified compound: Analytes tentatively identified in the sample by using a library search. Only results not in the calibration standard will be reported as tentatively identified compounds. Results for tentatively identified compounds that are not present in the calibration standard, but are assigned a specific chemical name based upon the library search, are calculated using total peak areas from reconstructed ion chromatograms and a response factor of one. The nearest Internal Standard is used for the calculation. The results of any TICs must be considered estimated, and are flagged with a "T". If the estimated result is above the calibration range it is flagged "ET"
TNTC	Too numerous to count (> 200 CFU)

Definitions

Client: Geosyntec Consultants
Work Order: 21032011
Client Project: GLP8006/GLP8007
Report Date: 23-Apr-21

Qualifiers

- # - Unknown hydrocarbon
- B - Analyte detected in associated Method Blank
- C - RL shown is a Client Requested Quantitation Limit
- E - Value above quantitation range
- H - Holding times exceeded
- I - Associated internal standard was outside method criteria
- J - Analyte detected below quantitation limits
- M - Manual Integration used to determine area response
- ND - Not Detected at the Reporting Limit
- R - RPD outside accepted recovery limits
- S - Spike Recovery outside recovery limits
- T - TIC(Tentatively identified compound)
- X - Value exceeds Maximum Contaminant Level

Case Narrative

http://www.teklabinc.com/

Client: Geosyntec Consultants
Client Project: GLP8006/GLP8007

Work Order: 21032011
Report Date: 23-Apr-21

Cooler Receipt Temp: 2.4 °C

Locations

Collinsville

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
Email jhriley@teklabinc.com

Springfield

Address 3920 Pintail Dr
Springfield, IL 62711-9415
Phone (217) 698-1004
Fax (217) 698-1005
Email KKlostermann@teklabinc.com

Kansas City

Address 8421 Nieman Road
Lenexa, KS 66214
Phone (913) 541-1998
Fax (913) 541-1998
Email jhriley@teklabinc.com

Collinsville Air

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
Email EHurley@teklabinc.com

Chicago

Address 1319 Butterfield Rd.
Downers Grove, IL 60515
Phone (630) 324-6855
Fax
Email arenner@teklabinc.com

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

State	Dept	Cert #	NELAP	Exp Date	Lab
Illinois	IEPA	100226	NELAP	1/31/2022	Collinsville
Kansas	KDHE	E-10374	NELAP	4/30/2021	Collinsville
Louisiana	LDEQ	05002	NELAP	6/30/2021	Collinsville
Louisiana	LDEQ	05003	NELAP	6/30/2021	Collinsville
Oklahoma	ODEQ	9978	NELAP	8/31/2021	Collinsville
Arkansas	ADEQ	88-0966		3/14/2022	Collinsville
Illinois	IDPH	17584		5/31/2021	Collinsville
Kentucky	UST	0073		1/31/2022	Collinsville
Missouri	MDNR	00930		5/31/2021	Collinsville
Missouri	MDNR	930		1/31/2022	Collinsville

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Lab ID: 21032011-001 **Client Sample ID:** MW-18S-20210330

Matrix: GROUNDWATER **Collection Date:** 03/30/2021 10:42

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**258**	mg/L	1	04/05/2021 10:58	R289315
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/05/2021 10:58	R289315
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**576**	mg/L	1	04/05/2021 14:53	R289355
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**153**	mg/L	4	04/05/2021 13:48	R289261
SW-846 9251 (TOTAL)								
Chloride	NELAP	4		**69**	mg/L	4	04/05/2021 13:49	R289264
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/13/2021 5:22	175346
Manganese	NELAP	0.0020		**0.0039**	mg/L	5	04/19/2021 0:19	175346
Molybdenum	NELAP	0.0015		**0.144**	mg/L	5	04/10/2021 11:28	175346
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**3.29**	mg/L	5	04/19/2021 19:37	175337
Calcium	NELAP	0.125	S	**106**	mg/L	5	04/19/2021 19:37	175337
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/15/2021 15:11	175337
Lithium	*	0.0030		**0.0657**	mg/L	5	04/19/2021 19:37	175337
Magnesium	NELAP	0.0500		**28.6**	mg/L	5	04/19/2021 19:37	175337
Manganese	NELAP	0.0020		**0.0047**	mg/L	5	04/19/2021 19:37	175337
Molybdenum	NELAP	0.0015		**0.153**	mg/L	5	04/15/2021 15:11	175337
Potassium	NELAP	0.175	S	**12.2**	mg/L	5	04/19/2021 19:37	175337
Sodium	NELAP	0.225		**57.8**	mg/L	5	04/19/2021 19:37	175337

Matrix spike control limits for Ca & K are not applicable due to high sample/spike ratio.

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Lab ID: 21032011-002 **Client Sample ID:** MW-03R-20210330

Matrix: GROUNDWATER **Collection Date:** 03/30/2021 9:32

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**252**	mg/L	1	04/05/2021 11:04	R289315
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/05/2021 11:04	R289315
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**512**	mg/L	1	04/05/2021 14:53	R289355
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**94**	mg/L	4	04/05/2021 14:07	R289261
SW-846 9251 (TOTAL)								
Chloride	NELAP	4		**85**	mg/L	4	04/05/2021 14:07	R289264
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/13/2021 5:30	175346
Manganese	NELAP	0.0020		**0.0293**	mg/L	5	04/19/2021 0:27	175346
Molybdenum	NELAP	0.0015		**0.152**	mg/L	5	04/10/2021 11:36	175346
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**0.964**	mg/L	5	04/19/2021 19:45	175337
Calcium	NELAP	0.125		**89.2**	mg/L	5	04/19/2021 19:45	175337
Iron	NELAP	0.0250		**0.0290**	mg/L	5	04/15/2021 15:20	175337
Lithium	*	0.0030		**0.0348**	mg/L	5	04/19/2021 19:45	175337
Magnesium	NELAP	0.0500		**26.7**	mg/L	5	04/19/2021 19:45	175337
Manganese	NELAP	0.0020		**0.0886**	mg/L	5	04/19/2021 19:45	175337
Molybdenum	NELAP	0.0015		**0.153**	mg/L	5	04/15/2021 15:20	175337
Potassium	NELAP	0.175		**12.6**	mg/L	5	04/19/2021 19:45	175337
Sodium	NELAP	0.225		**53.7**	mg/L	5	04/19/2021 19:45	175337

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Lab ID: 21032011-003 **Client Sample ID:** MW-18D-20210330

Matrix: GROUNDWATER **Collection Date:** 03/30/2021 11:45

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**287**	mg/L	1	04/05/2021 11:11	R289315
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/05/2021 11:11	R289315
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**536**	mg/L	1	04/05/2021 14:54	R289355
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**108**	mg/L	4	04/05/2021 14:10	R289261
SW-846 9251 (TOTAL)								
Chloride	NELAP	4		**77**	mg/L	4	04/05/2021 14:10	R289264
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/13/2021 5:38	175346
Manganese	NELAP	0.0020		**0.0523**	mg/L	5	04/20/2021 23:35	175346
Molybdenum	NELAP	0.0015		**0.0279**	mg/L	5	04/10/2021 11:44	175346
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**1.68**	mg/L	5	04/19/2021 19:54	175337
Calcium	NELAP	0.125		**98.7**	mg/L	5	04/19/2021 19:54	175337
Iron	NELAP	0.0250		**0.175**	mg/L	5	04/15/2021 15:28	175337
Lithium	*	0.0030		**0.0296**	mg/L	5	04/19/2021 19:54	175337
Magnesium	NELAP	0.0500		**31.9**	mg/L	5	04/19/2021 19:54	175337
Manganese	NELAP	0.0020		**0.0601**	mg/L	5	04/19/2021 19:54	175337
Molybdenum	NELAP	0.0015		**0.0319**	mg/L	5	04/15/2021 15:28	175337
Potassium	NELAP	0.175		**9.51**	mg/L	5	04/19/2021 19:54	175337
Sodium	NELAP	0.225		**54.1**	mg/L	5	04/19/2021 19:54	175337

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Lab ID: 21032011-004 **Client Sample ID:** MW-51-0210330

Matrix: GROUNDWATER **Collection Date:** 03/30/2021 13:45

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**355**	mg/L	1	04/05/2021 11:50	R289315
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/05/2021 11:50	R289315
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**644**	mg/L	1	04/05/2021 14:55	R289355
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**116**	mg/L	4	04/05/2021 14:12	R289261
SW-846 9251 (TOTAL)								
Chloride	NELAP	4		**99**	mg/L	4	04/05/2021 14:13	R289264
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0137**	mg/L	5	04/10/2021 11:52	175346
Iron	NELAP	0.0250		**4.72**	mg/L	5	04/13/2021 5:46	175346
Manganese	NELAP	0.0020		**0.0991**	mg/L	5	04/20/2021 23:43	175346
Molybdenum	NELAP	0.0015		**0.0108**	mg/L	5	04/10/2021 11:52	175346
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0165**	mg/L	5	04/19/2021 21:23	175337
Boron	NELAP	0.0250		**2.51**	mg/L	5	04/19/2021 21:23	175337
Calcium	NELAP	0.125		**123**	mg/L	5	04/19/2021 21:23	175337
Iron	NELAP	0.0250		**6.67**	mg/L	5	04/15/2021 15:37	175337
Lithium	*	0.0030		**0.0238**	mg/L	5	04/19/2021 21:23	175337
Magnesium	NELAP	0.0500		**45.1**	mg/L	5	04/19/2021 21:23	175337
Manganese	NELAP	0.0020		**0.135**	mg/L	5	04/19/2021 21:23	175337
Molybdenum	NELAP	0.0015		**0.0120**	mg/L	5	04/15/2021 15:37	175337
Potassium	NELAP	0.175		**4.32**	mg/L	5	04/19/2021 21:23	175337
Sodium	NELAP	0.225		**54.5**	mg/L	5	04/19/2021 21:23	175337

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Lab ID: 21032011-005 **Client Sample ID:** MW-23-20210330

Matrix: GROUNDWATER **Collection Date:** 03/30/2021 11:00

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**179**	mg/L	1	04/05/2021 11:57	R289315
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/05/2021 11:57	R289315
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**860**	mg/L	1	04/05/2021 14:55	R289355
SW-846 9036 (TOTAL)								
Sulfate	NELAP	200		**426**	mg/L	20	04/05/2021 14:23	R289261
SW-846 9251 (TOTAL)								
Chloride	NELAP	2		**58**	mg/L	2	04/05/2021 14:18	R289264
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	04/10/2021 12:01	175346
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/13/2021 5:54	175346
Manganese	NELAP	0.0020		**1.01**	mg/L	5	04/20/2021 23:51	175346
Molybdenum	NELAP	0.0015		**0.0127**	mg/L	5	04/10/2021 12:01	175346
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	04/19/2021 21:31	175337
Boron	NELAP	0.0250		**8.92**	mg/L	5	04/19/2021 21:31	175337
Calcium	NELAP	0.125		**118**	mg/L	5	04/19/2021 21:31	175337
Iron	NELAP	0.0250		**0.0469**	mg/L	5	04/15/2021 17:13	175337
Lithium	*	0.0030		**0.0056**	mg/L	5	04/19/2021 21:31	175337
Magnesium	NELAP	0.0500		**85.6**	mg/L	5	04/19/2021 21:31	175337
Manganese	NELAP	0.0020		**1.10**	mg/L	5	04/19/2021 21:31	175337
Molybdenum	NELAP	0.0015		**0.0141**	mg/L	5	04/15/2021 17:13	175337
Potassium	NELAP	0.175		**3.07**	mg/L	5	04/19/2021 21:31	175337
Sodium	NELAP	0.225		**47.3**	mg/L	5	04/19/2021 21:31	175337

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Lab ID: 21032011-006 **Client Sample ID:** MW-22-20210330

Matrix: GROUNDWATER **Collection Date:** 03/30/2021 8:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**346**	mg/L	1	04/05/2021 12:10	R289315
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/05/2021 12:10	R289315
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**618**	mg/L	1	04/05/2021 14:55	R289355
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**107**	mg/L	4	04/05/2021 14:26	R289261
SW-846 9251 (TOTAL)								
Chloride	NELAP	4		**97**	mg/L	4	04/05/2021 14:26	R289264
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0011**	mg/L	5	04/10/2021 12:09	175346
Iron	NELAP	0.0250		**2.10**	mg/L	5	04/13/2021 7:36	175346
Manganese	NELAP	0.0020		**0.0698**	mg/L	5	04/20/2021 23:59	175346
Molybdenum	NELAP	0.0015		**0.0058**	mg/L	5	04/10/2021 12:09	175346
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	04/19/2021 21:39	175337
Boron	NELAP	0.0250		**1.17**	mg/L	5	04/19/2021 21:39	175337
Calcium	NELAP	0.125		**72.2**	mg/L	5	04/19/2021 21:39	175337
Iron	NELAP	0.0250		**2.32**	mg/L	5	04/15/2021 17:22	175337
Lithium	*	0.0030		**0.0090**	mg/L	5	04/19/2021 21:39	175337
Magnesium	NELAP	0.0500		**25.4**	mg/L	5	04/19/2021 21:39	175337
Manganese	NELAP	0.0020		**0.0446**	mg/L	5	04/19/2021 21:39	175337
Molybdenum	NELAP	0.0015		**0.0063**	mg/L	5	04/15/2021 17:22	175337
Potassium	NELAP	0.175		**1.84**	mg/L	5	04/19/2021 21:39	175337
Sodium	NELAP	0.225		**24.5**	mg/L	5	04/19/2021 21:39	175337

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Lab ID: 21032011-007 **Client Sample ID:** EQB-20210330

Matrix: GROUNDWATER **Collection Date:** 03/30/2021 8:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**0.0296**	mg/L	5	04/10/2021 19:04	175337
Calcium	NELAP	0.125		**0.134**	mg/L	5	04/19/2021 21:47	175337
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/15/2021 17:31	175337
Lithium	*	0.0030		**< 0.0030**	mg/L	5	04/19/2021 21:47	175337
Magnesium	NELAP	0.0500		**< 0.0500**	mg/L	5	04/19/2021 21:47	175337
Manganese	NELAP	0.0020		**< 0.0020**	mg/L	5	04/19/2021 21:47	175337
Molybdenum	NELAP	0.0015		**< 0.0015**	mg/L	5	04/15/2021 17:31	175337
Potassium	NELAP	0.175		**< 0.175**	mg/L	5	04/19/2021 21:47	175337
Sodium	NELAP	0.225		**< 0.225**	mg/L	5	04/19/2021 21:47	175337

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Lab ID: 21032011-008 **Client Sample ID:** HEN-W-20210330

Matrix: GROUNDWATER **Collection Date:** 03/30/2021 14:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**241**	mg/L	1	04/05/2021 12:17	R289315
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/05/2021 12:17	R289315
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**498**	mg/L	1	04/05/2021 14:57	R289355
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**68**	mg/L	4	04/05/2021 14:31	R289261
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**130**	mg/L	5	04/05/2021 15:01	R289264
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0011**	mg/L	5	04/10/2021 12:17	175346
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/13/2021 7:44	175346
Manganese	NELAP	0.0020		**0.0118**	mg/L	5	04/21/2021 0:07	175346
Molybdenum	NELAP	0.0015		**0.0039**	mg/L	5	04/10/2021 12:17	175346
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0030**	mg/L	5	04/19/2021 21:55	175337
Boron	NELAP	0.0250		**0.154**	mg/L	5	04/19/2021 21:55	175337
Calcium	NELAP	0.125		**89.3**	mg/L	5	04/19/2021 21:55	175337
Iron	NELAP	0.0250		**6.28**	mg/L	5	04/15/2021 17:39	175337
Lithium	*	0.0030		**0.0109**	mg/L	5	04/19/2021 21:55	175337
Magnesium	NELAP	0.0500		**35.2**	mg/L	5	04/19/2021 21:55	175337
Manganese	NELAP	0.0020		**0.249**	mg/L	5	04/19/2021 21:55	175337
Molybdenum	NELAP	0.0015		**0.0042**	mg/L	5	04/15/2021 17:39	175337
Potassium	NELAP	0.175		**5.00**	mg/L	5	04/19/2021 21:55	175337
Sodium	NELAP	0.225		**72.9**	mg/L	5	04/19/2021 21:55	175337

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Lab ID: 21032011-009 **Client Sample ID:** HEN-E-20210330

Matrix: GROUNDWATER **Collection Date:** 03/30/2021 14:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**232**	mg/L	1	04/05/2021 12:25	R289315
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/05/2021 12:25	R289315
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**500**	mg/L	1	04/05/2021 14:58	R289355
SW-846 9036 (TOTAL)								
Sulfate	NELAP	40		**66**	mg/L	4	04/05/2021 15:11	R289261
SW-846 9251 (TOTAL)								
Chloride	NELAP	4		**124**	mg/L	4	04/05/2021 15:11	R289264
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/13/2021 7:52	175346
Manganese	NELAP	0.0020		**0.0113**	mg/L	5	04/21/2021 0:16	175346
Molybdenum	NELAP	0.0015		**0.0039**	mg/L	5	04/10/2021 13:47	175346
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**0.0857**	mg/L	5	04/10/2021 19:21	175337
Calcium	NELAP	0.125		**81.5**	mg/L	5	04/19/2021 22:04	175337
Iron	NELAP	0.0250		**1.19**	mg/L	5	04/15/2021 17:48	175337
Lithium	*	0.0030		**0.0071**	mg/L	5	04/19/2021 22:04	175337
Magnesium	NELAP	0.0500		**32.7**	mg/L	5	04/19/2021 22:04	175337
Manganese	NELAP	0.0020		**0.0700**	mg/L	5	04/19/2021 22:04	175337
Molybdenum	NELAP	0.0015		**0.0044**	mg/L	5	04/15/2021 17:48	175337
Potassium	NELAP	0.175		**4.25**	mg/L	5	04/19/2021 22:04	175337
Sodium	NELAP	0.225		**75.3**	mg/L	5	04/19/2021 22:04	175337

Client: Geosyntec Consultants
Work Order: 21032011
Client Project: GLP8006/GLP8007
Report Date: 23-Apr-21

Lab Sample ID	Client Sample ID	Matrix	Fractions	Collection Date
21032011-001	MW-18S-20210330	Groundwater	4	03/30/2021 10:42
21032011-002	MW-03R-20210330	Groundwater	4	03/30/2021 9:32
21032011-003	MW-18D-20210330	Groundwater	4	03/30/2021 11:45
21032011-004	MW-51-0210330	Groundwater	4	03/30/2021 13:45
21032011-005	MW-23-20210330	Groundwater	4	03/30/2021 11:00
21032011-006	MW-22-20210330	Groundwater	4	03/30/2021 8:30
21032011-007	EQB-20210330	Groundwater	1	03/30/2021 8:30
21032011-008	HEN-W-20210330	Groundwater	4	03/30/2021 14:30
21032011-009	HEN-E-20210330	Groundwater	4	03/30/2021 14:30

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			Prep Date/Time	Analysis Date/Time
21032011-001A	MW-18S-20210330	03/30/2021 10:42	03/31/2021 14:40		
	Standard Methods 2320 B (Total) 1997, 2011				04/05/2021 10:58
	Standard Methods 2320 B 1997, 2011				04/05/2021 10:58
	Standard Methods 2540 C (Total) 1997, 2011				04/05/2021 14:53
21032011-001B	MW-18S-20210330	03/30/2021 10:42	03/31/2021 14:40		
	SW-846 9036 (Total)				04/05/2021 13:48
	SW-846 9251 (Total)				04/05/2021 13:49
21032011-001C	MW-18S-20210330	03/30/2021 10:42	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/15/2021 15:11
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/19/2021 19:37
21032011-001D	MW-18S-20210330	03/30/2021 10:42	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/10/2021 11:28
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/13/2021 5:22
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/19/2021 0:19
21032011-002A	MW-03R-20210330	03/30/2021 9:32	03/31/2021 14:40		
	Standard Methods 2320 B (Total) 1997, 2011				04/05/2021 11:04
	Standard Methods 2320 B 1997, 2011				04/05/2021 11:04
	Standard Methods 2540 C (Total) 1997, 2011				04/05/2021 14:53
21032011-002B	MW-03R-20210330	03/30/2021 9:32	03/31/2021 14:40		
	SW-846 9036 (Total)				04/05/2021 14:07
	SW-846 9251 (Total)				04/05/2021 14:07
21032011-002C	MW-03R-20210330	03/30/2021 9:32	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/15/2021 15:20
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/19/2021 19:45
21032011-002D	MW-03R-20210330	03/30/2021 9:32	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/10/2021 11:36
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/13/2021 5:30
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/19/2021 0:27
21032011-003A	MW-18D-20210330	03/30/2021 11:45	03/31/2021 14:40		
	Standard Methods 2320 B (Total) 1997, 2011				04/05/2021 11:11
	Standard Methods 2320 B 1997, 2011				04/05/2021 11:11
	Standard Methods 2540 C (Total) 1997, 2011				04/05/2021 14:54
21032011-003B	MW-18D-20210330	03/30/2021 11:45	03/31/2021 14:40		
	SW-846 9036 (Total)				04/05/2021 14:10
	SW-846 9251 (Total)				04/05/2021 14:10
21032011-003C	MW-18D-20210330	03/30/2021 11:45	03/31/2021 14:40		

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/15/2021 15:28
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/19/2021 19:54
21032011-003D	MW-18D-20210330	03/30/2021 11:45	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/10/2021 11:44
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/13/2021 5:38
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/20/2021 23:35
21032011-004A	MW-51-0210330	03/30/2021 13:45	03/31/2021 14:40		
	Standard Methods 2320 B (Total) 1997, 2011				04/05/2021 11:50
	Standard Methods 2320 B 1997, 2011				04/05/2021 11:50
	Standard Methods 2540 C (Total) 1997, 2011				04/05/2021 14:55
21032011-004B	MW-51-0210330	03/30/2021 13:45	03/31/2021 14:40		
	SW-846 9036 (Total)				04/05/2021 14:12
	SW-846 9251 (Total)				04/05/2021 14:13
21032011-004C	MW-51-0210330	03/30/2021 13:45	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/15/2021 15:37
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/19/2021 21:23
21032011-004D	MW-51-0210330	03/30/2021 13:45	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/10/2021 11:52
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/13/2021 5:46
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/20/2021 23:43
21032011-005A	MW-23-20210330	03/30/2021 11:00	03/31/2021 14:40		
	Standard Methods 2320 B (Total) 1997, 2011				04/05/2021 11:57
	Standard Methods 2320 B 1997, 2011				04/05/2021 11:57
	Standard Methods 2540 C (Total) 1997, 2011				04/05/2021 14:55
21032011-005B	MW-23-20210330	03/30/2021 11:00	03/31/2021 14:40		
	SW-846 9036 (Total)				04/05/2021 14:23
	SW-846 9251 (Total)				04/05/2021 14:18
21032011-005C	MW-23-20210330	03/30/2021 11:00	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/15/2021 17:13
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/19/2021 21:31
21032011-005D	MW-23-20210330	03/30/2021 11:00	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/10/2021 12:01
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/13/2021 5:54
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/20/2021 23:51
21032011-006A	MW-22-20210330	03/30/2021 8:30	03/31/2021 14:40		
	Standard Methods 2320 B (Total) 1997, 2011				04/05/2021 12:10

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
	Standard Methods 2320 B 1997, 2011				04/05/2021 12:10
	Standard Methods 2540 C (Total) 1997, 2011				04/05/2021 14:55
21032011-006B	MW-22-20210330	03/30/2021 8:30	03/31/2021 14:40		
	SW-846 9036 (Total)				04/05/2021 14:26
	SW-846 9251 (Total)				04/05/2021 14:26
21032011-006C	MW-22-20210330	03/30/2021 8:30	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/15/2021 17:22
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/19/2021 21:39
21032011-006D	MW-22-20210330	03/30/2021 8:30	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/10/2021 12:09
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/13/2021 7:36
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/20/2021 23:59
21032011-007A	EQB-20210330	03/30/2021 8:30	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/10/2021 19:04
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/15/2021 17:31
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/19/2021 21:47
21032011-008A	HEN-W-20210330	03/30/2021 14:30	03/31/2021 14:40		
	Standard Methods 2320 B (Total) 1997, 2011				04/05/2021 12:17
	Standard Methods 2320 B 1997, 2011				04/05/2021 12:17
	Standard Methods 2540 C (Total) 1997, 2011				04/05/2021 14:57
21032011-008B	HEN-W-20210330	03/30/2021 14:30	03/31/2021 14:40		
	SW-846 9036 (Total)				04/05/2021 14:31
	SW-846 9251 (Total)				04/05/2021 15:01
21032011-008C	HEN-W-20210330	03/30/2021 14:30	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/15/2021 17:39
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/19/2021 21:55
21032011-008D	HEN-W-20210330	03/30/2021 14:30	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/10/2021 12:17
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/13/2021 7:44
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/21/2021 0:07
21032011-009A	HEN-E-20210330	03/30/2021 14:30	03/31/2021 14:40		
	Standard Methods 2320 B (Total) 1997, 2011				04/05/2021 12:25
	Standard Methods 2320 B 1997, 2011				04/05/2021 12:25
	Standard Methods 2540 C (Total) 1997, 2011				04/05/2021 14:58
21032011-009B	HEN-E-20210330	03/30/2021 14:30	03/31/2021 14:40		
	SW-846 9036 (Total)				04/05/2021 15:11

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
	SW-846 9251 (Total)				04/05/2021 15:11
21032011-009C	HEN-E-20210330	03/30/2021 14:30	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/10/2021 19:21
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/15/2021 17:48
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			03/31/2021 17:42	04/19/2021 22:04
21032011-009D	HEN-E-20210330	03/30/2021 14:30	03/31/2021 14:40		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/10/2021 13:47
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/13/2021 7:52
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			03/31/2021 21:58	04/21/2021 0:16

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

STANDARD METHODS 2540 C (TOTAL) 1997, 2011

Batch R289355 **SampType:** MBLK Units **mg/L**

SampID: MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	04/05/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	04/05/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	04/05/2021

Batch R289355 **SampType:** LCS Units **mg/L**

SampID: LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**946**	1000	0	94.6	90	110	04/05/2021
Total Dissolved Solids		20		**954**	1000	0	95.4	90	110	04/05/2021
Total Dissolved Solids		20		**968**	1000	0	96.8	90	110	04/05/2021

Batch R289355 **SampType:** DUP Units **mg/L** RPD Limit **5**

SampID: 21032011-006ADUP

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Total Dissolved Solids		20		**590**				618.0	4.64	04/05/2021

SW-846 9036 (TOTAL)

Batch R289261 **SampType:** MBLK Units **mg/L**

SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	04/05/2021

Batch R289261 **SampType:** LCS Units **mg/L**

SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**20**	20.00	0	98.1	90	110	04/05/2021

Batch R289261 **SampType:** MS Units **mg/L**

SampID: 21032011-008BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		40		**137**	80.00	67.75	86.6	85	115	04/05/2021

Batch R289261 **SampType:** MSD Units **mg/L** RPD Limit **10**

SampID: 21032011-008BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Sulfate		40		**140**	80.00	67.75	89.8	137.0	1.89	04/05/2021

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

SW-846 9251 (TOTAL)

Batch R289264 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	04/05/2021

Batch R289264 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**21**	20.00	0	104.2	90	110	04/05/2021

Batch R289264 **SampType:** MS Units **mg/L**
SampID: 21032011-008BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		5		**217**	100.0	130.2	87.2	85	115	04/05/2021

Batch R289264 **SampType:** MSD Units **mg/L** RPD Limit **15**
SampID: 21032011-008BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Chloride		5		**216**	100.0	130.2	85.7	217.4	0.68	04/05/2021

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 175346 **SampType:** MBLK Units **mg/L**
SampID: MBLK-175346

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	04/10/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	04/13/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	04/18/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	04/20/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	04/10/2021

Batch 175346 **SampType:** LCS Units **mg/L**
SampID: LCS-175346

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.463**	0.5000	0	92.5	80	120	04/10/2021
Iron		0.0250		**1.78**	2.000	0	88.9	80	120	04/13/2021
Manganese		0.0020		**0.498**	0.5000	0	99.5	80	120	04/18/2021
Manganese		0.0020		**0.486**	0.5000	0	97.2	80	120	04/20/2021
Molybdenum		0.0015		**0.434**	0.5000	0	86.8	80	120	04/10/2021

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 175346 **SampType:** MS Units **mg/L**

SampID: 21032011-001DMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Iron		0.0250		**1.82**	2.000	0	91.0	75	125	04/13/2021
Manganese		0.0020		**0.489**	0.5000	0.003919	97.1	75	125	04/19/2021
Molybdenum		0.0015		**0.587**	0.5000	0.1437	88.6	75	125	04/10/2021

Batch 175346 **SampType:** MSD Units **mg/L** RPD Limit **20**

SampID: 21032011-001DMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Iron		0.0250		**1.85**	2.000	0	92.6	1.821	1.76	04/13/2021
Manganese		0.0020		**0.494**	0.5000	0.003919	98.0	0.4892	0.98	04/19/2021
Molybdenum		0.0015		**0.582**	0.5000	0.1437	87.6	0.5868	0.85	04/10/2021

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 175337 **SampType:** MBLK Units **mg/L**

SampID: MBLK-175337

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	04/19/2021
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	04/15/2021
Boron		0.0250		**< 0.0250**	0.0093	0	0	-100	100	04/10/2021
Boron		0.0250		**< 0.0250**	0.0093	0	0	-100	100	04/15/2021
Calcium		0.125		**< 0.125**	0.0700	0	0	-100	100	04/19/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	04/15/2021
Lithium	*	0.0030		**< 0.0030**	0.0015	0	0	-100	100	04/15/2021
Lithium	*	0.0030		**< 0.0030**	0.0015	0	0	-100	100	04/19/2021
Magnesium		0.0500		**< 0.0500**	0.0175	0	0	-100	100	04/19/2021
Magnesium		0.0500	S	**0.0697**	0.0175	0	398.0	-100	100	04/17/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	04/19/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	04/15/2021
Potassium		0.175		**< 0.175**	0.0800	0	0	-100	100	04/19/2021
Potassium		0.175		**< 0.175**	0.0800	0	0	-100	100	04/15/2021
Sodium		0.225	S	**0.311**	0.0750	0	414.9	-100	100	04/17/2021
Sodium		0.225		**< 0.225**	0.0750	0	0	-100	100	04/19/2021

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 175337 **SampType:** LCS Units **mg/L**

SampID: LCS-175337

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.542**	0.5000	0	108.4	80	120	04/15/2021
Arsenic		0.0010		**0.563**	0.5000	0	112.5	80	120	04/19/2021
Boron		0.0250		**0.512**	0.5000	0	102.5	80	120	04/15/2021
Boron		0.0250		**0.499**	0.5000	0	99.8	80	120	04/10/2021
Calcium		0.125		**2.56**	2.500	0	102.3	80	120	04/19/2021
Iron		0.0250		**1.96**	2.000	0	98.2	80	120	04/15/2021
Lithium	*	0.0030		**0.542**	0.5000	0	108.5	80	120	04/19/2021
Lithium	*	0.0030		**0.548**	0.5000	0	109.7	80	120	04/15/2021
Magnesium		0.0500		**2.66**	2.500	0	106.5	80	120	04/19/2021
Magnesium		0.0500	B	**2.49**	2.500	0	99.7	80	120	04/17/2021
Manganese		0.0020		**0.545**	0.5000	0	109.0	80	120	04/19/2021
Molybdenum		0.0015		**0.467**	0.5000	0	93.3	80	120	04/15/2021
Potassium		0.175		**2.50**	2.500	0	100.1	80	120	04/15/2021
Potassium		0.175		**2.75**	2.500	0	110.0	80	120	04/19/2021
Sodium		0.225	B	**2.48**	2.500	0	99.3	80	120	04/17/2021
Sodium		0.225		**2.50**	2.500	0	99.9	80	120	04/19/2021

Batch 175337 **SampType:** MS Units **mg/L**

SampID: 21032011-001CMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Boron		0.0250		**3.82**	0.5000	3.289	106.6	75	125	04/19/2021
Calcium		0.125	S	**111**	2.500	106.1	206.7	75	125	04/19/2021
Iron		0.0250		**1.94**	2.000	0	97.0	75	125	04/15/2021
Lithium	*	0.0030		**0.652**	0.5000	0.06573	117.3	75	125	04/19/2021
Magnesium		0.0500		**31.5**	2.500	28.63	112.7	75	125	04/19/2021
Manganese		0.0020		**0.531**	0.5000	0.004683	105.3	75	125	04/19/2021
Molybdenum		0.0015		**0.620**	0.5000	0.1533	93.2	75	125	04/15/2021
Potassium		0.175		**15.2**	2.500	12.23	119.3	75	125	04/19/2021
Sodium		0.225		**60.9**	2.500	57.76	124.9	75	125	04/19/2021

Client: Geosyntec Consultants **Work Order:** 21032011

Client Project: GLP8006/GLP8007 **Report Date:** 23-Apr-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch **175337** **SampType:** **MSD** Units **mg/L** RPD Limit **20**

SampID: 21032011-001CMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Boron		0.0250		**3.72**	0.5000	3.289	86.7	3.822	2.64	04/19/2021
Calcium		0.125	S	**112**	2.500	106.1	241.5	111.3	0.78	04/19/2021
Iron		0.0250		**1.98**	2.000	0	99.1	1.939	2.21	04/15/2021
Lithium	*	0.0030		**0.638**	0.5000	0.06573	114.4	0.6523	2.27	04/19/2021
Magnesium		0.0500		**31.3**	2.500	28.63	106.0	31.45	0.54	04/19/2021
Manganese		0.0020		**0.534**	0.5000	0.004683	105.8	0.5309	0.56	04/19/2021
Molybdenum		0.0015		**0.643**	0.5000	0.1533	98.0	0.6195	3.74	04/15/2021
Potassium		0.175	S	**15.4**	2.500	12.23	127.4	15.21	1.32	04/19/2021
Sodium		0.225		**59.8**	2.500	57.76	83.6	60.88	1.71	04/19/2021

Receiving Check List

Teklab, Inc. Environmental Laboratory

http://www.teklabinc.com/

Client: Geosyntec Consultants
Client Project: GLP8006/GLP8007

Work Order: 21032011
Report Date: 23-Apr-21

Carrier: Tim Mathis

Received By: MEK

Completed by: Marvin L. Darling II
On: 31-Mar-21
Marvin L. Darling

Reviewed by: Emily Pohlman
On: 31-Mar-21
Emily Pohlman

Pages to follow: Chain of custody 1 Extra pages included 0

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	Temp °C 2.4
Type of thermal preservation?	None ☐	Ice ☑	Blue Ice ☐	Dry Ice ☐
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		
Reported field parameters measured:	Field ☐	Lab ☐	NA ☑	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐		
When thermal preservation is required, samples are compliant with a temperature between 0.1°C - 6.0°C, or when samples are received on ice the same day as collected.				
Water – at least one vial per sample has zero headspace?	Yes ☐	No ☐	No VOA vials ☑	
Water - TOX containers have zero headspace?	Yes ☐	No ☐	No TOX containers ☑	
Water - pH acceptable upon receipt?	Yes ☑	No ☐	NA ☐	
NPDES/CWA TCN interferences checked/treated in the field?	Yes ☐	No ☐	NA ☑	

Any No responses must be detailed below or on the COC.

pH strip# 75145. ERH 3/31/21

CHAIN OF CUSTODY

pg. 1 of 1 Work order # 21032011

TEKLAB, INC. 5445 Horseshoe Lake Road - Collinsville, IL 62234 - Phone: (618) 344-1004 - Fax: (618) 344-1005

Client:	Geosyntec Consultants
Address:	1 McBride and Son Center Drive, Suite 202
City / State / Zip	Chesterfield, MO 63005
Contact:	Allison Kreinberg **Phone:** (636) 812-0809
E-Mail:	AKreinberg@Geosyntec.com **Fax:**

Samples on: [X] ICE [ ] BLUE ICE [ ] NO ICE 12.4 °C LTG# 5

Preserved in: [ ] LAB [X] FIELD

Lab Notes 75145 EH 3/31/21

FOR LAB USE ONLY

metals per project history. MLOD 3/31/21

Are these samples known to be involved in litigation? If yes, a surcharge will apply [ ] Yes [ ] No

Are these samples known to be hazardous? [ ] Yes [ ] No

Are there any required reporting limits to be met on the requested analysis?. If yes, please provide limits in the comment section. [ ] Yes [ ] No

Client Comments:

*/** Client to provide metals list

- Test HEN-W-20210330 for Arsenic
- Test 22,23,51 for cadmium

- Stickered Diss are diss metals

Project Name/Number	Sample Collector's Name
GLP8006/GLP8007	

Results Requested

[ ] Standard [ ] 1-2 Day (100% Surcharge) [ ] Other ____ [ ] 3 Day (50% Surcharge)

Billing Instructions

Lab Use Only	Sample Identification	Date/Time Sampled	# and Type of Containers: UNPRES	HNO3	NaOH	H2SO4	HCL	MeOH	NaHSO4	OTHER	MATRIX: Aqueous	Drinking Water	Soil	Sludge	Special Waste	Groundwater	INDICATE ANALYSIS REQUESTED: Alkalinity	Chloride	Metals (Dissolved)**	Metals (Total)*	Sulfate	TDS
21032011-cc1	MW-18S-20210330	3-30-21 1042	1	3												/	/	/	/	/	/	/
-cc2	[redacted]-20210330	3-30-21 932	1	3												/	/	/	/	/	/	/
-cc3	[redacted]-20210330	3-30-21 1145	1	3												/	/	/	/	/	/	/
-cc4	[redacted]-20210330	3-30-21 1345	1	3												/	/	/	/	/	/	/
-cc5	[redacted]-20210330	3-30-21 1100	1	3												/	/	/	/	/	/	/
-cc6	[redacted]-20210330	3-30-21 0830	1	3												/	/	/	/	/	/	/
-cc7	[redacted]	[redacted]		1							/								/			
-cc8	HEN-W-20210330	3-30-21 [redacted]	1	3							/						/	/	/	/	/	/
-cc9	HEN-E-20210330	3-30-21 1430	1	3							/						/	/	/	/	/	/

Cancelled

Relinquished By	Date/Time	Received By	Date/Time
[signature]	3-30-21	[signature]	3-31-21 1234
[signature]	3-31-21 1440	Mary Kemp	3/31/21 1440

The individual signing this agreement on behalf of the client, acknowledges that he/she has read and understands the terms and conditions of this agreement, and that he/she has the authority to sign on behalf of the client. See www.teklabinc.com for terms and conditions.

BottleOrder: 64634

EH 3/31/21

May 12, 2021

Allison Kreinberg
Geosyntec Consultants
1 McBride and Son Center Drive, Suite 202
Chesterfield, MO 63005
TEL: (614) 468-0421
FAX:

Illinois	100226
Kansas	E-10374
Louisiana	05002
Louisiana	05003
Oklahoma	9978

RE: GLP8006/GLP8007 **WorkOrder:** 21041324

Dear Allison Kreinberg:

TEKLAB, INC received 8 samples on 4/21/2021 5:47:00 PM for the analysis presented in the following report.

Samples are analyzed on an as received basis unless otherwise requested and documented. The sample results contained in this report relate only to the requested analytes of interest as directed on the chain of custody. NELAP accredited fields of testing are indicated by the letters NELAP under the Certification column. Unless otherwise documented within this report, Teklab Inc. analyzes samples utilizing the most current methods in compliance with 40CFR. All tests are performed in the Collinsville, IL laboratory unless otherwise noted in the Case Narrative.

All quality control criteria applicable to the test methods employed for this project have been satisfactorily met and are in accordance with NELAP except where noted. The following report shall not be reproduced, except in full, without the written approval of Teklab, Inc.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Aaron Renner
Project Manager
(630)324-6855
arenner@teklabinc.com

Report Contents

Client: Geosyntec Consultants
Work Order: 21041324
Client Project: GLP8006/GLP8007
Report Date: 12-May-21

This reporting package includes the following:

Cover Letter	1
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Accreditations	6
Laboratory Results	7
Sample Summary	15
Dates Report	16
Quality Control Results	19
Receiving Check List	27
Chain of Custody	Appended

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Abbr	Definition
*	Analytes on report marked with an asterisk are not NELAP accredited
CCV	Continuing calibration verification is a check of a standard to determine the state of calibration of an instrument between recalibration.
CRQL	A Client Requested Quantitation Limit is a reporting limit that varies according to customer request. The CRQL may not be less than the MDL.
DF	Dilution factor is the dilution performed during analysis only and does not take into account any dilutions made during sample preparation. The reported result is final and includes all dilution factors.
DNI	Did not ignite
DUP	Laboratory duplicate is a replicate aliquot prepared under the same laboratory conditions and independently analyzed to obtain a measure of precision.
ICV	Initial calibration verification is a check of a standard to determine the state of calibration of an instrument before sample analysis is initiated.
IDPH	IL Dept. of Public Health
LCS	Laboratory control sample is a sample matrix, free from the analytes of interest,spiked with verified known amounts of analytes and analyzed exactly like a sample to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.
LCSD	Laboratory control sample duplicate is a replicate laboratory control sample that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MBLK	Method blank is a sample of a matrix similar to the batch of associated sample (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences should present at concentrations that impact the analytical results for sample analyses.
MDL	"The method detection limit is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results."
MS	Matrix spike is an aliquot of matrix fortified (spiked) with known quantities of specific analytes that is subjected to the entire analytical procedures in order to determine the effect of the matrix on an approved test method's recovery system. The acceptable recovery range is listed in the QC Package (provided upon request).
MSD	Matrix spike duplicate means a replicate matrix spike that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MW	Molecular weight
NC	Data is not acceptable for compliance purposes
ND	Not Detected at the Reporting Limit
NELAP	NELAP Accredited
PQL	Practical quantitation limit means the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.
RL	The reporting limit the lowest level that the data is displayed in the final report. The reporting limit may vary according to customer request or sample dilution. The reporting limit may not be less than the MDL.
RPD	Relative percent difference is a calculated difference between two recoveries (ie. MS/MSD). The acceptable recovery limit is listed in the QC Package (provided upon request).
SPK	The spike is a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery deficiency or for other quality control purposes.
Surr	Surrogates are compounds which are similar to the analytes of interest in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.
TIC	Tentatively identified compound: Analytes tentatively identified in the sample by using a library search. Only results not in the calibration standard will be reported as tentatively identified compounds. Results for tentatively identified compounds that are not present in the calibration standard, but are assigned a specific chemical name based upon the library search, are calculated using total peak areas from reconstructed ion chromatograms and a response factor of one. The nearest Internal Standard is used for the calculation. The results of any TICs must be considered estimated, and are flagged with a "T". If the estimated result is above the calibration range it is flagged "ET"
TNTC	Too numerous to count (> 200 CFU)

Client: Geosyntec Consultants
Work Order: 21041324
Client Project: GLP8006/GLP8007
Report Date: 12-May-21

Qualifiers

- # - Unknown hydrocarbon
- B - Analyte detected in associated Method Blank
- C - RL shown is a Client Requested Quantitation Limit
- E - Value above quantitation range
- H - Holding times exceeded
- I - Associated internal standard was outside method criteria
- J - Analyte detected below quantitation limits
- M - Manual Integration used to determine area response
- ND - Not Detected at the Reporting Limit
- R - RPD outside accepted recovery limits
- S - Spike Recovery outside recovery limits
- T - TIC(Tentatively identified compound)
- X - Value exceeds Maximum Contaminant Level

Case Narrative

http://www.teklabinc.com/

Client: Geosyntec Consultants
Work Order: 21041324
Client Project: GLP8006/GLP8007
Report Date: 12-May-21

Cooler Receipt Temp: 4.6 °C

Locations

Collinsville

Address	5445 Horseshoe Lake Road Collinsville, IL 62234-7425
Phone	(618) 344-1004
Fax	(618) 344-1005
Email	jhriley@teklabinc.com

Springfield

Address	3920 Pintail Dr Springfield, IL 62711-9415
Phone	(217) 698-1004
Fax	(217) 698-1005
Email	KKlostermann@teklabinc.com

Kansas City

Address	8421 Nieman Road Lenexa, KS 66214
Phone	(913) 541-1998
Fax	(913) 541-1998
Email	jhriley@teklabinc.com

Collinsville Air

Address	5445 Horseshoe Lake Road Collinsville, IL 62234-7425
Phone	(618) 344-1004
Fax	(618) 344-1005
Email	EHurley@teklabinc.com

Chicago

Address	1319 Butterfield Rd. Downers Grove, IL 60515
Phone	(630) 324-6855
Fax	
Email	arenner@teklabinc.com

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

State	Dept	Cert #	NELAP	Exp Date	Lab
Illinois	IEPA	100226	NELAP	1/31/2022	Collinsville
Kansas	KDHE	E-10374	NELAP	4/30/2022	Collinsville
Louisiana	LDEQ	05002	NELAP	6/30/2021	Collinsville
Louisiana	LDEQ	05003	NELAP	6/30/2021	Collinsville
Oklahoma	ODEQ	9978	NELAP	8/31/2021	Collinsville
Arkansas	ADEQ	88-0966		3/14/2022	Collinsville
Illinois	IDPH	17584		5/31/2021	Collinsville
Kentucky	UST	0073		1/31/2022	Collinsville
Missouri	MDNR	00930		5/31/2021	Collinsville
Missouri	MDNR	930		1/31/2022	Collinsville

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Lab ID: 21041324-001 **Client Sample ID:** MW-03-20210420

Matrix: GROUNDWATER **Collection Date:** 04/20/2021 10:26

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**238**	mg/L	1	04/28/2021 9:53	R290321
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/28/2021 9:53	R290321
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**522**	mg/L	1	04/26/2021 17:43	R290281
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**86**	mg/L	5	04/26/2021 19:06	R290232
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**85**	mg/L	5	04/26/2021 19:06	R290233
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/27/2021 0:06	176137
Manganese	NELAP	0.0020		**0.0477**	mg/L	5	04/27/2021 0:06	176137
Molybdenum	NELAP	0.0015		**0.147**	mg/L	5	04/27/2021 0:06	176137
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250	B	**0.915**	mg/L	5	05/06/2021 16:36	176223
Calcium	NELAP	0.125	S	**92.2**	mg/L	5	05/09/2021 4:58	176223
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	05/09/2021 4:58	176223
Lithium	*	0.0030		**0.0328**	mg/L	5	05/06/2021 16:36	176223
Magnesium	NELAP	0.0500	S	**25.4**	mg/L	5	05/06/2021 16:36	176223
Manganese	NELAP	0.0020		**0.0978**	mg/L	5	05/06/2021 16:36	176223
Molybdenum	NELAP	0.0015		**0.191**	mg/L	5	05/06/2021 16:36	176223
Potassium	NELAP	0.175	S	**14.4**	mg/L	5	05/06/2021 16:36	176223
Sodium	NELAP	0.225		**53.4**	mg/L	5	05/09/2021 4:58	176223

Matrix spike control limits for Ca are not applicable due to high sample/spike ratio.

Sample result for B exceeds 10 times the method blank contamination. Data is reportable per the TNI Standard.

Matrix spike control limits for Mg & K are not applicable due to high sample/spike ratio.

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Lab ID: 21041324-002 **Client Sample ID:** MW-18D-20210420

Matrix: GROUNDWATER **Collection Date:** 04/20/2021 11:52

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**274**	mg/L	1	04/28/2021 10:00	R290321
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/28/2021 10:00	R290321
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**550**	mg/L	1	04/26/2021 17:44	R290281
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**97**	mg/L	5	04/26/2021 19:08	R290232
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**77**	mg/L	5	04/26/2021 19:08	R290233
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/27/2021 1:19	176137
Manganese	NELAP	0.0020		**0.0450**	mg/L	5	04/27/2021 1:19	176137
Molybdenum	NELAP	0.0015		**0.0297**	mg/L	5	04/27/2021 1:19	176137
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250	B	**1.38**	mg/L	5	05/06/2021 17:46	176223
Calcium	NELAP	0.125		**127**	mg/L	5	05/11/2021 14:59	176223
Iron	NELAP	0.0250		**0.239**	mg/L	5	05/06/2021 17:46	176223
Lithium	*	0.0030		**0.0264**	mg/L	5	05/06/2021 17:46	176223
Magnesium	NELAP	0.0500		**27.4**	mg/L	5	05/06/2021 17:46	176223
Manganese	NELAP	0.0020		**0.0520**	mg/L	5	05/06/2021 17:46	176223
Molybdenum	NELAP	0.0015		**0.0348**	mg/L	5	05/06/2021 17:46	176223
Potassium	NELAP	0.175		**9.97**	mg/L	5	05/06/2021 17:46	176223
Sodium	NELAP	0.225		**67.4**	mg/L	5	05/11/2021 14:59	176223

Sample result for B exceeds 10 times the method blank contamination. Data is reportable per the TNI Standard.

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Lab ID: 21041324-003 **Client Sample ID:** MW-51-20210420

Matrix: GROUNDWATER **Collection Date:** 04/20/2021 13:50

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**352**	mg/L	1	04/28/2021 10:14	R290321
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/28/2021 10:14	R290321
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**646**	mg/L	1	04/26/2021 17:44	R290281
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**105**	mg/L	5	04/26/2021 19:11	R290232
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**99**	mg/L	5	04/26/2021 19:11	R290233
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0148**	mg/L	5	04/27/2021 1:27	176137
Iron	NELAP	0.0250		**4.61**	mg/L	5	04/27/2021 1:27	176137
Manganese	NELAP	0.0020		**0.107**	mg/L	5	04/27/2021 1:27	176137
Molybdenum	NELAP	0.0015		**0.0105**	mg/L	5	04/27/2021 1:27	176137
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0232**	mg/L	5	05/06/2021 17:54	176223
Boron	NELAP	0.0250	B	**2.34**	mg/L	5	05/06/2021 17:54	176223
Calcium	NELAP	0.125		**157**	mg/L	5	05/11/2021 15:07	176223
Iron	NELAP	0.0250		**18.7**	mg/L	5	05/06/2021 17:54	176223
Lithium	*	0.0030		**0.0296**	mg/L	5	05/06/2021 17:54	176223
Magnesium	NELAP	0.0500		**44.0**	mg/L	5	05/06/2021 17:54	176223
Manganese	NELAP	0.0020		**0.319**	mg/L	5	05/06/2021 17:54	176223
Molybdenum	NELAP	0.0015		**0.0131**	mg/L	5	05/06/2021 17:54	176223
Potassium	NELAP	0.175		**5.47**	mg/L	5	05/06/2021 17:54	176223
Sodium	NELAP	0.225		**63.5**	mg/L	5	05/11/2021 15:07	176223

Sample result for B exceeds 10 times the method blank contamination. Data is reportable per the TNI Standard.

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Lab ID: 21041324-004 **Client Sample ID:** MW-23-20210420

Matrix: GROUNDWATER **Collection Date:** 04/20/2021 10:20

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**162**	mg/L	1	04/28/2021 10:22	R290321
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/28/2021 10:22	R290321
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**870**	mg/L	1	04/26/2021 17:44	R290281
SW-846 9036 (TOTAL)								
Sulfate	NELAP	200		**422**	mg/L	20	04/26/2021 19:16	R290232
SW-846 9251 (TOTAL)								
Chloride	NELAP	20		**60**	mg/L	20	04/26/2021 19:16	R290233
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	04/27/2021 1:35	176137
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/27/2021 1:35	176137
Manganese	NELAP	0.0020		**0.875**	mg/L	5	04/27/2021 1:35	176137
Molybdenum	NELAP	0.0015		**0.0127**	mg/L	5	04/27/2021 1:35	176137
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	05/06/2021 18:03	176223
Boron	NELAP	0.0250	B	**8.63**	mg/L	5	05/06/2021 18:03	176223
Calcium	NELAP	0.125		**129**	mg/L	5	05/11/2021 15:15	176223
Iron	NELAP	0.0250		**0.0538**	mg/L	5	05/06/2021 18:03	176223
Lithium	*	0.0030		**0.0052**	mg/L	5	05/06/2021 18:03	176223
Magnesium	NELAP	0.0500		**83.7**	mg/L	5	05/06/2021 18:03	176223
Manganese	NELAP	0.0020		**1.01**	mg/L	5	05/06/2021 18:03	176223
Molybdenum	NELAP	0.0015		**0.0150**	mg/L	5	05/06/2021 18:03	176223
Potassium	NELAP	0.175		**2.93**	mg/L	5	05/06/2021 18:03	176223
Sodium	NELAP	0.225		**50.7**	mg/L	5	05/11/2021 15:15	176223

Sample result for B exceeds 10 times the method blank contamination. Data is reportable per the TNI Standard.

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Lab ID: 21041324-005 **Client Sample ID:** MW-22-20210420

Matrix: GROUNDWATER **Collection Date:** 04/20/2021 8:25

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**326**	mg/L	1	04/28/2021 10:28	R290321
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/28/2021 10:28	R290321
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**624**	mg/L	1	04/26/2021 17:45	R290281
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**104**	mg/L	5	04/26/2021 19:19	R290232
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**97**	mg/L	5	04/26/2021 19:19	R290233
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	04/27/2021 1:43	176137
Iron	NELAP	0.0250		**2.05**	mg/L	5	04/27/2021 1:43	176137
Manganese	NELAP	0.0020		**0.0652**	mg/L	5	04/27/2021 1:43	176137
Molybdenum	NELAP	0.0015		**0.0061**	mg/L	5	04/27/2021 1:43	176137
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0012**	mg/L	5	05/06/2021 18:12	176223
Boron	NELAP	0.0250	B	**2.00**	mg/L	5	05/06/2021 18:12	176223
Calcium	NELAP	0.125		**138**	mg/L	5	05/11/2021 15:23	176223
Iron	NELAP	0.0250		**2.55**	mg/L	5	05/06/2021 18:12	176223
Lithium	*	0.0030		**0.0162**	mg/L	5	05/06/2021 18:12	176223
Magnesium	NELAP	0.0500		**40.3**	mg/L	5	05/06/2021 18:12	176223
Manganese	NELAP	0.0020		**0.0786**	mg/L	5	05/06/2021 18:12	176223
Molybdenum	NELAP	0.0015		**0.0071**	mg/L	5	05/06/2021 18:12	176223
Potassium	NELAP	0.175		**3.19**	mg/L	5	05/06/2021 18:12	176223
Sodium	NELAP	0.225		**47.8**	mg/L	5	05/11/2021 15:23	176223

Sample result for B exceeds 10 times the method blank contamination. Data is reportable per the TNI Standard.

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Lab ID: 21041324-006 **Client Sample ID:** EQB-20210420

Matrix: AQUEOUS **Collection Date:** 04/20/2021 8:25

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**< 0.0010**	mg/L	5	05/06/2021 18:20	176223
Boron	NELAP	0.0250	B	**< 0.0250**	mg/L	5	05/06/2021 18:20	176223
Calcium	NELAP	0.125		**< 0.125**	mg/L	5	05/11/2021 15:31	176223
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	05/06/2021 18:20	176223
Lithium	*	0.0030		**< 0.0030**	mg/L	5	05/06/2021 18:20	176223
Magnesium	NELAP	0.0500		**< 0.0500**	mg/L	5	05/06/2021 18:20	176223
Manganese	NELAP	0.0020		**< 0.0020**	mg/L	5	05/06/2021 18:20	176223
Molybdenum	NELAP	0.0015		**< 0.0015**	mg/L	5	05/06/2021 18:20	176223
Potassium	NELAP	0.175		**< 0.175**	mg/L	5	05/06/2021 18:20	176223
Sodium	NELAP	0.225		**< 0.225**	mg/L	5	05/11/2021 15:31	176223

Contamination present in the MBLK for B. Sample results below the reporting limit are reportable per the TNI Standard.

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Lab ID: 21041324-007 **Client Sample ID:** HEN-W-20210420

Matrix: GROUNDWATER **Collection Date:** 04/20/2021 0:00

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**192**	mg/L	1	04/28/2021 10:36	R290321
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**23**	mg/L	1	04/28/2021 10:36	R290321
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**544**	mg/L	1	04/26/2021 18:34	R290281
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**73**	mg/L	5	04/26/2021 19:22	R290232
SW-846 9251 (TOTAL)								
Chloride	NELAP	5		**123**	mg/L	5	04/26/2021 19:22	R290233
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Arsenic	NELAP	0.0010		**0.0011**	mg/L	5	04/27/2021 1:51	176137
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	04/27/2021 1:51	176137
Manganese	NELAP	0.0020		**0.0242**	mg/L	5	04/27/2021 1:51	176137
Molybdenum	NELAP	0.0015		**0.0058**	mg/L	5	04/27/2021 1:51	176137
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Arsenic	NELAP	0.0010		**0.0014**	mg/L	5	05/09/2021 12:23	176238
Boron	NELAP	0.0250		**0.254**	mg/L	5	05/06/2021 23:59	176238
Calcium	NELAP	0.125	S	**75.2**	mg/L	5	05/09/2021 12:23	176238
Iron	NELAP	0.0250		**0.590**	mg/L	5	05/09/2021 12:23	176238
Lithium	*	0.0030		**0.0084**	mg/L	5	05/06/2021 23:59	176238
Magnesium	NELAP	0.0500	S	**30.8**	mg/L	5	05/06/2021 23:59	176238
Manganese	NELAP	0.0020		**0.0798**	mg/L	5	05/09/2021 12:23	176238
Molybdenum	NELAP	0.0015		**0.0073**	mg/L	5	05/06/2021 23:59	176238
Potassium	NELAP	0.175		**4.62**	mg/L	5	05/06/2021 23:59	176238
Sodium	NELAP	0.225	S	**73.1**	mg/L	5	05/09/2021 12:23	176238

Sample result for Fe exceeds 10 times the CCB. Data is reportable per the TNI Standard.
Matrix spike control limits for Ca & Na are not applicable due to high sample/spike ratio.
Matrix spike control limits for Mg are not applicable due to high sample/spike ratio.

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Lab ID: 21041324-008 **Client Sample ID:** MW-18-S-20210420

Matrix: GROUNDWATER **Collection Date:** 04/20/2021 13:20

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
STANDARD METHODS 2320 B (TOTAL) 1997, 2011								
Alkalinity, Bicarbonate (as CaCO3)	NELAP	0		**229**	mg/L	1	04/28/2021 11:02	R290321
STANDARD METHODS 2320 B 1997, 2011								
Alkalinity, Carbonate (as CaCO3)	NELAP	0		**0**	mg/L	1	04/28/2021 11:02	R290321
STANDARD METHODS 2540 C (TOTAL) 1997, 2011								
Total Dissolved Solids	NELAP	20		**590**	mg/L	1	04/26/2021 18:35	R290281
SW-846 9036 (TOTAL)								
Sulfate	NELAP	50		**154**	mg/L	5	04/26/2021 19:27	R290232
SW-846 9251 (TOTAL)								
Chloride	NELAP	10		**64**	mg/L	10	04/27/2021 17:05	R290302
SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)								
Iron	NELAP	0.0250		**0.0313**	mg/L	5	04/27/2021 2:00	176137
Manganese	NELAP	0.0020		**< 0.0020**	mg/L	5	04/27/2021 2:00	176137
Molybdenum	NELAP	0.0015		**0.153**	mg/L	5	04/27/2021 2:00	176137
SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)								
Boron	NELAP	0.0250		**3.23**	mg/L	5	05/07/2021 0:08	176238
Calcium	NELAP	0.125		**108**	mg/L	5	05/09/2021 12:31	176238
Iron	NELAP	0.0250		**< 0.0250**	mg/L	5	05/09/2021 12:31	176238
Lithium	*	0.0030		**0.0601**	mg/L	5	05/07/2021 0:08	176238
Magnesium	NELAP	0.0500		**25.4**	mg/L	5	05/07/2021 0:08	176238
Manganese	NELAP	0.0020		**< 0.0020**	mg/L	5	05/07/2021 0:08	176238
Molybdenum	NELAP	0.0015		**0.176**	mg/L	5	05/07/2021 0:08	176238
Potassium	NELAP	0.175		**12.5**	mg/L	5	05/07/2021 0:08	176238
Sodium	NELAP	0.225		**54.9**	mg/L	5	05/09/2021 12:31	176238

Contamination present in the CCB for Fe. Sample results below the reporting limit are reportable per the TNI Standard.

Sample result for Ca exceeds 10 times the CCB. Data is reportable per the TNI Standard.

CCV recovered outside the upper control limits for Mn. Sample results are below the reporting limit. Data is reportable per the TNI standard.

Client: Geosyntec Consultants
Client Project: GLP8006/GLP8007

Work Order: 21041324
Report Date: 12-May-21

Lab Sample ID	Client Sample ID	Matrix	Fractions	Collection Date
21041324-001	MW-03-20210420	Groundwater	4	04/20/2021 10:26
21041324-002	MW-18D-20210420	Groundwater	4	04/20/2021 11:52
21041324-003	MW-51-20210420	Groundwater	4	04/20/2021 13:50
21041324-004	MW-23-20210420	Groundwater	4	04/20/2021 10:20
21041324-005	MW-22-20210420	Groundwater	4	04/20/2021 8:25
21041324-006	EQB-20210420	Aqueous	1	04/20/2021 8:25
21041324-007	HEN-W-20210420	Groundwater	4	04/20/2021 0:00
21041324-008	MW-18-S-20210420	Groundwater	4	04/20/2021 13:20

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			Prep Date/Time	Analysis Date/Time
21041324-001A	MW-03-20210420	04/20/2021 10:26	04/21/2021 17:47		
	Standard Methods 2320 B (Total) 1997, 2011				04/28/2021 9:53
	Standard Methods 2320 B 1997, 2011				04/28/2021 9:53
	Standard Methods 2540 C (Total) 1997, 2011				04/26/2021 17:43
21041324-001B	MW-03-20210420	04/20/2021 10:26	04/21/2021 17:47		
	SW-846 9036 (Total)				04/26/2021 19:06
	SW-846 9251 (Total)				04/26/2021 19:06
21041324-001C	MW-03-20210420	04/20/2021 10:26	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/06/2021 16:36
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/09/2021 4:58
21041324-001D	MW-03-20210420	04/20/2021 10:26	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			04/22/2021 17:20	04/27/2021 0:06
21041324-002A	MW-18D-20210420	04/20/2021 11:52	04/21/2021 17:47		
	Standard Methods 2320 B (Total) 1997, 2011				04/28/2021 10:00
	Standard Methods 2320 B 1997, 2011				04/28/2021 10:00
	Standard Methods 2540 C (Total) 1997, 2011				04/26/2021 17:44
21041324-002B	MW-18D-20210420	04/20/2021 11:52	04/21/2021 17:47		
	SW-846 9036 (Total)				04/26/2021 19:08
	SW-846 9251 (Total)				04/26/2021 19:08
21041324-002C	MW-18D-20210420	04/20/2021 11:52	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/06/2021 17:46
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/11/2021 14:59
21041324-002D	MW-18D-20210420	04/20/2021 11:52	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			04/22/2021 17:20	04/27/2021 1:19
21041324-003A	MW-51-20210420	04/20/2021 13:50	04/21/2021 17:47		
	Standard Methods 2320 B (Total) 1997, 2011				04/28/2021 10:14
	Standard Methods 2320 B 1997, 2011				04/28/2021 10:14
	Standard Methods 2540 C (Total) 1997, 2011				04/26/2021 17:44
21041324-003B	MW-51-20210420	04/20/2021 13:50	04/21/2021 17:47		
	SW-846 9036 (Total)				04/26/2021 19:11
	SW-846 9251 (Total)				04/26/2021 19:11
21041324-003C	MW-51-20210420	04/20/2021 13:50	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/06/2021 17:54
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/11/2021 15:07
21041324-003D	MW-51-20210420	04/20/2021 13:50	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			04/22/2021 17:20	04/27/2021 1:27

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			Prep Date/Time	Analysis Date/Time
21041324-004A	MW-23-20210420	04/20/2021 10:20	04/21/2021 17:47		
	Standard Methods 2320 B (Total) 1997, 2011				04/28/2021 10:22
	Standard Methods 2320 B 1997, 2011				04/28/2021 10:22
	Standard Methods 2540 C (Total) 1997, 2011				04/26/2021 17:44
21041324-004B	MW-23-20210420	04/20/2021 10:20	04/21/2021 17:47		
	SW-846 9036 (Total)				04/26/2021 19:16
	SW-846 9251 (Total)				04/26/2021 19:16
21041324-004C	MW-23-20210420	04/20/2021 10:20	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/06/2021 18:03
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/11/2021 15:15
21041324-004D	MW-23-20210420	04/20/2021 10:20	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			04/22/2021 17:20	04/27/2021 1:35
21041324-005A	MW-22-20210420	04/20/2021 8:25	04/21/2021 17:47		
	Standard Methods 2320 B (Total) 1997, 2011				04/28/2021 10:28
	Standard Methods 2320 B 1997, 2011				04/28/2021 10:28
	Standard Methods 2540 C (Total) 1997, 2011				04/26/2021 17:45
21041324-005B	MW-22-20210420	04/20/2021 8:25	04/21/2021 17:47		
	SW-846 9036 (Total)				04/26/2021 19:19
	SW-846 9251 (Total)				04/26/2021 19:19
21041324-005C	MW-22-20210420	04/20/2021 8:25	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/06/2021 18:12
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/11/2021 15:23
21041324-005D	MW-22-20210420	04/20/2021 8:25	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			04/22/2021 17:20	04/27/2021 1:43
21041324-006A	EQB-20210420	04/20/2021 8:25	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/06/2021 18:20
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 14:02	05/11/2021 15:31
21041324-007A	HEN-W-20210420	04/20/2021 0:00	04/21/2021 17:47		
	Standard Methods 2320 B (Total) 1997, 2011				04/28/2021 10:36
	Standard Methods 2320 B 1997, 2011				04/28/2021 10:36
	Standard Methods 2540 C (Total) 1997, 2011				04/26/2021 18:34
21041324-007B	HEN-W-20210420	04/20/2021 0:00	04/21/2021 17:47		
	SW-846 9036 (Total)				04/26/2021 19:22
	SW-846 9251 (Total)				04/26/2021 19:22
21041324-007C	HEN-W-20210420	04/20/2021 0:00	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 18:15	05/06/2021 23:59

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

Sample ID	Client Sample ID	Collection Date	Received Date		
	Test Name			**Prep Date/Time**	**Analysis Date/Time**
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 18:15	05/09/2021 12:23
21041324-007D	HEN-W-20210420	04/20/2021 0:00	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			04/22/2021 17:20	04/27/2021 1:51
21041324-008A	MW-18-S-20210420	04/20/2021 13:20	04/21/2021 17:47		
	Standard Methods 2320 B (Total) 1997, 2011				04/28/2021 11:02
	Standard Methods 2320 B 1997, 2011				04/28/2021 11:02
	Standard Methods 2540 C (Total) 1997, 2011				04/26/2021 18:35
21041324-008B	MW-18-S-20210420	04/20/2021 13:20	04/21/2021 17:47		
	SW-846 9036 (Total)				04/26/2021 19:27
	SW-846 9251 (Total)				04/27/2021 17:05
21041324-008C	MW-18-S-20210420	04/20/2021 13:20	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 18:15	05/07/2021 0:08
	SW-846 3005A, 6020A, Metals by ICPMS (Total)			04/26/2021 18:15	05/09/2021 12:31
21041324-008D	MW-18-S-20210420	04/20/2021 13:20	04/21/2021 17:47		
	SW-846 3005A, 6020A, Metals by ICPMS (Dissolved)			04/22/2021 17:20	04/27/2021 2:00

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

STANDARD METHODS 2540 C (TOTAL) 1997, 2011

Batch R290281 **SampType:** MBLK Units **mg/L**

SampID: MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	04/27/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	04/26/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	04/26/2021
Total Dissolved Solids		20		**< 20**	16.00	0	0	-100	100	04/26/2021

Batch R290281 **SampType:** LCS Units **mg/L**

SampID: LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Total Dissolved Solids		20		**920**	1000	0	92.0	90	110	04/26/2021
Total Dissolved Solids		20		**944**	1000	0	94.4	90	110	04/26/2021
Total Dissolved Solids		20		**942**	1000	0	94.2	90	110	04/26/2021
Total Dissolved Solids		20		**916**	1000	0	91.6	90	110	04/27/2021

Batch R290281 **SampType:** DUP Units **mg/L** RPD Limit **5**

SampID: 21041324-007ADUP

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Total Dissolved Solids		20		**536**				544.0	1.48	04/26/2021

SW-846 9036 (TOTAL)

Batch R290232 **SampType:** MBLK Units **mg/L**

SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	04/26/2021

Batch R290232 **SampType:** LCS Units **mg/L**

SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**20**	20.00	0	101.8	90	110	04/26/2021

Batch R290232 **SampType:** MS Units **mg/L**

SampID: 21041324-008BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		50		**244**	100.0	153.5	90.0	85	115	04/26/2021

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

SW-846 9036 (TOTAL)

Batch R290232 **SampType:** MSD Units **mg/L** RPD Limit **10**

SampID: 21041324-008BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Sulfate		50		**249**	100.0	153.5	95.4	243.6	2.17	04/26/2021

Batch R290301 **SampType:** MBLK Units **mg/L**

SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	04/27/2021

Batch R290301 **SampType:** MBLK Units **mg/L**

SampID: MBLK/ICB

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**< 10**	6.140	0	0	-100	100	04/28/2021

Batch R290301 **SampType:** MBLK Units **mg/L**

SampID: MBLK-176252

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate	*	10		**< 10**	7.620	0	0	-100	100	04/27/2021

Batch R290301 **SampType:** LCS Units **mg/L**

SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**19**	20.00	0	93.6	90	110	04/27/2021

Batch R290301 **SampType:** LCS Units **mg/L**

SampID: LCS/ICV

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate		10		**18**	20.00	0	91.2	90	110	04/28/2021

SW-846 9251 (TOTAL)

Batch R290233 **SampType:** MBLK Units **mg/L**

SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	04/26/2021

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

SW-846 9251 (TOTAL)

Batch R290233 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**20**	20.00	0	102.4	90	110	04/26/2021

Batch R290302 **SampType:** MBLK Units **mg/L**
SampID: ICB/MBLK

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	04/27/2021

Batch R290302 **SampType:** MBLK Units **mg/L**
SampID: MBLK/ICB

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**< 1**	0.5000	0	0	-100	100	04/28/2021

Batch R290302 **SampType:** MBLK Units **mg/L**
SampID: MBLK-176252

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride	*	1		**< 1**	0.5000	0	0	-100	100	04/27/2021

Batch R290302 **SampType:** LCS Units **mg/L**
SampID: ICV/LCS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**20**	20.00	0	99.4	90	110	04/27/2021

Batch R290302 **SampType:** LCS Units **mg/L**
SampID: LCS/ICV

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		1		**19**	20.00	0	97.0	90	110	04/28/2021

Batch R290302 **SampType:** MS Units **mg/L**
SampID: 21041324-008BMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride		10		**247**	200.0	64.14	91.7	85	115	04/27/2021

Batch R290302 **SampType:** MSD Units **mg/L** RPD Limit **15**
SampID: 21041324-008BMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Chloride		10		**246**	200.0	64.14	91.2	247.5	0.42	04/27/2021

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

SW-846 3005A, 6020A, METALS BY ICPMS (DISSOLVED)

Batch 176137 **SampType:** MBLK Units **mg/L**

SampID: MBLK-176137

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	04/25/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	04/25/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	04/26/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	04/26/2021

Batch 176137 **SampType:** LCS Units **mg/L**

SampID: LCS-176137

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.519**	0.5000	0	103.9	80	120	04/25/2021
Iron		0.0250		**1.94**	2.000	0	97.0	80	120	04/25/2021
Manganese		0.0020		**0.486**	0.5000	0	97.3	80	120	04/26/2021
Molybdenum		0.0015		**0.475**	0.5000	0	95.0	80	120	04/26/2021

Batch 176137 **SampType:** MS Units **mg/L**

SampID: 21041324-001DMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Iron		0.0250		**1.82**	2.000	0	91.0	75	125	04/27/2021
Manganese		0.0020		**0.529**	0.5000	0.04765	96.2	75	125	04/27/2021
Molybdenum		0.0015		**0.595**	0.5000	0.1467	89.6	75	125	04/27/2021

Batch 176137 **SampType:** MSD Units **mg/L** RPD Limit **20**

SampID: 21041324-001DMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Iron		0.0250		**1.81**	2.000	0	90.3	1.820	0.74	04/27/2021
Manganese		0.0020		**0.514**	0.5000	0.04765	93.2	0.5286	2.82	04/27/2021
Molybdenum		0.0015		**0.607**	0.5000	0.1467	92.1	0.5946	2.06	04/27/2021

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 176223 **SampType:** MBLK Units **mg/L**

SampID: MBLK-176223

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	05/06/2021
Boron		0.0250	S	**< 0.0250**	0.0093	0	218.3	-100	100	05/06/2021
Calcium		0.125		**< 0.125**	0.0700	0	0	-100	100	05/09/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	05/06/2021
Lithium	*	0.0030		**< 0.0030**	0.0015	0	0	-100	100	05/06/2021
Magnesium		0.0500		**< 0.0500**	0.0175	0	0	-100	100	05/06/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	05/06/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	05/06/2021
Potassium		0.175		**< 0.175**	0.0800	0	0	-100	100	05/06/2021
Sodium		0.225		**< 0.225**	0.0750	0	0	-100	100	05/09/2021

Batch 176223 **SampType:** LCS Units **mg/L**

SampID: LCS-176223

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.551**	0.5000	0	110.2	85	115	05/10/2021
Boron		0.0250	B	**0.574**	0.5000	0	114.8	85	115	05/06/2021
Calcium		0.125		**2.71**	2.500	0	108.4	85	115	05/09/2021
Iron		0.0250		**2.23**	2.000	0	111.5	85	115	05/06/2021
Lithium	*	0.0030		**0.530**	0.5000	0	106.0	85	115	05/09/2021
Magnesium		0.0500		**2.63**	2.500	0	105.2	85	115	05/06/2021
Manganese		0.0020		**0.547**	0.5000	0	109.4	85	115	05/09/2021
Molybdenum		0.0015		**0.549**	0.5000	0	109.8	85	115	05/06/2021
Potassium		0.175		**2.81**	2.500	0	112.5	85	115	05/06/2021
Sodium		0.225		**2.47**	2.500	0	98.7	85	115	05/09/2021

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 176223 **SampType:** MS Units **mg/L**

SampID: 21041324-001CMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Boron		0.0250	B	**1.50**	0.5000	0.9149	116.8	75	125	05/06/2021
Calcium		0.125		**94.9**	2.500	92.22	109.3	75	125	05/09/2021
Iron		0.0250		**2.00**	2.000	0.02098	99.2	75	125	05/09/2021
Lithium	*	0.0030		**0.584**	0.5000	0.03280	110.2	75	125	05/06/2021
Magnesium		0.0500	S	**27.1**	2.500	25.44	66.6	75	125	05/06/2021
Manganese		0.0020		**0.639**	0.5000	0.09776	108.2	75	125	05/06/2021
Molybdenum		0.0015		**0.729**	0.5000	0.1905	107.8	75	125	05/06/2021
Potassium		0.175	S	**16.2**	2.500	14.36	73.9	75	125	05/06/2021
Sodium		0.225		**55.9**	2.500	53.41	101.5	75	125	05/09/2021

Batch 176223 **SampType:** MSD Units **mg/L** RPD Limit **20**

SampID: 21041324-001CMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Boron		0.0250	B	**1.50**	0.5000	0.9149	117.9	1.499	0.34	05/06/2021
Calcium		0.125	S	**93.4**	2.500	92.22	48.5	94.95	1.62	05/09/2021
Iron		0.0250		**1.99**	2.000	0.02098	98.2	2.004	0.91	05/09/2021
Lithium	*	0.0030		**0.563**	0.5000	0.03280	106.0	0.5840	3.71	05/06/2021
Magnesium		0.0500		**27.4**	2.500	25.44	76.5	27.10	0.91	05/06/2021
Manganese		0.0020		**0.648**	0.5000	0.09776	110.0	0.6387	1.38	05/06/2021
Molybdenum		0.0015		**0.719**	0.5000	0.1905	105.8	0.7293	1.37	05/06/2021
Potassium		0.175		**16.4**	2.500	14.36	81.6	16.21	1.18	05/06/2021
Sodium		0.225		**56.0**	2.500	53.41	103.6	55.95	0.09	05/09/2021

Batch 176238 **SampType:** MBLK Units **mg/L**

SampID: MBLK-176238

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**< 0.0010**	0.0004	0	0	-100	100	05/06/2021
Boron		0.0250		**< 0.0250**	0.0093	0	0	-100	100	05/06/2021
Calcium		0.125		**< 0.125**	0.0700	0	0	-100	100	05/09/2021
Iron		0.0250		**< 0.0250**	0.0115	0	0	-100	100	05/09/2021
Lithium	*	0.0030		**< 0.0030**	0.0015	0	0	-100	100	05/06/2021
Magnesium		0.0500		**< 0.0500**	0.0175	0	0	-100	100	05/06/2021
Manganese		0.0020		**< 0.0020**	0.0008	0	0	-100	100	05/06/2021
Molybdenum		0.0015		**< 0.0015**	0.0006	0	0	-100	100	05/06/2021
Potassium		0.175		**< 0.175**	0.0800	0	0	-100	100	05/06/2021
Sodium		0.225		**< 0.225**	0.0750	0	0	-100	100	05/09/2021

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch 176238 **SampType:** LCS Units **mg/L**

SampID: LCS-176238

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.582**	0.5000	0	116.3	80	120	05/06/2021
Boron		0.0250		**0.549**	0.5000	0	109.8	80	120	05/06/2021
Calcium		0.125		**2.17**	2.500	0	86.8	80	120	05/09/2021
Iron		0.0250		**2.05**	2.000	0	102.5	80	120	05/09/2021
Lithium	*	0.0030		**0.550**	0.5000	0	110.0	80	120	05/06/2021
Magnesium		0.0500		**2.45**	2.500	0	97.9	80	120	05/06/2021
Manganese		0.0020		**0.561**	0.5000	0	112.2	80	120	05/06/2021
Molybdenum		0.0015		**0.525**	0.5000	0	104.9	80	120	05/06/2021
Potassium		0.175		**2.59**	2.500	0	103.6	80	120	05/06/2021
Sodium		0.225		**2.38**	2.500	0	95.1	80	120	05/09/2021

Batch 176238 **SampType:** MS Units **mg/L**

SampID: 21041324-007CMS

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Arsenic		0.0010		**0.563**	0.5000	0.001375	112.3	75	125	05/09/2021
Boron		0.0250		**0.801**	0.5000	0.2536	109.5	75	125	05/07/2021
Calcium		0.125	S	**79.7**	2.500	75.18	179.1	75	125	05/09/2021
Iron		0.0250		**2.61**	2.000	0.5905	101.2	75	125	05/09/2021
Lithium	*	0.0030		**0.550**	0.5000	0.008370	108.4	75	125	05/07/2021
Magnesium		0.0500		**33.9**	2.500	30.79	124.6	75	125	05/07/2021
Manganese		0.0020		**0.609**	0.5000	0.07979	105.8	75	125	05/09/2021
Molybdenum		0.0015		**0.525**	0.5000	0.007329	103.5	75	125	05/07/2021
Potassium		0.175		**7.38**	2.500	4.619	110.3	75	125	05/07/2021
Sodium		0.225	S	**78.4**	2.500	73.11	209.9	75	125	05/09/2021

Client: Geosyntec Consultants **Work Order:** 21041324

Client Project: GLP8006/GLP8007 **Report Date:** 12-May-21

SW-846 3005A, 6020A, METALS BY ICPMS (TOTAL)

Batch **176238** **SampType:** **MSD** Units **mg/L** RPD Limit **20**

SampID: 21041324-007CMSD

Analyses	Cert	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Arsenic		0.0010		**0.566**	0.5000	0.001375	112.9	0.5628	0.58	05/09/2021
Boron		0.0250		**0.808**	0.5000	0.2536	110.9	0.8011	0.86	05/07/2021
Calcium		0.125	S	**79.7**	2.500	75.18	181.1	79.66	0.06	05/09/2021
Iron		0.0250		**2.65**	2.000	0.5905	102.9	2.614	1.34	05/09/2021
Lithium	*	0.0030		**0.552**	0.5000	0.008370	108.7	0.5503	0.33	05/07/2021
Magnesium		0.0500	S	**34.0**	2.500	30.79	126.8	33.91	0.16	05/07/2021
Manganese		0.0020		**0.610**	0.5000	0.07979	106.1	0.6090	0.18	05/09/2021
Molybdenum		0.0015		**0.528**	0.5000	0.007329	104.1	0.5246	0.63	05/07/2021
Potassium		0.175		**7.41**	2.500	4.619	111.8	7.376	0.53	05/07/2021
Sodium		0.225	S	**77.2**	2.500	73.11	162.8	78.35	1.51	05/09/2021

Receiving Check List

http://www.teklabinc.com/

Client: Geosyntec Consultants
Client Project: GLP8006/GLP8007

Work Order: 21041324
Report Date: 12-May-21

Carrier: Alec Rebbe

Received By: BSJ

Completed by: Ellie Hopkins
On: 22-Apr-21

Reviewed by: Marvin L. Darling
On: 22-Apr-21

Pages to follow: Chain of custody [1] Extra pages included [0]

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	Temp °C	4.6	
Type of thermal preservation?	None ☐	Ice ☑	Blue Ice ☐	Dry Ice	☐	
Chain of custody present?	Yes ☑	No ☐				
Chain of custody signed when relinquished and received?	Yes ☑	No ☐				
Chain of custody agrees with sample labels?	Yes ☑	No ☐				
Samples in proper container/bottle?	Yes ☑	No ☐				
Sample containers intact?	Yes ☑	No ☐				
Sufficient sample volume for indicated test?	Yes ☑	No ☐				
All samples received within holding time?	Yes ☑	No ☐				
Reported field parameters measured:	Field ☐	Lab ☐	NA ☑			
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐				

When thermal preservation is required, samples are compliant with a temperature between 0.1°C - 6.0°C, or when samples are received on ice the same day as collected.

Water – at least one vial per sample has zero headspace?	Yes ☐	No ☐	No VOA vials ☑
Water - TOX containers have zero headspace?	Yes ☐	No ☐	No TOX containers ☑
Water - pH acceptable upon receipt?	Yes ☑	No ☐	NA ☐
NPDES/CWA TCN interferences checked/treated in the field?	Yes ☐	No ☐	NA ☑

Any No responses must be detailed below or on the COC.

pH strip #75145 - SAH 4/22/21

CHAIN OF CUSTODY

pg. ____ of ____ Work order # 2104324

TEKLAB, INC. 5445 Horseshoe Lake Road - Collinsville, IL 62234 - Phone: (618) 344-1004 - Fax: (618) 344-1005

Client:	Geosyntec Consultants
Address:	1 McBride and Son Center Drive, Suite 202
City / State / Zip	Chesterfield, MO 63005
Contact:	Allison Kreinberg — **Phone:** (636) 812-0809
E-Mail:	AKreinberg@Geosyntec.com — **Fax:**

Samples on: ☒ ICE ☐ BLUE ICE ☐ NO ICE 4.6 °C LTG# 1

Preserved in: ☒ LAB ☒ FIELD

Lab Notes 75145 SR 4/22/21

FOR LAB USE ONLY

Are these samples known to be involved in litigation? If yes, a surcharge will apply ☐ Yes ☐ No

Are these samples known to be hazardous? ☐ Yes ☐ No

Are there any required reporting limits to be met on the requested analysis?. If yes, please provide limits in the comment section. ☐ Yes ☐ No

Client Comments:

Test Hex-Cr, MW-22, MW-23, MW-5 for arsenic
red capped bottle has been filtered in the field

Project Name/Number	Sample Collector's Name
GLP8006/GLP8007	Amanda Taye

Results Requested: ☒ Standard ☐ 1-2 Day (100% Surcharge) ☐ Other ____ ☐ 3 Day (50% Surcharge)

Billing Instructions

Lab Use Only	Sample Identification	Date/Time Sampled	# and Type of Containers: UNPRES	HNO3	NaOH	H2SO4	HCL	MeOH	NaHSO4	OTHER	MATRIX: Aqueous	Drinking Water	Soil	Sludge	Special Waste	Groundwater	INDICATE ANALYSIS REQUESTED: Alkalinity	Chloride	Metals (Dissolved)**	Metals (Total)*	Sulfate	TDS
2104324 -001	MW-03-20210420	4-20-21 1026	1	3												✓						
-002	MW-18D-20210420	4-20-21 1152	1	3												✓						
-003	MW-51-20210420	4-20-21 1350	1	3												✓						
-004	MW-23-20210420	4-20-21 1020	1	3												✓						
-005	MW-22-20210420	[redacted] 0825	1	3												✓						
-006	EQB-20210420	4-20-21 0825		1							✓											
-007	HEX-Cr-20210420	4-20-21	1	3												✓						
-008	MW-18S-20210420	4-20-21 1320	1	3												✓						

Courier

Relinquished By	Date/Time	Received By	Date/Time
	4/21/21 16:05		4/21/21 16:05
	4/22/21 1747	Brenda Stout	04/22/21 1747

The individual signing this agreement on behalf of the client, acknowledges that he/she has read and understands the terms and conditions of this agreement, and that he/she has the authority to sign on behalf of the client. See www.teklabinc.com for terms and conditions.

BottleOrder: 65028 SR 4/22/21

Appendix E

Groundwater Polishing Evaluation Report

Geosyntec consultants

engineers | scientists | innovators

Groundwater Polishing Evaluation Report

Hennepin Power Plant – West Ash Pond System

(IEPA ID No. W1550100002-01 and W1550100002-03)

Prepared for

Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Prepared by

Geosyntec Consultants, Inc.
134 N. Lasalle Street, Suite 300
Chicago, Illinois 60602

Project Number: GLP8079

May 2025

Geosyntec consultants

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ACRONYMS AND ABBREVIATIONS

BCU	bedrock confining unit
CAAA	Corrective Action Alternatives Analysis
CCR	coal combustion residuals
COC	constituent of concern
GCSM	geochemical conceptual site model
GWB	Geochemist's Workbench®
GWPS	groundwater protection standard
IEPA	Illinois Environmental Protection Agency
mg/kg	milligrams per kilogram
OWAP	Old West Ash Pond
OWPP	Old West Polishing Pond
redox	oxidation-reduction
SEP	sequential extraction procedure
SU	standard units
TDS	total dissolved solids
UAU	uppermost aquifer unit
µg/g	micrograms per gram
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency
WAPS	West Ash Pond System
XRD	X-ray diffraction

EXECUTIVE SUMMARY

This document has been prepared as an attachment to the Corrective Action Alternatives Analysis (CAAA) prepared by Gradient for Hennepin Power Plant West Ash Pond System (WAPS). The constituents of concern (COCs) addressed in this document are arsenic, boron, lithium, sulfate, and total dissolved solids (TDS), which have been identified as having exceedances[1] of the site-specific groundwater protection standards (GWPS) at the time of this analysis. Of these COCs, boron, sulfate, and arsenic were addressed in geochemical modeling efforts. Natural geochemical processes may be appropriate as a "polishing step" for residual plume management after effective source control implementation, if there are no risks to receptors and/or the contaminant plume is not expanding (United States Environmental Protection Agency [USEPA] 1999; USEPA 2015). Source control is a major component of every corrective action considered in the CAAA, and there are no risks to human health or the environment at Hennepin WAPS.

Natural groundwater polishing processes, which include both physical and chemical mechanisms, reduce the concentration of COCs in the groundwater. After source control is implemented, a geochemical trailing gradient may form in the subsurface as conditions undergo a return to background water quality which could affect chemical groundwater polishing mechanisms (Savannah River National Laboratory 2011). This report supports groundwater polishing as a component of the proposed corrective action by evaluating the contribution of chemical mechanisms to groundwater polishing under current conditions and after source control implementation. The groundwater flow and transport model estimated the time to reach the GWPS based on hydraulic properties of the aquifer. The results of this groundwater polishing evaluation contextualize these estimates by evaluating the potential for attenuation of COCs and for previously attenuated COCs to be mobilized to groundwater as groundwater quality returns to background conditions.

Groundwater polishing mechanisms were assessed using speciation and reaction geochemical models: speciation models assess the distribution of constituents between solid and aqueous phases, and reaction models evaluate how that distribution may change with changing site conditions (USEPA 2015). Inputs to the model include geochemically reactive solid mineral phases, compliance well groundwater composition, and background groundwater composition based on site-specific data. Additional modeling and analysis was completed to better understand arsenic speciation, solubility, and mechanisms of mobilization at wells with arsenic GWPS exceedances.

The results of the groundwater polishing evaluation indicate that chemical attenuation of modeled COCs (arsenic, boron, and sulfate) is feasible under current conditions through sorption to iron and aluminum oxide minerals. Though some degree of desorption is predicted with background

[1] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or Groundwater Protection Standards as described in the proposed groundwater monitoring program which was submitted to the IEPA on October 25, 2021 as part of Dynegy Midwest Generation, LLC's operating permit application for the West Ash Pond System. That operating permit application, including the proposed groundwater monitoring program, remains under review by the IEPA and therefore Dynegy Midwest Generation, LLC has not identified any actual exceedances.

water interaction, aqueous boron and sulfate (and therefore TDS) concentrations should decrease below the GWPS at all wells in the compliance monitoring network following source control. Remobilization of boron and sulfate is unlikely to affect the estimated time to reach the GWPS based on modeling results. Aqueous arsenic concentrations are predicted to increase at wells with current exceedances following remobilization of arsenic under future conditions. Remobilization may impact the time to reach the GWPS for arsenic. Lithium was not evaluated in the geochemical modeling because lithium concentrations continue to decline following unit closure. These results will inform corrective action groundwater monitoring and adaptive site management, critical components every corrective action considered in the CAAA.

1. INTRODUCTION

This document has been prepared as an attachment to the Corrective Action Alternatives Analysis (CAAA) prepared by Gradient for Hennepin Power Plant West Ash Pond System (WAPS). The purpose of the CAAA is to holistically evaluate potentially viable corrective actions to remediate groundwater and achieve compliance with GWPS for all monitored parameters under Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.600. The constituents of concern (COCs) addressed in this document are arsenic, boron, lithium, sulfate, and total dissolved solids (TDS)[2], which have been identified as having exceedances of the site-specific groundwater protection standards (GWPS) at the time of this analysis. In the CAAA, all corrective actions considered consist of source control and residual plume management. Natural geochemical processes may be appropriate as a "polishing step" for residual plume management after effective source control implementation, if there are no risks to receptors and/or the contaminant plume is not expanding (United States Environmental Protection Agency [USEPA] 1999; USEPA 2015). Source control is a major component of every corrective action considered in the CAAA, and there are no risks to human health or the environment at Hennepin WAPS.[3]

Groundwater polishing processes include both physical and chemical mechanisms within the subsurface which reduce the concentration of COCs in the groundwater. Physical components of groundwater polishing, including advection, dilution, and dispersion, are assessed by groundwater flow and transport modeling (Groundwater Modeling Technical Memorandum[4]). Chemical mechanisms of groundwater polishing include sorption and mineral precipitation. After source control is implemented, a geochemical trailing gradient may form in the subsurface as conditions undergo a return to background water quality which could affect chemical groundwater polishing mechanisms (Savannah River National Laboratory [SRNL], 2011). The chemical mechanisms of groundwater polishing at Hennepin WAPS are evaluated herein using a geochemical modeling-based approach informed by site-specific data. This report uses geochemical modeling to evaluate the influence of chemical mechanisms on groundwater polishing under current conditions and future conditions. Additional modeling and analyses were conducted to further investigate arsenic distribution, solubility, and mobilization within the western portion of the WAPS.

The groundwater flow and transport model (Groundwater Modeling Technical Memorandum[5]) estimated the time for COCs to reach their respective GWPS under different potential corrective actions based on physical components of groundwater polishing and did not incorporate any potential chemical controls on parameter distribution. The geochemical modeling efforts presented herein support the assessment of groundwater polishing as a component of the proposed corrective

[2] TDS measurements represent the total mass of dissolved constituents in a sample rather than a single chemical behavior. Because sulfate is the dominant contributor to TDS, results for sulfate in this analysis also apply to TDS.
[3] The Human Health and Ecological Risk Assessment serves as Appendix A of the CAAA to which this report is attached.
[4] The Groundwater Modeling Technical Memorandum serves as Appendix B.1 of the CAAA Supporting Information Report; the Corrective Action Supporting Information Report serves as Appendix B of the CAAA to which this report is attached.
[5] Ibid.

action by evaluating the potential for chemical attenuation of COCs under current and predicted future conditions as a means of contextualizing the times estimated in the flow and transport model. This analysis also provides an initial foundation for understanding groundwater chemistry to inform adaptive site management as a key component of the Corrective Action Groundwater Monitoring Plan[6].

[6] The Corrective Action Groundwater Monitoring Plan serves as Appendix B.1 to the Construction Permit Application.

2. SITE BACKGROUND

2.1 Site Overview

A thorough overview of general site characteristics is presented in Section 1 of the CAAA to which this document is attached and summarized here. The Hennepin Power Plant is owned by Dynegy Midwest Generation, LLC and was in operation from the early 1950s to 2019. The facility is located four miles northeast of the Village of Hennepin, Illinois, along the Illinois River. The Hennepin WAPS is located west of the Hennepin Power Plant and adjacent to the Illinois River. The Hennepin Power Plant property is bordered by farm fields to the east and south, low lying floodplains to the west, and the Illinois River to the north.

The WAPS is comprised of two inactive sub-units, the Old West Ash Pond (OWAP) and the Old West Polishing Pond (OWPP). The OWAP includes a 9.3-acre Pond No.1 on the eastern end of the WAPS impoundment and a 16.4-acre Pond No. 3 in the central portion of the impoundment. Pond No. 1 accepted bottom ash and slag and Pond No. 3 accepted mixed coal ash. The 4.7-acre OWPP was used as a secondary pond and is located on the western end of the impoundment. The WAPS operated between 1952 and 1996, and closure occurred between 2019 and 2020 (Dynegy 2020a and 2020b).

A groundwater monitoring network was proposed in the Initial Operating Permit Application (Burns & McDonnell 2021) in accordance with 35 I.A.C. § 845.630 to monitor groundwater quality which passes the waste boundary as part of the Operating Permit Application to Illinois Environmental Protection Agency (IEPA) for the WAPS. The proposed groundwater monitoring network is shown in **Attachment A**. The monitoring network consists of nine compliance monitoring wells (21R, 22, 22D, 23, 27, 35, 49, 50, and 51) and two background wells (32 and 34).

The geology underlying the Site in the vicinity of the WAPS consists of three distinct hydrostratigraphic units (Natural Resource Technology, Inc. 2017):

- **Fill Unit:** The Fill Unit underlies the WAPS and was present in all Pond sub-units prior to closure. The Fill Unit consists of coal combustion residuals (CCR), primarily fly ash and smaller amounts of bottom ash and slag. In some locations within the unit, CCR was mixed with sand, silt, and clay to form constructed berms. The Fill Unit no longer underlies the western end of the WAPS, as CCR and one foot of soil beneath the CCR was removed from the OWPP during closure.
- **Uppermost Aquifer Unit (UAU):** The UAU contains clay, silt, and sand, collectively referred to as Cahokia alluvium, and outwash sand and gravel deposits of the Henry Formation. The UAU is the uppermost aquifer and primary groundwater transport pathway in the vicinity of the WAPS.
- **Bedrock Confining Unit (BCU):** The BCU is a low permeability unit comprised of Pennsylvanian age shale with interbedded limestone, sandstone, and clay.

Groundwater within the UAU and near the WAPS migrates north and west towards the Illinois River, consistent with surface topography. When the WAPS was operational, sluicing of ash created radial flow conditions that caused a portion of the groundwater beneath the WAPS to flow towards wetlands located south and west of the OWAP. Under normal post-closure conditions, groundwater beneath the WAPS flows toward the river. Groundwater typically flows laterally within the hydrostratigraphic units, with converging upward flow near and beneath the river. A map showing representative groundwater flow direction at the site is shown in **Attachment A**.

2.2 Identified Exceedances of the GWPS

The following GWPS exceedances at compliance groundwater monitoring wells likely attributable to the Hennepin WAPS were observed from 2023 Q2 through 2024 Q3 (Ramboll 2024):

- Arsenic – Observed at monitoring wells 21R and 51.
- Boron – Observed at monitoring wells 21R, 22, 23, and 35.
- Lithium – Observed at monitoring well 22.
- Sulfate – Observed at monitoring wells 23 and 35.
- TDS – Observed at monitoring well 35.

The data set for geochemical modeling was finalized after the 2024 Q3 sampling event. Groundwater at these compliance wells is representative of groundwater conditions downgradient of the unit, and samples may be referred to as downgradient groundwater.

GWPS exceedances in the WAPS network occur exclusively in the UAU. Arsenic exceedances are limited to two wells near the northwest corner of the WAPS. Arsenic concentrations at these two monitoring locations have been elevated post-closure. Boron is widely distributed throughout the WAPS network, with multiple locations containing boron exceedances. Boron is generally stable or decreasing over time, except at well 35 which may be influenced by localized post-closure flow conditions near the south boundary of the WAPS. Lithium exceedances are limited to one monitoring location which has exhibited a decreasing trend over time. Sulfate exceedances were observed at two monitoring locations (wells 23 and 35). TDS exceedances are observed at one monitoring location (well 35). Sulfate is the dominant contributor to TDS at well 35, so TDS concentrations are expected to follow sulfate trends at this location.

Modeling parameters with observed exceedances is appropriate to the scope of the CAAA. Additionally, the selected remedy will meet the performance standards of 35 I.A.C. § 845.670(d) and the Corrective Action Plan will be submitted to the Agency on or before May 8, 2025. Once implemented and completed, the selected remedy will attain the GWPSs.

2.3 Geochemical Conceptual Site Model

A Geochemical Conceptual Site Model (GCSM)[7] was developed for the Hennepin WAPS to describe the geochemical processes that contribute to mobilization and attenuation of constituents in the environment under current conditions, including evaluating whether chemical interactions of COCs with aquifer solids contribute to attenuation of aqueous concentrations at compliance monitoring wells (Geosyntec 2024). This discussion relies on lab reports and raw data previously presented in the Nature and Extent Report submitted to IEPA on May 8, 2024 (Ramboll 2024) in accordance with 35 I.A.C. § 845.650(d)(1) and provided again in full and with relevant updates presenting ongoing work as Appendix D of the CAAA to which this report is attached.

The primary source of arsenic, boron, lithium, sulfate, and TDS to UAU groundwater is expected to be WAPS CCR porewater. This finding is based on COC concentrations within the source and relationships to hydrogeological patterns at the site. Arsenic, boron, and lithium were identified in UAU solids adjacent to downgradient and background wells, which suggests that aquifer solids may provide an additional geogenic source of these COCs to the groundwater.

The pH is generally circumneutral and consistent across the site, though compliance wells along the north side of the WAPS tend to have slightly higher pH values than background wells. An oxidation-reduction (redox) gradient is observed across the WAPS monitoring network, with groundwater conditions changing from oxidizing to reducing from east to west, likely due to the observed increased presence of organic-rich silty soils in the subsurface of the western portion of the WAPS monitoring network. Reducing conditions at western monitoring wells likely enhance arsenic solubility and thus aqueous arsenic concentrations at wells 21R and 51.

Arsenic, boron, lithium, and sulfate in the groundwater may be attenuated via surface complexation reactions with metal oxides, such as iron and aluminum oxides. These relationships can be evaluated through analyses of aquifer solids samples, which were collected adjacent to various compliance and background monitoring wells. Detailed discussion of aquifer solids sampling and analytical results is provided in the GCSM. Discussion of additional solids sampling and analyses completed in 2024 is provided in an Addendum to the GCSM[8].

Iron oxides were detected in the initial aquifer solids dataset and are generally predicted to be stable across the network. Magnetite, a crystalline iron oxide, was detected during X-ray diffraction (XRD) analyses of aquifer solids samples with values ranging from 0.2 to 0.5%. An abundance of iron was also detected during total metals analysis of UAU solids, with concentrations ranging from 9,400 to 14,000 milligrams of iron per kilogram of solids (mg/kg). Total iron observations do not correlate well with magnetite concentrations (i.e., samples with higher iron concentrations do not necessarily have higher iron oxide minerals identified in XRD results). This suggests the presence of non-crystalline, amorphous iron oxides in the aquifer solids.

[7] The GCSM is a component of the Nature and Extent Report previously submitted to IEPA (Ramboll 2024) and is provided with relevant updates as Appendix D of the CAAA to which this report is attached.
[8] The GCSM is a component of the Nature and Extent Report previously submitted to IEPA (Ramboll 2024) and is provided with relevant updates as Appendix D of the CAAA to which this report is attached.

Amorphous (non-crystalline) iron oxides were confirmed in SEP results from samples collected and analyzed in 2024 which included a non-crystalline analysis component.

Clay minerals (kaolinite and chlorite) were also identified in aquifer solids datasets and may provide an additional attenuation mechanism for COCs due to their large surface area and electrostatic charge. At locations where reducing conditions are present, microbial sulfate reduction may contribute to lower sulfate concentrations in groundwater. TDS trends are generally consistent with the major ions in the WAPS groundwater system. Therefore, attenuation of major ions, particularly sulfate, is expected to contribute to a reduction in TDS in the groundwater.

Batch attenuation testing was conducted for arsenic to evaluate sorption and generate site-specific distribution coefficients between solid and aqueous phases. Testing yielded a K_d value in general agreement with academic studies, thus providing additional evidence of arsenic attenuation via sorption to solids in the UAU.

The GCSM findings suggest the potential for chemical attenuation of arsenic, boron, lithium, and sulfate based on detected abundances of iron oxide and clay minerals and groundwater redox conditions which are generally favorable for the stability of potential sorbing surfaces. These findings are supported by analytical results of supplementary sampling and analyses completed in 2024. Attenuation of major ions, such as sulfate, is expected to contribute to a reduction in TDS in the groundwater.

3. GROUNDWATER POLISHING REMEDY EVALUATION

This groundwater polishing evaluation uses geochemical modeling to evaluate chemical attenuation of COCs under current conditions and to predict changes in attenuation at exceedance locations following source control. This evaluation will therefore further assess if chemical mechanisms of groundwater polishing will contribute to the remedy achieving the GWPS in a reasonable amount of time. Speciation and reaction models are geochemical models that can be used to evaluate the potential for chemical attenuation in groundwater. Speciation models assess the distribution of constituents between solid and aqueous phases, and reaction models evaluate how that distribution may change with changing site conditions (USEPA 2015). The results of geochemical modeling provide insight into groundwater polishing mechanisms and additional context for the time estimated to reach the GWPS determined by the groundwater flow and transport model[9], which is based on hydraulic properties of the aquifer and does not take into account chemical interactions occurring within the hydrologic unit. Additional sampling and analyses were completed to strengthen the conceptual understanding of arsenic speciation and solubility at these two locations. Detailed discussion of additional sample collection, analyses, and results are provided in the GCSM Addendum.

3.1 Methods

Geochemical modeling was done in PHREEQC Version 3 (USGS 2021) using a modified MINTEQ v4 thermodynamic database (as described in relevant sections below). The geochemical modeling of groundwater polishing under current conditions and conditions after source control is completed includes speciation and reaction modeling (USEPA 2015):

1. Speciation: To understand groundwater polishing mechanisms under current conditions, a solid phase representative of site conditions is equilibrated with current downgradient groundwater. The results of speciation modeling represent the association of COCs with the solid phase under current conditions through mechanisms such as sorption or precipitation.

2. Reaction: In the reaction modeling, the solid phase generated during the speciation modeling phase is reacted iteratively with background groundwater. These results represent the geochemical conditions expected after the source is controlled during which a trailing geochemical gradient may be created (SRNL 2011). The reactions with background groundwater assess the potential for a trailing geochemical gradient to drive changes in groundwater chemistry. Persistence of elevated groundwater COC concentrations over several reaction iterations suggests a trailing geochemical gradient may affect the time to reach the GWPS.

The equilibrium thermodynamic modeling approach used herein allows that the solid and aqueous phases reach equilibrium during each step. The primary goal of this model is to assess whether groundwater polishing is an appropriate remedy for the site by evaluating dominant geochemical

[9] The Groundwater Modeling Technical Memorandum serves as Appendix B.1 of the Corrective Action Supporting Information Report; the Corrective Action Supporting Information Report serves as Appendix B of the CAAA to which this report is attached.

reactions that may occur at time scales relevant to groundwater flow, including adsorption and certain mineral dissolution/precipitation (i.e., iron and aluminum (hydr)oxides, carbonates, and some sulfates) as identified in the GCSM[10]. The model therefore includes those parameters that are expected to contribute to those reactions (as discussed below) and does not include every constituent of the solid phase and groundwater in order to capture "the salient aspects of the system's behavior without introducing unnecessary complexity" (USEPA 2015). This model is therefore a semi-quantitative estimation of chemical behavior in the subsurface rather than a prediction of groundwater quality, consistent with USEPA guidance that geochemical modeling "is often most helpful for identifying relative changes in contaminant speciation and distribution" (USEPA 2015).

3.1.1 Model Set-Up

Inputs to the model include solid phase composition, downgradient groundwater composition for wells 21R, 22, 23, 35, and 51, representative background groundwater composition, and representative Illinois River composition for select model runs. The PHREEQC input files and modified MINTEQ v4 database are provided in **Attachment B**. The data included for model parameterization is summarized in **Table 1** and discussed in greater detail in **Attachment C**. Most data used in the model and discussed below are provided in the Nature and Extent Report[11], including additional solids data collected in 2024 (iron and aluminum SEP results).

3.1.2 Solid Phase Inputs

Iron hydroxide (ferrihydrite, [$Fe(OH)_3$]) and aluminum hydroxide (gibbsite [$Al(OH)_3$]) are wide-spread in the environment and known to act as sorbing phases for many groundwater constituents, including arsenic, boron, and sulfate (Dzombak and Morel 1990; Karamalidis and Dzombak 2010). SEP analyses for iron and aluminum from October 2024 sampling were used to populate the ferrihydrite and gibbsite component of the geochemical models, as described in greater detail in **Attachment C**.

Metal oxide concentrations representing the 25th percentile, median, and 75th percentile of the observed data were used to test the sensitivity of the model to the amount of sorbing phase present. Both ferrihydrite and gibbsite were allowed to dissolve or precipitate in the reaction phase of the model.

Calcite and dolomite were included as mineral phases in the model because carbonate mineral formation and dissolution are often major controls on groundwater pH (Stumm and Morgan 1996; Stackelberg et al. 2020). Calcite and dolomite are present in site aquifer solids, and model input concentration were based on site-specific XRD results. Both calcite and dolomite were allowed to dissolve or precipitate in the reaction phase of the model.

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[10] The GCSM is a component of the Nature and Extent Report previously submitted to IEPA (Ramboll 2024) and is provided with relevant updates as Appendix D of the CAAA to which this report is attached.

[11] The Nature and Extent Report was previously submitted to IEPA (Ramboll 2024) and is provided with relevant updates as Appendix D of the CAAA to which this report is attached. The Nature and Extent report contains laboratory reports and tabulated results from solid phase analysis and tabulated results from groundwater analyses. Laboratory reports for groundwater data are provided quarterly to IEPA and posted to the facility's operating record in accordance with 35 I.A.C. § 845.800(d)(15).

Barite ($BaSO_4$) and gypsum ($CaSO_4$) are minerals that contain sulfate and have the potential to form under ambient environmental conditions in a timeframe consistent with the remedial effort. Therefore, these minerals may affect sulfate attenuation. Neither mineral phase was observed in mineralogical results for WAPS samples; therefore, both were made available to precipitate from the aqueous solution but did not have initial concentrations provided.

3.1.3 Aqueous Inputs

In addition to arsenic, boron, and sulfate, the following parameters are included to capture the expected attenuation and mobilization mechanisms (see Section 2.3):

- Temperature, pH and pe[12]
- Major ions: Carbonate and bicarbonate alkalinity, chloride, fluoride, calcium, magnesium, potassium, and sodium
- Oxyanions: Silicon and phosphate
- Redox-active metals: Aluminum, iron, and manganese.
- Remaining constituents regulated under 35 I.A.C. § 845.600[13]

This full suite of geochemical parameters for this model was measured in Quarter 2 and Quarter 3, 2023. The medians of these results were used in the model to represent average groundwater interacting with the solid phase (details provided in **Attachment C**). For downgradient wells with GWPS exceedances, the median for each parameter was calculated for each location individually.

The WAPS exhibits variable redox conditions and groundwater flow patterns across the site. Upgradient wells on the east side of the WAPS are not expected to be representative of background conditions for compliance wells on the west side of the WAPS, and vice-versa. The presence of a silty lens on the west side of the site is believed to contribute to more reducing conditions observed towards the west side of the WAPS, as discussed in Section 2.3. Additionally, groundwater monitoring has indicated the occasional reversal of groundwater flow direction at well 22 (i.e., from the river into the groundwater) due to elevated river levels associated with flooding events. As a result, background water sources in modeling must be specified for individual wells rather than applied to all WAPS compliance wells.

Background groundwater was represented in speciation and reaction modeling efforts for compliance wells 21R and 51 using the median composition of background well 34 from 2023 Q2 and Q3 sampling events (referred to as WAPS-West). Background groundwater was represented in modeling efforts for compliance wells 22, 23, and 35 using the median composition of background well 32 from 2023 Q2 and Q3 sampling events (referred to as WAPS-East).

[12] See **Appendix C** for details.

[13] Mercury, thallium, total dissolved solids, and radium were not included in the model. Mercury reactions within the environment are highly complex and would require a separate modeling effort, and the high frequency of non-detect concentrations in the groundwater indicate it would not contribute to model outcomes. Thallium forms a non-reactive monovalent cation and is rarely detected in the groundwater and is therefore not expected to contribute to model outcomes. Total dissolved solids are not a chemical parameter, but rather the result of other chemical abundances taken together. Radium is not included in most thermodynamic databases.

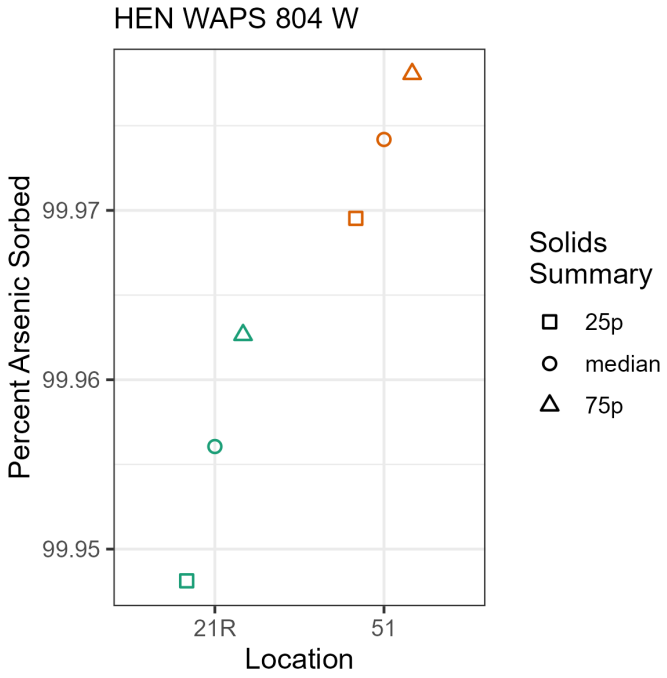
Additionally, the median composition of eight surface water samples collected from three sampling locations in the Illinois River immediately north of the WAPS was used in a separate model scenario to evaluate the Illinois River as a background water source for well 22 during flooding events (referred to as WAPS-River). These data are provided and discussed in the GCSM Addendum[14].

3.2 Results and Discussion

Geochemical modeling results are shown on **Figures 1 through 12** below. Current geochemical conditions are represented in model output figures as 'Speciation Model' and subsequent reaction calculation results are represented with 'First Reaction' and 'Second Reaction'. Full modeling outputs are provided in **Attachment D**. Results of geochemical modeling for WAPS-West model runs (wells 21R and 51) are presented in **Figures 1 to 5**. Results of modeling for WAPS-East model runs (wells 22, 23, and 35) are presented in **Figures 6 to 10**. **Figures 11 to 12** illustrate the effect of river water (WAPS-River) on geochemical reactions at well 22.

3.2.1 Model Results: WAPS West

Figure 1: Percentage of Sorbed Arsenic – West



[14]The GCSM is a component of the Nature and Extent Report previously submitted to IEPA (Ramboll 2024) and is provided with relevant updates as Appendix D of the CAAA to which this report is attached.

Figure 2: Modeled Arsenic Behavior – West

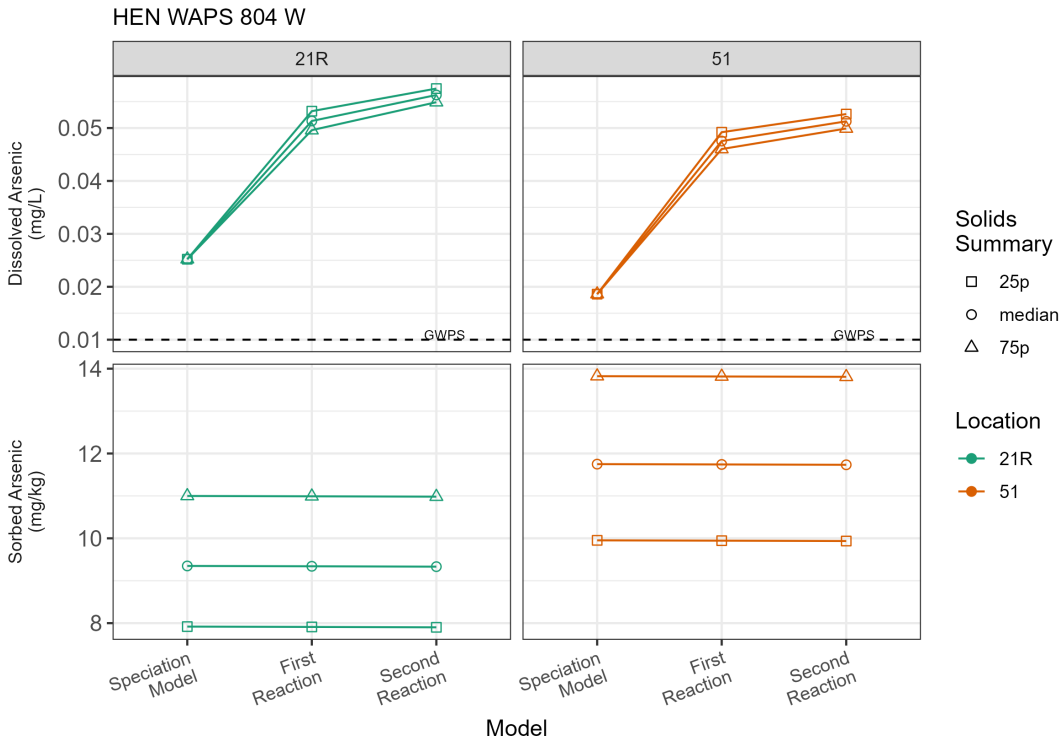


Figure 3: Percentage of Sorbed Boron - West

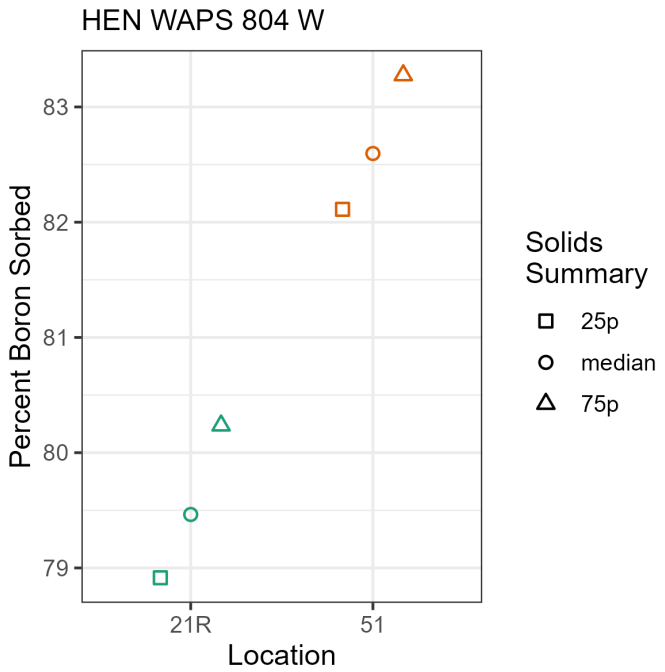


Figure 4: Modeled Boron Behavior – West

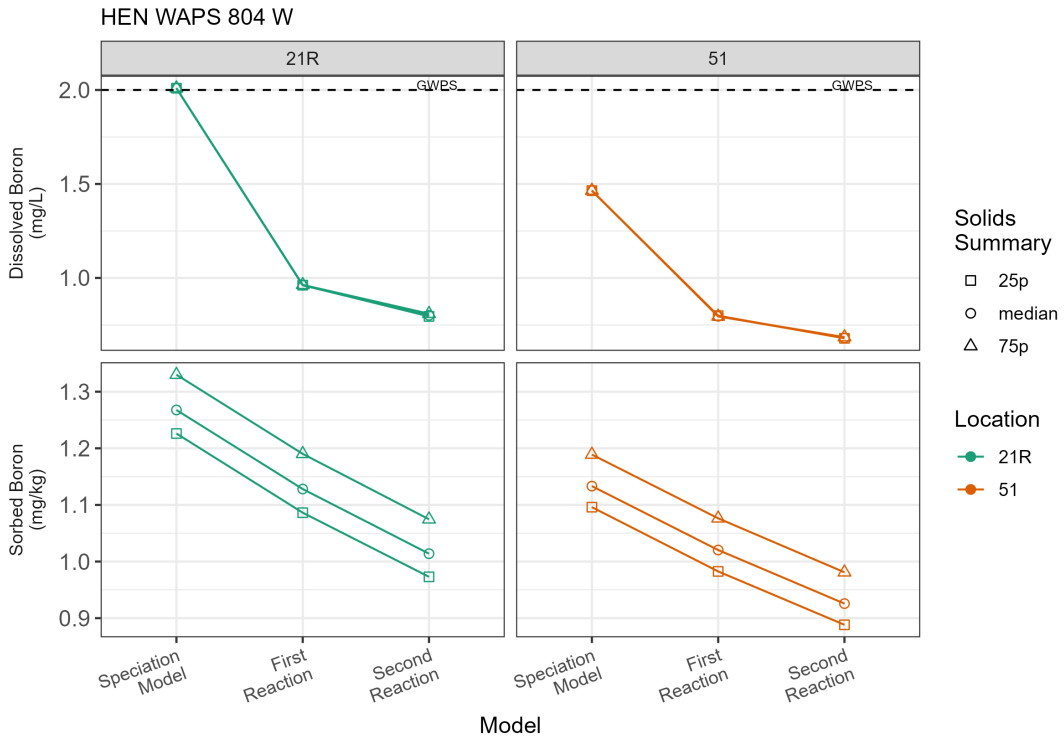
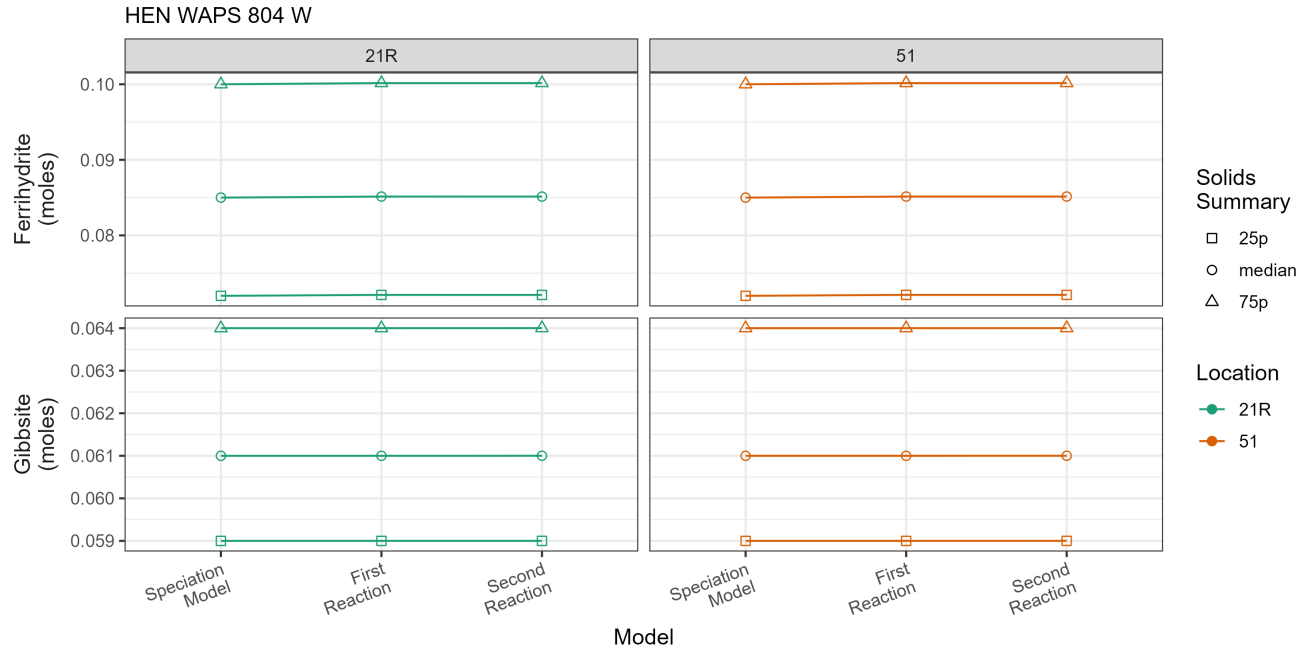


Figure 5: Modeled Sorbing Phase Behavior – West



Results of speciation modeling for WAPS-West support the determination of the GCSM that chemical attenuation of arsenic and boron is likely to occur. Speciation calculations indicate that at wells with arsenic exceedances (21R and 51) greater than 99% of the arsenic present at (modeled) compliance wells is sorbed to mineral surfaces (**Figure 1**). Sensitivity assessments demonstrate that the sorbing mineral mass inputs have a minor impact on arsenic sorption, with the 25th and 75th percentile values for mineral mass accounting for differences of less than 1% of aqueous arsenic sorbed under current conditions. These results suggest that arsenic sorption to iron and aluminum hydroxide minerals should occur under current geochemical conditions.

Speciation calculations for boron indicate that at well 21R (the only well with boron exceedances on the western side of the WAPS), between 79 and 80% of boron present in groundwater will sorb to mineral surfaces (**Figure 3**). Sensitivity assessments demonstrate that the mineral mass inputs have a minor impact on boron sorption at well 21R, with the 25th and 75th percentile values for mineral mass accounting for approximately 1% of variability in aqueous boron sorbed under current conditions.

Reaction modeling results of conditions under future conditions for WAPS-West demonstrate that aqueous arsenic and boron concentrations change with interaction with background water. Aqueous arsenic concentrations are predicted to increase at wells with current exceedances (wells 21R and 51) with each iterative reaction (**Figure 2**). The predicted mobilization of arsenic is associated with desorption of arsenic from oxides, particularly ferrihydrite (**Attachment D**). This desorption is predicted to result in aqueous arsenic concentration increases following source control activities, which may impact the observed time to reach GWPS for arsenic. Arsenic speciation, solubility, and mobilization within the western portion of the WAPS is explored in greater detail in Section 3.3 of this document.

Aqueous boron concentrations at well 21R are predicted to decrease with each iterative reaction (**Figure 4**). While some boron desorption (< 0.3 mg/kg over two iterative reactions) is predicted for well 21R, the impact of this desorption on aqueous boron concentrations is offset by the influence of background groundwater containing lower aqueous boron concentrations. Mobilization of boron at well 21R is therefore unlikely to affect the modeled time to reach the GWPS.

3.2.2 Model Results – WAPS East

Results of modeling for WAPS-East model runs (wells 22, 23, and 35 with background well 32) are presented in **Figures 6 to 10**.

Figure 6: Percentage of Sorbed Boron – East

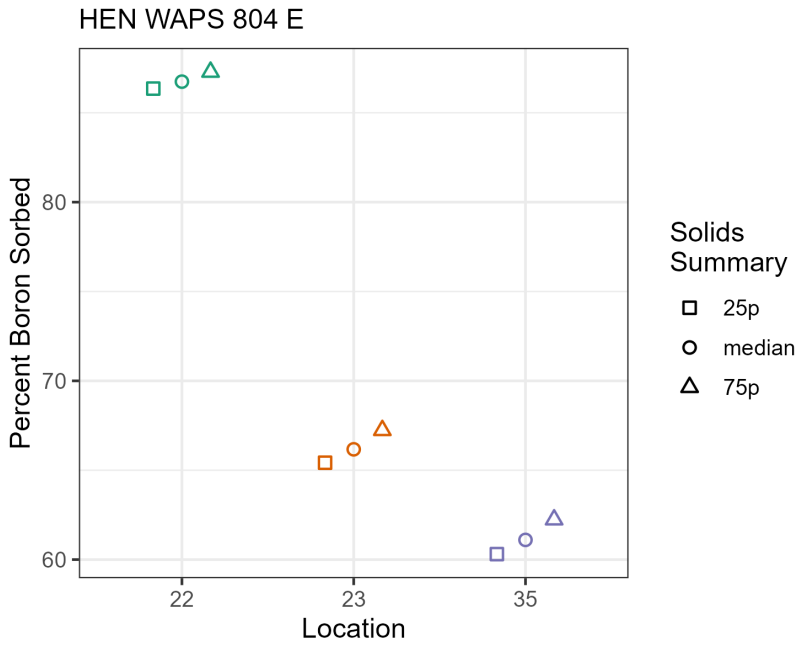


Figure 7: Modeled Boron Behavior – East

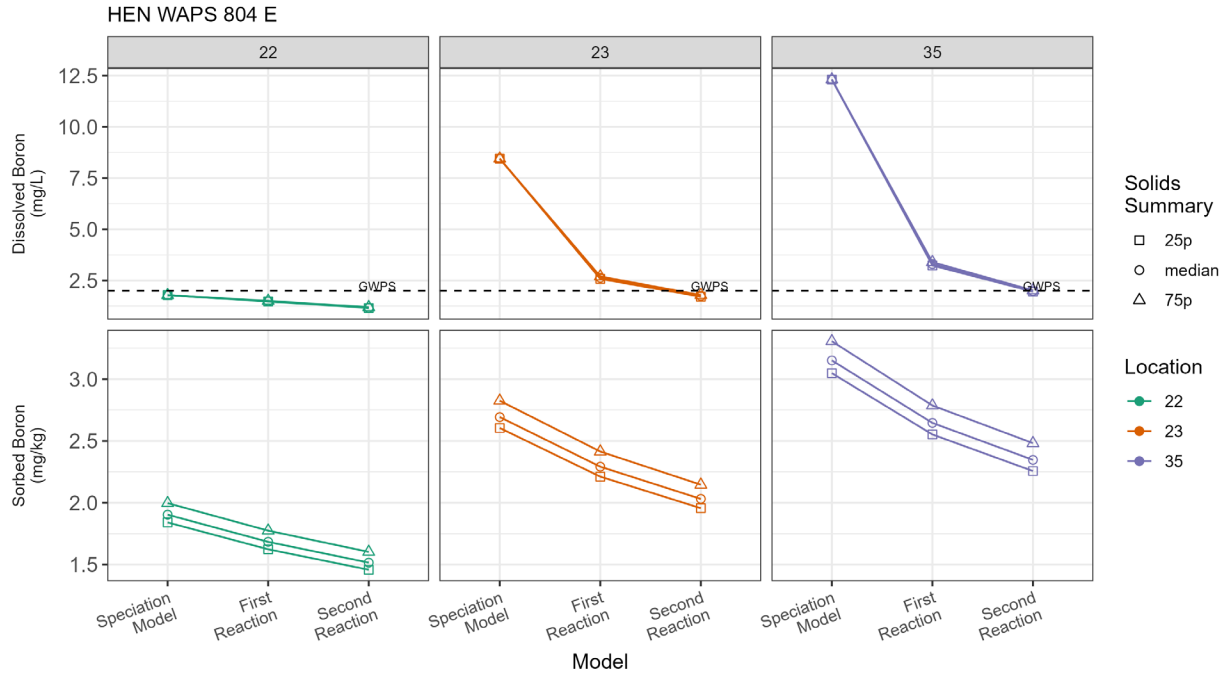


Figure 8: Percentage of Sorbed Sulfate – East

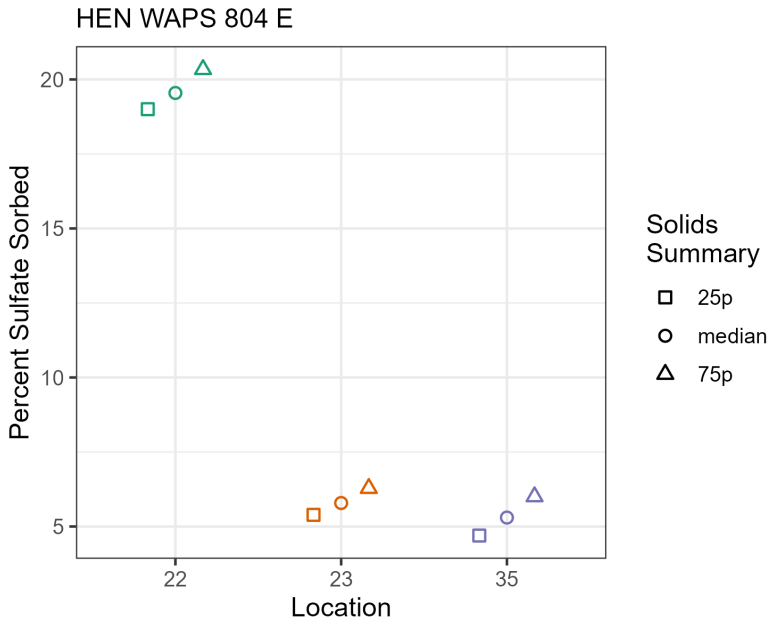


Figure 9: Modeled Sulfate Behavior – East

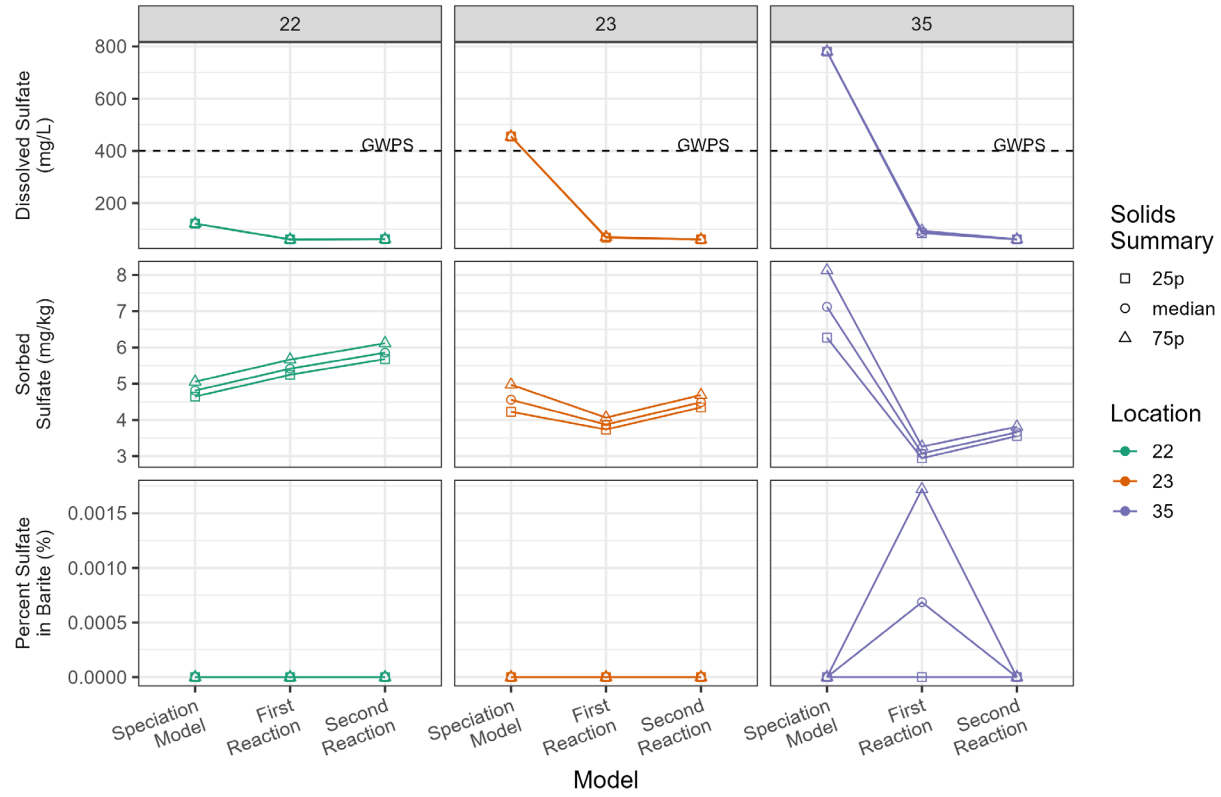
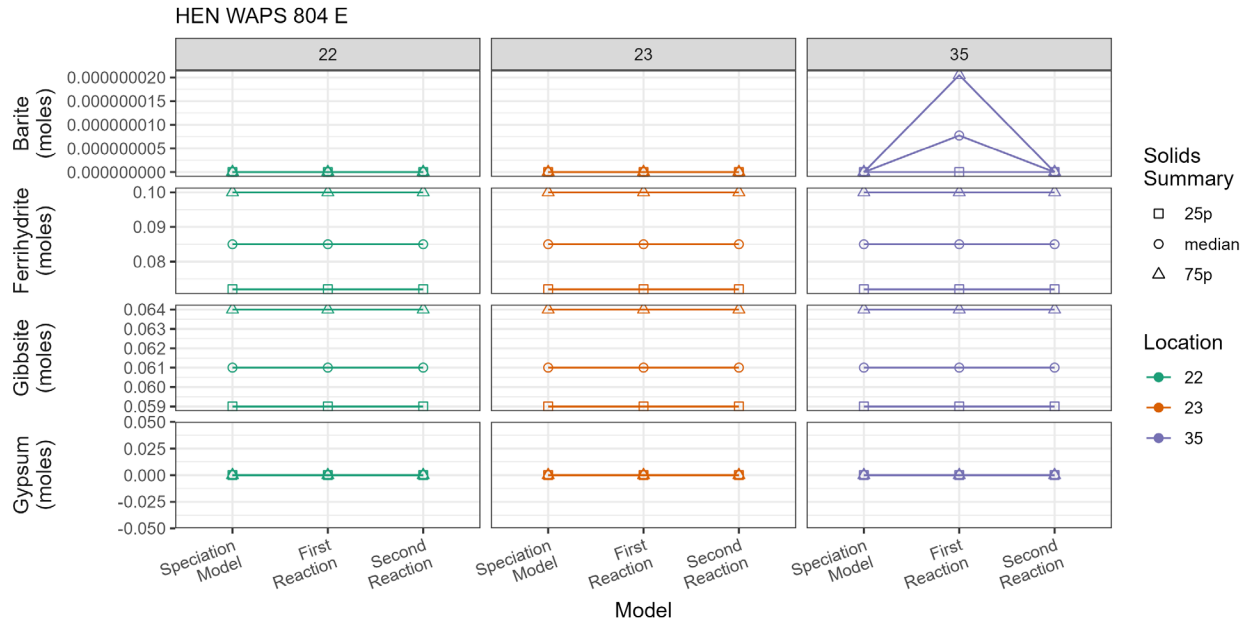


Figure 10: Modeled Sorbing Phase Behavior – East



Results of speciation modeling for WAPS-East support the determination of the GCSM that chemical attenuation of boron and (to a lesser extent) sulfate is likely to occur. Wells with boron exceedances on the eastern side of the WAPS (wells 22, 23, and 35) are predicted to have between 60 and 87% of the boron present at (modeled) compliance wells is sorbed to mineral surfaces (**Figure 6**). Well 22 is predicted to experience notably greater boron sorption under current conditions than wells 23 and 35. Sensitivity assessments demonstrate that the mineral mass inputs have a minor impact on boron sorption, with the 25th and 75th percentile values for mineral mass accounting for differences of approximately 3% of aqueous boron sorbed at each well under current conditions. These results suggest that boron sorption is likely to occur under current geochemical conditions across the site, although at different magnitudes depending on well-specific geochemical conditions.

Speciation calculations for sulfate indicate that at wells with sulfate exceedances (wells 23 and 35), between 5 and 8% of sulfate present at (modeled) compliance wells is sorbed to mineral surfaces (**Figure 8**). Sensitivity assessments demonstrate that the mineral mass inputs have a minor impact on sulfate sorption, with the 25th and 75th percentile values for mineral mass accounting for differences of less than 2% of aqueous sulfate sorbed at each well under current conditions (**Figure 8**). These results suggest that some degree of sulfate sorption to iron and aluminum hydroxide minerals is likely to occur under current geochemical conditions, although less sorption is expected for aqueous sulfate relative to other COCs.

Reaction modeling results of conditions under future conditions for WAPS-East demonstrate that aqueous boron and sulfate concentrations change with interaction with background water. Aqueous boron concentrations at wells with exceedances on the eastern side of the WAPS (wells 22, 23, and 35) are predicted to decrease with each iterative reaction (**Figure 7**). Though a small amount of boron desorption (up to 0.8 mg/kg) is predicted at each well, the impact of this

desorption on aqueous boron concentrations is offset by the influence of background groundwater containing lower aqueous boron concentrations. Well 22 is predicted to achieve the boron GWPS following the first reaction and wells 23 and 35 are predicted to achieve the boron GWPS following the second reaction. These results indicate that mobilization of currently attenuated boron is unlikely to affect the modeled time to reach the GWPS.

Concentrations of aqueous sulfate at wells with exceedances (wells 23 and 35) are predicted to decrease at both wells with each iterative reaction (**Figure 9**). Some degree (up to 4.5 mg/kg) of sulfate desorption is predicted following the first reaction. However, the impact of this desorption on aqueous sulfate concentrations is offset by interactions with background groundwater containing lower aqueous sulfate concentrations. Barite precipitation is predicted under future conditions, particularly at well 35, which provides an additional attenuation mechanism for aqueous sulfate. These results indicate that mobilization of currently attenuated sulfate is unlikely to affect the modeled time to reach the GWPS.

3.2.3 Model Results – WAPS River

Figures 11 to 12 illustrate the effect of river water (WAPS-River) on geochemical reactions at well 22.

Figure 11: Modeled Boron Behavior – River

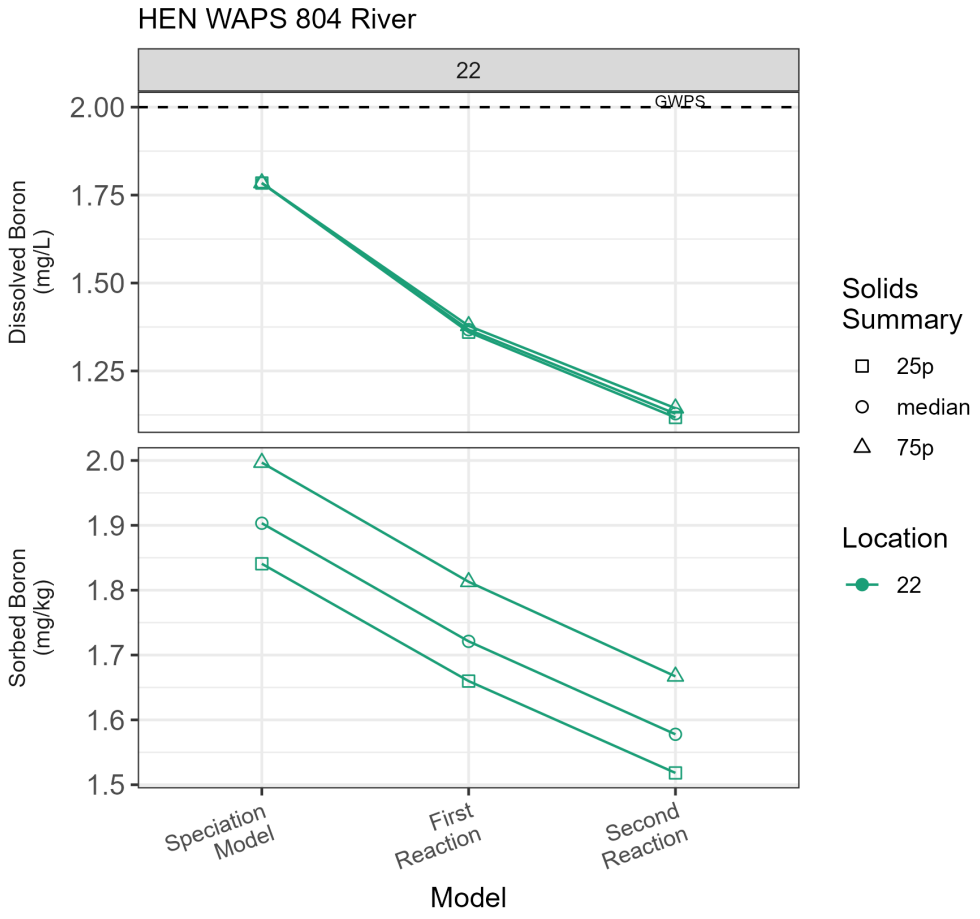
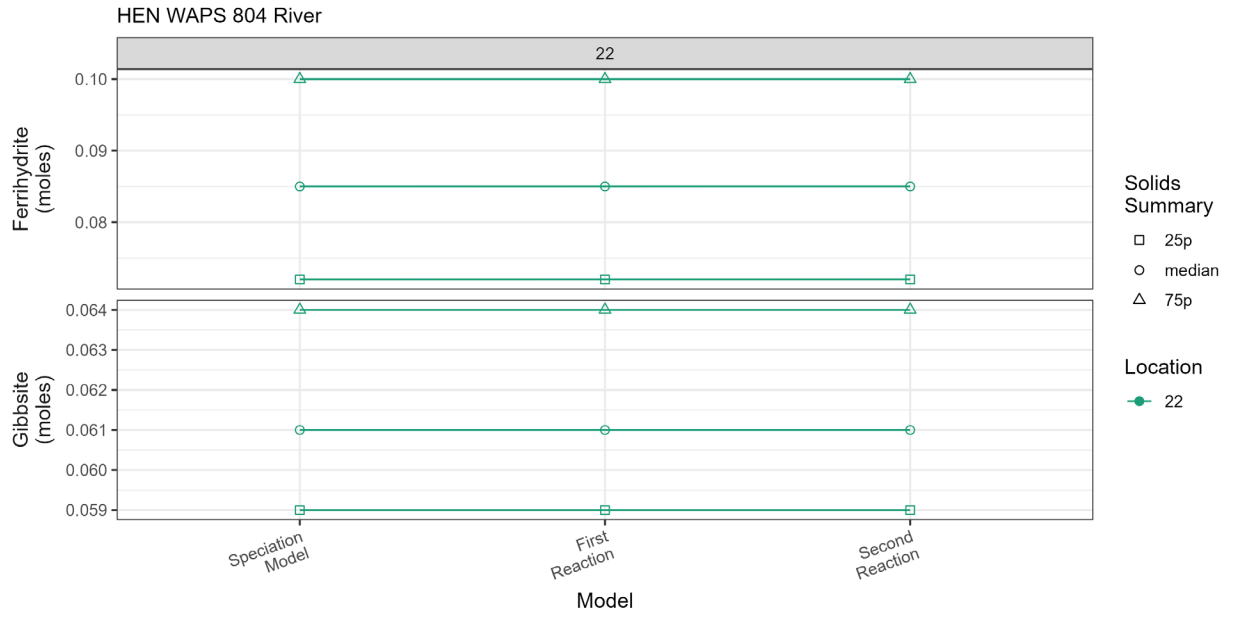


Figure 12: Modeled Sorbing Phase Behavior – River



Speciation modeling results for well 22 are identical in the WAPS-River model (**Figure 11**) and the WAPS-East model (**Figure 7**), as both models incorporate the same initial aqueous and solid phase geochemical conditions at well 22.

Reaction modeling results of conditions under future conditions for WAPS-River demonstrate that aqueous boron concentrations change with interaction with background water. Reaction modeling with river water as a background source at well 22 yielded similar results as WAPS-East models with regards to boron behavior (**Figure 11**). Aqueous boron concentrations at well 22 are predicted to decrease with each iterative reaction with river water, and a small amount of boron desorption (approximately 0.3 mg/kg) is predicted.

3.2.4 Reaction Modeling Summary

Arsenic, boron, and sulfate are predicted to sorb to ferrihydrite and gibbsite. Both minerals are predicted to be stable and exhibit minor (less than 1%, **Table 2**) changes due to precipitation or dissolution reactions under future conditions (**Figures 5, 10, and 12**). Minor barite precipitation is predicted under most future conditions. The predicted stability of sorbing mineral phases and precipitation of barite under future conditions demonstrates the continued feasibility of chemical attenuation mechanisms for all COCs in the WAPS.

The primary chemical attenuation mechanism for arsenic and boron is anticipated to be sorption to iron and aluminum oxide mineral phases which are predicted to be stable under future conditions. Chemical attenuation mechanisms for sulfate are expected to include sorption to iron and aluminum oxide minerals and precipitation of barite. Results suggest that the flow and transport model conclusions are approximately correct for boron and sulfate, and that the time to reach the respective GWPS is not anticipated to be affected by desorption of COCs from the solid

phase. Chemical attenuation of sulfate is also expected to contribute to a reduction in TDS at well 35. Aqueous arsenic concentrations are predicted to be impacted by remobilization of attenuated arsenic following interaction of representative background groundwater with arsenic-bearing aquifer solids at wells 21R and 51. As such, the time to reach the GWPS for arsenic may be longer than predicted by the groundwater flow and transport model.

3.3 Supplemental Arsenic Geochemical Assessment

Remobilization of arsenic from CCR porewater and natural sources was predicted by reaction modeling and was further explored through additional solid and aqueous phase sampling and geochemical analyses as discussed in an Addendum to the GCSM[15]. The results were used as the basis of supplemental geochemical modeling with the goal of better understanding arsenic speciation, solubility, and mechanisms of mobilization at wells with arsenic GWPS exceedances.

3.3.1 Arsenic Speciation and Association

The reaction modeling results discussed in Section 3.2 predict the presence of a trailing geochemical gradient for arsenic, the result of which is a temporary increase to aqueous arsenic concentrations at wells 21R and 51 after source control is completed.

Solids analyses presented in the GCSM indicate that arsenic is present in the solid phase at background and compliance locations, indicating that a component of arsenic is geogenic. SEP analyses indicate that the majority of arsenic is associated with the oxide component. This finding was supported by XRD results which detected the iron oxide mineral magnetite, as well as other iron-bearing minerals (pyrite and ankerite).

Additional 2024 sampling and SEP analyses also indicated arsenic association with the oxide fraction, as well as notable association with the residual fraction, the sulfide fraction, and the non-crystalline fraction which is commonly associated with amorphous oxide materials; however, XRD results from 2024 sampling did not indicate the presence of iron (hydr)oxide or iron sulfide minerals.

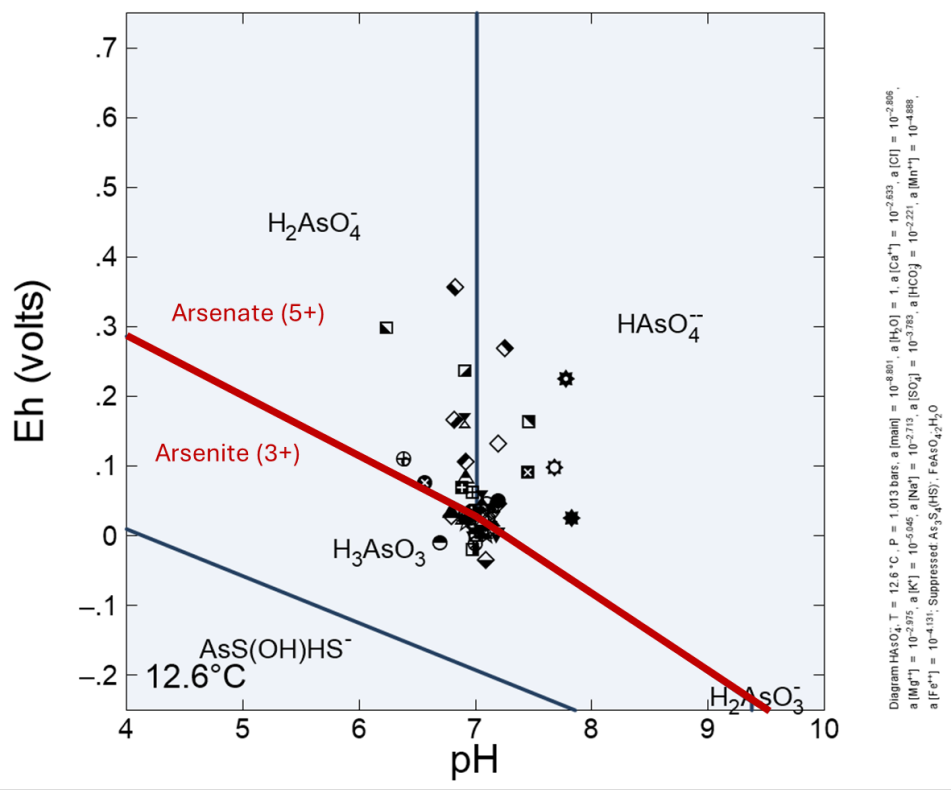
Groundwater at both wells with arsenic GWPS exceedances (21R and 51) and background well 34 was sampled in September 2024 for analysis of aqueous arsenic speciation and aqueous metals (total and dissolved). These results are provided in the GCSM Addendum. Aqueous arsenic concentrations were observed to be approximately two orders of magnitude lower at background well 34 compared to both wells with exceedances, based on total metals and arsenic speciation analyses. While aqueous arsenic at background well 34 was nearly evenly comprised of arsenite (H_3AsO_3; arsenic with a 3^+ oxidation state) and arsenate ($H_2AsO_4^{--}$; arsenic with a 5^+ oxidation state), arsenite was reported as the dominant oxidation state in wells 21R and 51. Arsenic speciation results reflect the elevated arsenic concentrations at the wells with exceedances compared to the nearest background locations and indicate that arsenite, the more mobile oxidation state of the two, dominants aqueous arsenic at these locations.

[15] The GCSM is a component of the Nature and Extent Report previously submitted to IEPA (Ramboll 2024) and is provided with relevant updates as Appendix D of the CAAA to which this report is attached.

3.3.2 Thermodynamic Evaluation

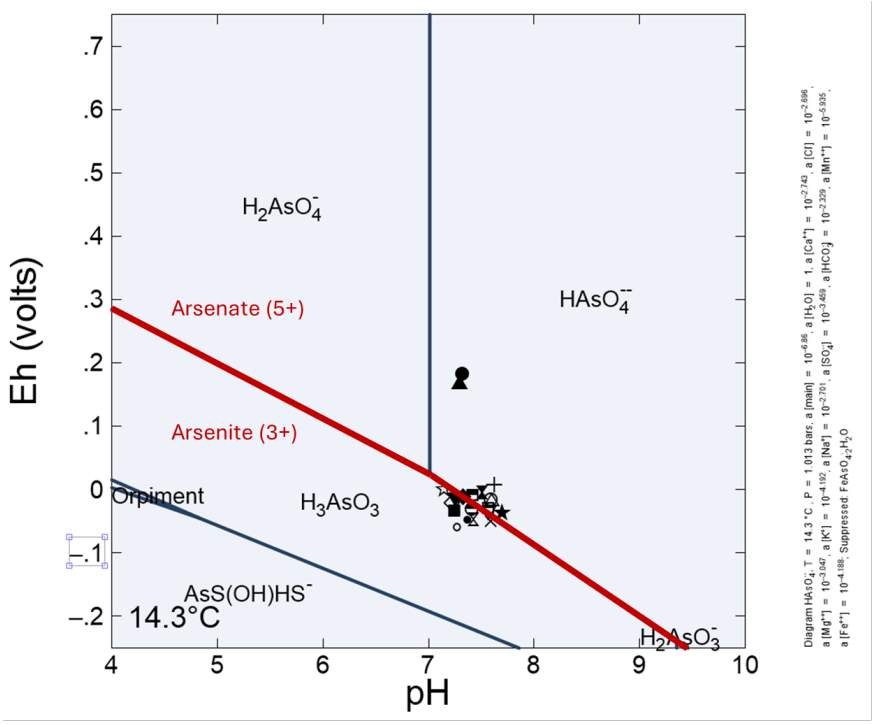
Arsenic speciation results were used to calculate electron potential (Eh) values for the arsenite/arsenate redox couple using the Nerst Equation (Panagiotaras et al. 2012). These arsenic redox couple-specific Eh values can be compared to field measured Eh values derived by converting oxidation-reduction potential (ORP) measurements (**Table 3**). Field Eh measurements account for any redox reaction occurring in the groundwater and represent an average, rather than compound-specific, redox state. Therefore, calculated Eh values were compared to Eh values measured in the field during the September sampling event provide an assessment of the discrepancy between methods, with calculated Eh values interpreted to be a more accurate representation of groundwater redox measurements for arsenic. An Eh adjustment factor of -0.08373 (V) was calculated as the difference between the mean value of calculated and measured Eh values for the September 2024 sampling event. This adjustment factor was then applied to historical Eh field measurements from wells 34, 21R, and 51. Pourbaix diagrams were then constructed using the composition of each well from the September 2024 sampling event to construct phase stability boundaries, and samples were plotted using both field-measured and adjusted Eh values (**Figures 13, 14, and 15**). Samples that plot above the red line indicate thermodynamic stability of arsenate aqueous species, whereas samples that plot below the red line indicate thermodynamic stability of arsenite aqueous species.

Figure 13: Well 34 Arsenic Pourbaix Diagram – Calculated Eh Values



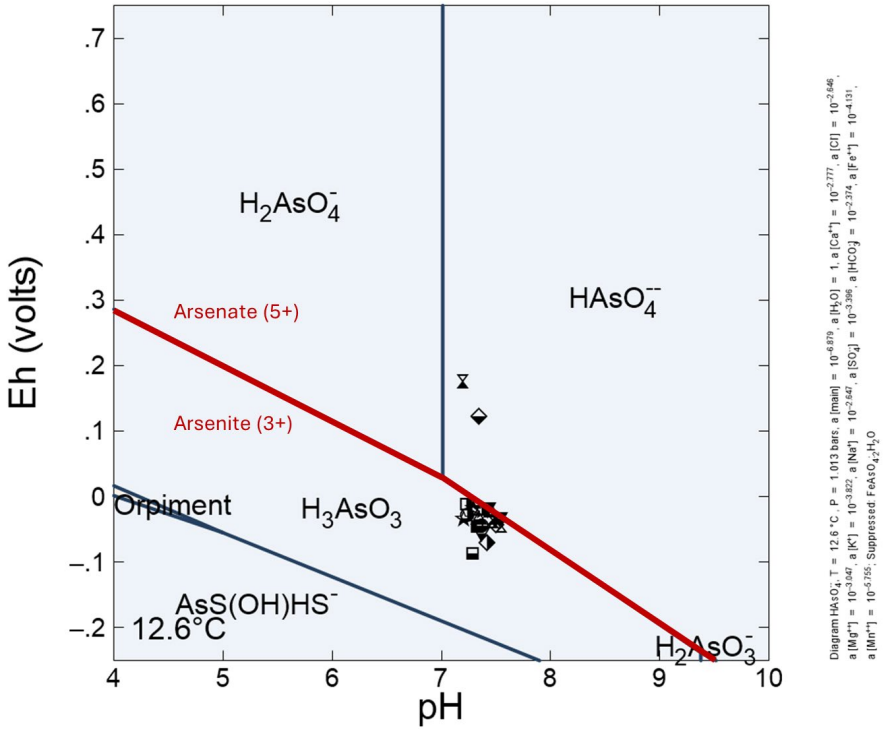
Note: Samples collected between 9/25/1996 and 10/08/2024 are displayed on the diagram

Figure 14: Well 21R Arsenic Pourbaix Diagram – Calculated Eh Values



Note: Samples collected from 03/11/2020 through 10/08/2024 are displayed on the diagram

Figure 15: Well 51 Arsenic Pourbaix Diagram – Calculated Eh Values



The arsenic speciation results and associated Pourbaix diagram findings contrast with the existing GCSM for arsenic at 21R and 51, which posited that arsenate species may be more prevalent at these locations based on data available at the time the CGSM was prepared. Recently collected data indicate that the consistently reducing conditions at these wells are actually associated with arsenic speciation favoring more mobile species (i.e., arsenite).

Arsenic speciation analyses and thermodynamic evaluations indicate that arsenite species dominate groundwater at locations with arsenic GWPS exceedances, a trait which is likely exclusive to the highly reducing, organic-rich lithology underlying the western portion of the WAPS. The current predominance of arsenite species at these locations is linked to elevated aqueous arsenic concentrations following source control, suggesting that the dominant arsenite will more readily desorb from aquifer solids with migration of background groundwater.

3.3.3 Reaction Pathway Modeling

Supplemental reaction pathway modeling was completed for well 21R to investigate the impact of dynamic geochemical conditions potentially associated with closure activities on arsenic mobility at this location. Similar to the geochemical reaction modeling described in Section 3.2, reaction pathway modeling predicts how aqueous and solid arsenic concentrations will change following source control during interaction with background water. However, reaction pathway modeling adjusts single geochemical parameters (i.e., pH and Eh) to understand their potential impacts on sorption and aqueous concentrations in isolation from the effect of desorption due to re-equilibration with a lower concentration solution. Reaction pathway modeling was only completed for well 21R as it was the only location with contemporaneous arsenic speciation and aquifer solids data collected.

Geochemist's Workbench (GWB) software package was used for reaction pathway modeling. The MINTEQ v4 database[16] was used in model calculations. Sorption to iron oxides was incorporated into the model calculations using the Dzombak and Morel (1990) two-layer surface complexation model, which is provided in GWB for the MINTEQ database as sorption dataset FeOH_minteq.sdat. Sorption sites to iron oxide materials are defined in this sorption dataset for the mineral ferrihydrite. A porosity value of 22% was used for the UAU (Natural Resource Technology, Inc., 2017).

Solids sampling adjacent to well 21R produced an SEP dataset containing results for fractions associated with oxides and non-crystalline components, which are typically representative of amorphous oxide components. These components were incorporated into the reaction pathway model to reflect the impact of arsenic sorption to well-specific aquifer solids within the model.

The initial aqueous component of the geochemical model was populated using the groundwater composition of the sample collected at well 21R in September 2024 (the nearest sampling event to the collection of aquifer solids near 21R). The model was run twice utilizing varying geochemical conditions to evaluate separately the impact of pH and redox variability on arsenic sorption and

[16]The standard MINTEQ v4 database contains identical thermodynamic data for arsenic species as the modified MINTEQ v4 database used in speciation and reaction modeling efforts. Usage of the modified database was therefore not required to maintain thermodynamic database consistence between modeling efforts.

mobility; initially fixing the pH value and setting Eh values to vary along a sliding scale towards conditions more similar to background, and secondly fixing Eh and setting pH values to vary along a sliding scale towards conditions more similar to background. Fixed pH and Eh values for the aqueous component within the model were set at values measured from well 21R during the September 2024 sampling event (pH value of 7.4 standard units [SU]; Eh value of 0.0256 mV). pH values were set to slide from 8.0 to 6.0 SU, a value inclusive of both the pH value measured at background well 34 during the September 2024 sampling event (6.8 SU) and typical range of pH values measured at well 21R. Eh values were set to slide from 0.02 to 0.20 V, a value inclusive of the less reducing groundwater conditions at well 34 (the September 2024 sampling event Eh reported value was 0.0672 V; previously observed Eh values varied from 0.0517 V to 0.443 V, with an average of 0.1630 V). Solid-phase iron reactants incorporated for sorption assessment were defined based on SEP results for iron oxides and non-crystalline materials (analytical data provided in the GCSM Addendum). Ferrihydrite was included at a mass of 4,400 micrograms per gram (µg/g), calculated by averaging the sum of iron associated with the iron oxide and iron non-crystalline material fractions for SEP samples from both well 21R solid sample intervals.

The geochemical models were used to calculate the anticipated individual effects of pH and redox variability on aqueous arsenic concentrations. Aqueous arsenic concentrations as a function of pH are shown on **Figure 16**, and concentrations as a function of Eh are shown on **Figure 17**.

Figure 16: 21R Aqueous Arsenic Concentrations as a Function of pH Variability

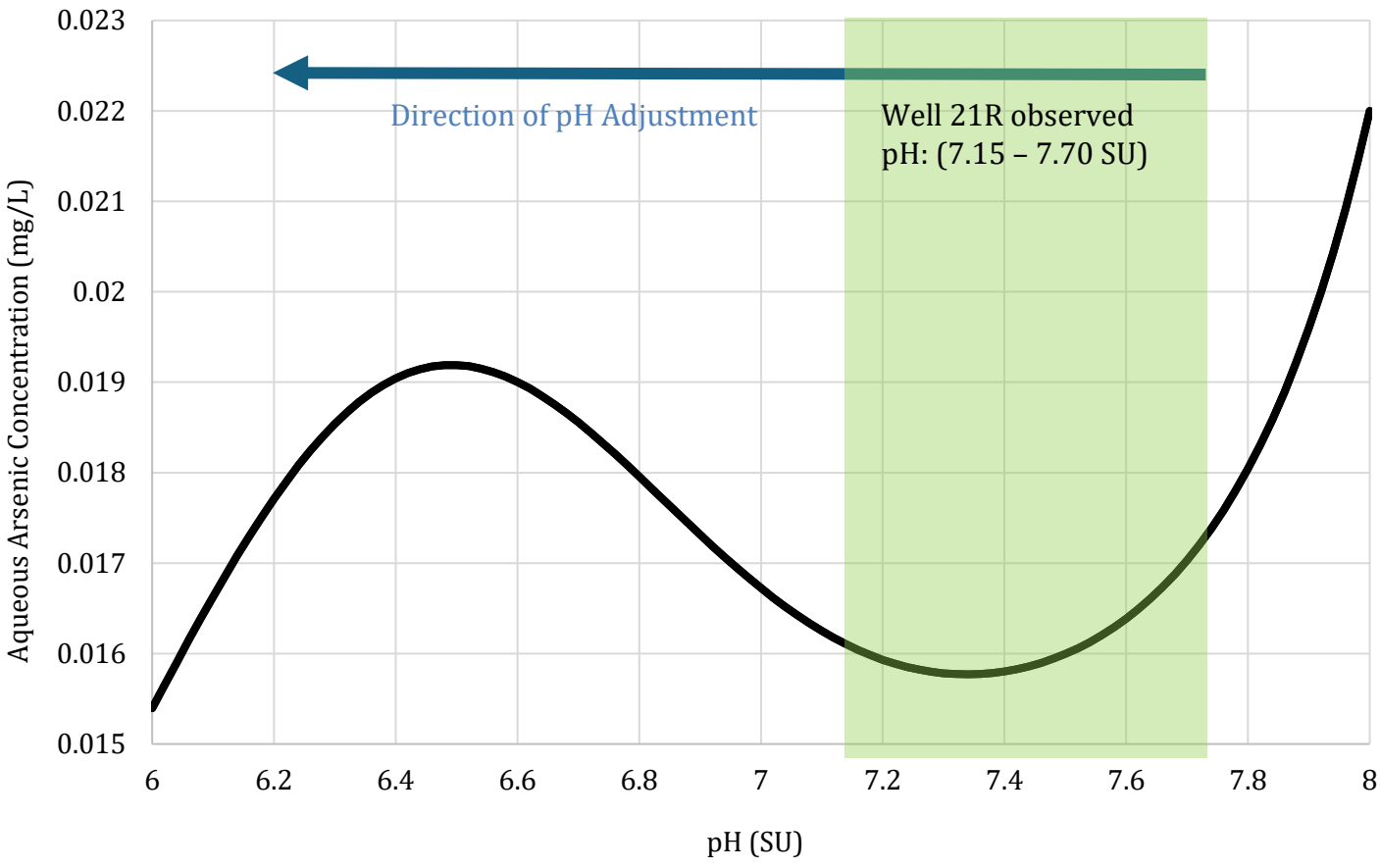
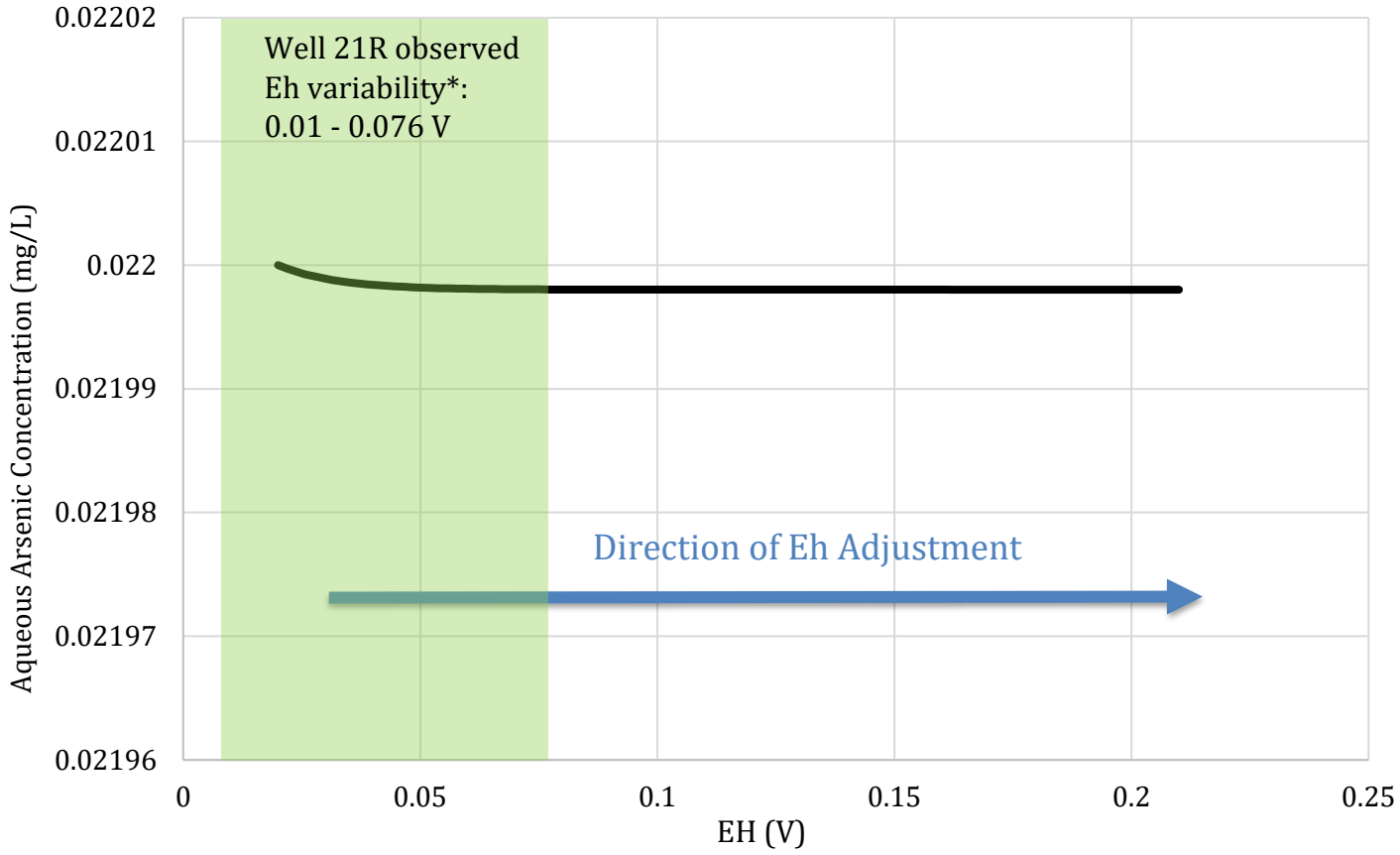


Figure 17: 21R Aqueous Arsenic Concentrations as a Function of Eh Variability



*: 21R Eh measurement variability excludes two outlier measurements of 0.252 and 0.237 V measured on 6/7/2022 and 9/13/2022 respectively

The results of the reaction pathway modeling presented in **Figures 16 and 17** indicate that while fluctuations in pH (and to a notably lesser extent, redox conditions) have a degree of influence on aqueous arsenic concentrations, the predicted aqueous arsenic increases from reaction modeling presented in Section 3.2 are unable to be achieved without interaction with low arsenic-concentration water. Reaction pathway modeling results predict that aqueous arsenic concentrations should vary from a minimum of 0.0158 mg/L (at pH 7.32 SU) to a maximum of 0.0170 mg/L (at pH 7.7 SU) within the pH range observed at well 21R to date; however, further decreases in pH values associated with background conditions are expected to influence arsenic concentrations, potentially increasing aqueous concentrations to a predicted maximum of 0.0192 mg/L at pH 6.5 (**Figure 16**). This maximum predicted value is still well below the predicted aqueous arsenic concentrations from reaction modeling presented in Section 3.2 (maximum aqueous concentrations of approximately 0.0600 mg/L, **Figure 2**).

In comparison, redox conditions (represented by Eh in the modeling effort) have less influence on aqueous arsenic concentrations, with aqueous arsenic concentrations predicted to vary negligibly as a function of Eh changes (**Figure 17**).

Combined, Section 3.2 and Section 3.3 modeling results suggest that previously modeled aqueous arsenic increases are anticipated to be caused primarily by the physical migration of lower arsenic concentration groundwater from background locations (represented by well 34 in the WAPS-West model) triggering re-equilibration leading to the subsequent desorption of arsenic from UAU solids. However, a component of aqueous arsenic mobilization is also predicted to be associated with pH changes at wells with arsenic exceedances. If groundwater flow conditions or remedial activities at the site drive substantial pH changes, additional arsenic mobilization may occur.

4. CONCLUSIONS

This report evaluated the contribution of chemical mechanisms to groundwater polishing using geochemical modeling. The results of the groundwater polishing evaluation also contextualize estimates of the modeled time to reach the GWPS by evaluating potential changes in COC attenuation as groundwater quality returns to background conditions.

Geochemical modeling of current WAPS conditions demonstrates chemical attenuation of arsenic, boron, and (to a lesser extent) sulfate via sorption to aquifer solids, particularly iron and aluminum oxides. Modeling of anticipated future conditions predicts some desorption of arsenic, boron, and sulfate from solids. Aqueous arsenic concentrations are predicted to increase at wells with current exceedances following remobilization of previously attenuated arsenic (whether due to the influence of the WAPS or from geogenic sources) under future conditions. Modeling predicts that iron and aluminum oxide sorbing mineral phases will remain stable in post-source control conditions, and as a result this chemical attenuation mechanism will remain viable for boron and sulfate. Barite precipitation is predicted under future conditions which will provide an additional attenuation mechanism for sulfate. It is expected that attenuation of sulfate will also contribute to a reduction in TDS, as sulfate is the primary contributor to TDS at well 35. Lithium was not addressed in the geochemical modeling, but lithium concentrations have steadily declined following initiation of closure activities.

Results of the geochemical modeling suggest that the time to reach boron and sulfate GWPS is not anticipated to be impacted by desorption from aquifer solids under future conditions. The observed time to reach the GWPS for arsenic may be longer than predicted by the groundwater flow and transport model due to remobilization of previously attenuated arsenic. Arsenic speciation and mobilization were further investigated in a supplemental assessment which included evaluation of recently collected solid and aqueous phase data as well as geochemical modeling. Results indicate that arsenic exists in the solid and aqueous phase at wells with arsenic GWPS exceedances, and the majority of aqueous arsenic is in the arsenic (III) oxidation state at these locations. Supplemental geochemical modeling determined that changes to pH (and to a lesser extent, redox) conditions at wells with exceedances will influence arsenic mobility somewhat. However, modeling results generally suggest that re-equilibration of aquifer solids containing sorbed or geogenic arsenic with background groundwater containing lower aqueous arsenic concentration is the primary driver of aqueous arsenic increases at wells with exceedances. These results will inform corrective action groundwater monitoring and adaptive site management, critical components of every corrective action considered in the CAAA.

5. REFERENCES

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TABLES

Table 1. Summary of Geochemical Model Inputs
Groundwater Polishing Evaluation Report
Hennepin Power Plant - West Ash Pond System

Model Component	Parameters	Data source(s)
Solid Phase	Iron (hydr)oxides, aluminum (hydr)oxides	Site-specific sequential extraction results from October 2024 sampling
	Calcite and dolomite	X-ray diffraction results
Downgradient groundwater (COC exceedance locations)	Arsenic, boron, sulfate, iron, manganese, major ions[1], 845 constituents[1]	Median concentrations per well from data collected in Q2 and Q3 2023
Background groundwater		Median concentrations from network background wells using data collected in Q2 and Q3 2023 (West and East model runs). Median concentrations from eight Illinois River water sampling events (River model run)

[1]See Section 3.1.1.2 for details.

Table 2: Geochemical Modeling Response of Sorbing Phases
Groundwater Polishing Evaluation
Hennepin Power Plant - West Ash Pond System

Program ID	Parameter	Hydrostratigraphic Unit	Location	Summary Type	First Reaction Change		Second Reaction Change	
					mg/kg	%	mg/kg	%
HEN 804 W	Barite	UA	21R	25p	0.008	NA	0.007	85.90
HEN 804 W	Barite	UA	21R	median	0.008	NA	0.007	84.86
HEN 804 W	Barite	UA	21R	75p	0.008	NA	0.007	83.77
HEN 804 W	Barite	UA	51	25p	0.008	NA	0.007	88.84
HEN 804 W	Barite	UA	51	median	0.008	NA	0.007	87.94
HEN 804 W	Barite	UA	51	75p	0.008	NA	0.007	86.98
HEN 804 W	Ferrihydrite	UA	21R	25p	2.146	0.17	-0.067	<0.01
HEN 804 W	Ferrihydrite	UA	21R	median	2.418	0.16	-0.037	<0.01
HEN 804 W	Ferrihydrite	UA	21R	75p	2.723	0.16	-0.006	<0.01
HEN 804 W	Ferrihydrite	UA	51	25p	2.194	0.17	-0.002	<0.01
HEN 804 W	Ferrihydrite	UA	51	median	2.455	0.17	0.026	<0.01
HEN 804 W	Ferrihydrite	UA	51	75p	2.748	0.16	0.054	<0.01
HEN 804 W	Gibbsite	UA	21R	25p	0.004	<0.01	0.004	<0.01
HEN 804 W	Gibbsite	UA	21R	median	0.004	<0.01	0.004	<0.01
HEN 804 W	Gibbsite	UA	21R	75p	0.004	<0.01	0.004	<0.01
HEN 804 W	Gibbsite	UA	51	25p	0.004	<0.01	0.004	<0.01
HEN 804 W	Gibbsite	UA	51	median	0.004	<0.01	0.004	<0.01
HEN 804 W	Gibbsite	UA	51	75p	0.004	<0.01	0.004	<0.01
HEN 804 E	Barite	UA	22	25p	0.000	NA	0.000	NA
HEN 804 E	Barite	UA	22	median	0.000	NA	0.000	NA
HEN 804 E	Barite	UA	22	75p	0.000	NA	0.000	NA
HEN 804 E	Barite	UA	23	25p	0.000	NA	0.000	NA
HEN 804 E	Barite	UA	23	median	0.000	NA	0.000	NA
HEN 804 E	Barite	UA	23	75p	0.000	NA	0.000	NA
HEN 804 E	Barite	UA	35	25p	0.000	NA	0.000	NA
HEN 804 E	Barite	UA	35	median	0.000	NA	-0.000	<0.01
HEN 804 E	Barite	UA	35	75p	0.001	NA	-0.001	<0.01
HEN 804 E	Ferrihydrite	UA	22	25p	0.005	<0.01	0.005	<0.01
HEN 804 E	Ferrihydrite	UA	22	median	0.005	<0.01	0.005	<0.01
HEN 804 E	Ferrihydrite	UA	22	75p	0.005	<0.01	0.005	<0.01
HEN 804 E	Ferrihydrite	UA	23	25p	0.005	<0.01	0.005	<0.01
HEN 804 E	Ferrihydrite	UA	23	median	0.005	<0.01	0.005	<0.01
HEN 804 E	Ferrihydrite	UA	23	75p	0.005	<0.01	0.005	<0.01
HEN 804 E	Ferrihydrite	UA	35	25p	0.005	<0.01	0.005	<0.01
HEN 804 E	Ferrihydrite	UA	35	median	0.005	<0.01	0.005	<0.01
HEN 804 E	Ferrihydrite	UA	35	75p	0.005	<0.01	0.005	<0.01
HEN 804 E	Gibbsite	UA	22	25p	0.004	<0.01	0.004	<0.01
HEN 804 E	Gibbsite	UA	22	median	0.004	<0.01	0.004	<0.01
HEN 804 E	Gibbsite	UA	22	75p	0.004	<0.01	0.004	<0.01
HEN 804 E	Gibbsite	UA	23	25p	0.004	<0.01	0.004	<0.01
HEN 804 E	Gibbsite	UA	23	median	0.004	<0.01	0.004	<0.01
HEN 804 E	Gibbsite	UA	23	75p	0.004	<0.01	0.004	<0.01

Table 2: Geochemical Modeling Response of Sorbing Phases
Groundwater Polishing Evaluation
Hennepin Power Plant - West Ash Pond System

Program ID	Parameter	Hydrostratigraphic Unit	Location	Summary Type	First Reaction Change		Second Reaction Change	
					mg/kg	%	mg/kg	%
HEN 804 E	Gibbsite	UA	35	25p	0.004	<0.01	0.004	<0.01
HEN 804 E	Gibbsite	UA	35	median	0.004	<0.01	0.004	<0.01
HEN 804 E	Gibbsite	UA	35	75p	0.004	<0.01	0.004	<0.01
HEN 804 River	Barite	UA	22	25p	0.008	NA	0.008	101.37
HEN 804 River	Barite	UA	22	median	0.008	NA	0.008	101.15
HEN 804 River	Barite	UA	22	75p	0.008	NA	0.008	100.88
HEN 804 River	Ferrihydrite	UA	22	25p	0.039	<0.01	0.039	<0.01
HEN 804 River	Ferrihydrite	UA	22	median	0.039	<0.01	0.039	<0.01
HEN 804 River	Ferrihydrite	UA	22	75p	0.039	<0.01	0.039	<0.01
HEN 804 River	Gibbsite	UA	22	25p	0.002	<0.01	0.002	<0.01
HEN 804 River	Gibbsite	UA	22	median	0.002	<0.01	0.002	<0.01
HEN 804 River	Gibbsite	UA	22	75p	0.002	<0.01	0.002	<0.01

Notes:
% = percent
25p = 25th percentile
75p = 75th percentile
mg/kg = milligram/kilogram
NA = not applicable
UA = Uppermost Aquifer

Table 3 - Groundwater Oxidation-Reduction (Redox) Conditions
Groundwater Polishing Report
Hennepin West Ash Pond System, Illinois

Constituent	Units	Background	Compliance	
		34	21R	51
pH	SU	6.85	7.38	7.23
Arsenic (III)	µg/L	0.141	21.0	18.1
Arsenic (V)	µg/L	0.103	2.36	2.48
Field ORP Measurement	mV	-132.8	-174.4	-146.2
Eh - Calculated from ORP	V	0.0672	0.0256	0.0538
Eh - Calculated from Nernst Equation	V	-0.0204	-0.0444	-0.0398

Notes

Nernst equation used to calculate Eh for the arsenite/arsenate oxidation-reduction couple using methods from Panagiotaras et al. 2012.

An Ag/AgCl electrode was assumed for the calculation of Eh from field ORP measurements.

SU - standard units

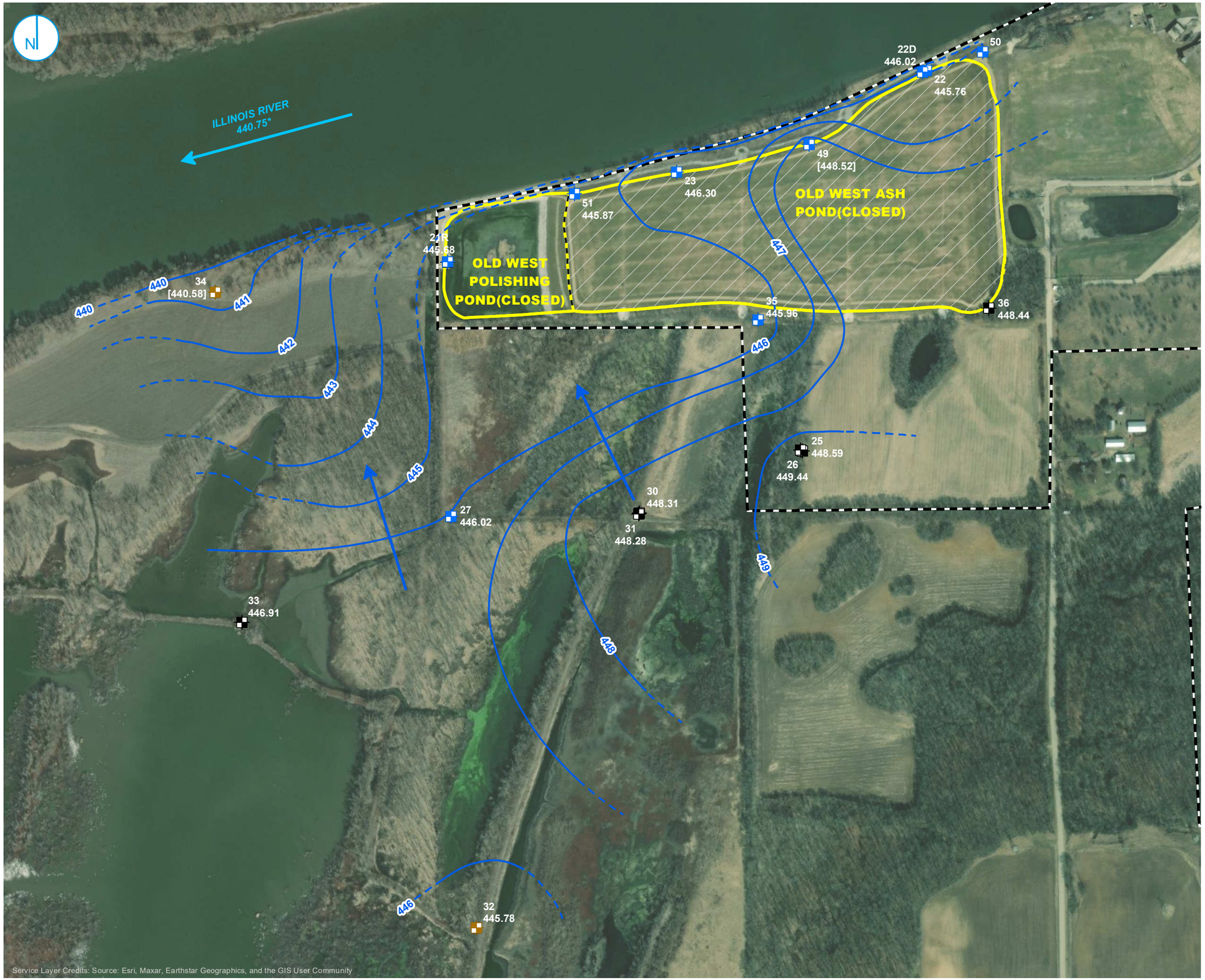
µg/L - microgram per liter

mV - millivolt

V - volt

ATTACHMENT A

Potentiometric Surface Map – August 21 and 22, 2023



COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
MONITORING WELL
GROUNDWATER ELEVATION CONTOUR (1 FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
REGULATED UNIT (SUBJECT UNIT)
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

NOTES:

1.ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.
2. ELEVATIONS IN BRACKETS WERE OBTAINED OUTSIDE OF THE 24 HOUR PERIOD FROM INITIATION OF DEPTH TO GROUNDWATER MEASUREMENTS BUT WITHIN THE SAME SAMPLING EVENT.
3. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)
*ILLINOIS RIVER ELEVATION OBTAINED FROM STAFF GAGE SG02, LOCATED AT THE HENNEPIN POWER PLANT

0 200 400 Feet

POTENTIOMETRIC SURFACE MAP AUGUST 21 AND 22, 2023

2023 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT
OLD WEST ASH POND
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\22851\MXD\GW_Contours\Round_2023\Hennepin\OWAP_804\HEN 804 OWAP Pot Surface 20230821.mxd

PROJECT: 169000XXXX | DATED: 12/18/2023 | DESIGNER: GALARNMC

ATTACHMENT B
PHREEQC Input Files and Thermodynamic Database

804W - 25th Percentile Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file HEN_845_804W_25p_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #21R (C - UA)
redox pe
units mg/l
density 1
pH 7.44
pe 0.98
temp 14.9
S(6) 92.5 as SO4
B 2.01
Li 0.02135
As 0.0252
C(4) 227.5 as CO3
Cl 99
F 0.175
Ca 120.5
Mg 40.35
Na 47.2
K 2.905
Ba 0.298
Si 9.085
P 0.217
Mn 0.1105
Fe 5.52
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.002
Co 0.00135
Pb 0.0024
Mo 0.00885
Se 0.000395
end

SOLUTION 2 #51 (C - UA)
redox pe
```

```
units mg/l
density 1
pH 7.305
pe 1.42
temp 15.1
S(6) 93.5 as SO4
B 1.465
Li 0.0482
As 0.0186
C(4) 208.5 as CO3
Cl 101.5
F 0.17
Ca 118.5
Mg 38.6
Na 55.45
K 6.125
Ba 0.1045
Si 8.115
P 0.023
Mn 0.1595
Fe 6.315
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.00125
Co 0.00083
Pb 0.0016
Mo 0.0078
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #21R (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #51 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2
```

```
SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

SOLUTION 3 #average background
redox pe
units mg/l
density 1
pH 7
pe 2.08
temp 12.55
S(6) 47.5
B 0.1
Li 0.0081
As 0.0022325
C(4) 327
Cl 70 charge
F 0.155
Ca 149.5
Mg 40.9
Na 48.75
K 0.435
Ba 0.10475
Si 12.2
P 0.119
Mn 1.21
Fe 5.825
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.00045
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 3

end

#FIRST REACTION

#21R (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#21R (C - UA) - Second Reaction
USE SOLUTION 3
```

```
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#51 (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#51 (C - UA) - Second Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end
```

804W - 25th Percentile Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file HEN_845_804W_25p_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #21R (C - UA)
redox pe
units mg/l
density 1
pH 7.44
pe 0.98
temp 14.9
S(6) 92.5 as SO4
B 2.01
Li 0.02135
As 0.0252
C(4) 227.5 as CO3
Cl 99 charge
F 0.175
Ca 120.5
Mg 40.35
Na 47.2
K 2.905
Ba 0.298
Si 9.085
P 0.217
Mn 0.1105
Fe 5.52
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.002
Co 0.00135
Pb 0.0024
Mo 0.00885
Se 0.000395
end

SOLUTION 2 #51 (C - UA)
redox pe
```

```
units mg/l
density 1
pH 7.305
pe 1.42
temp 15.1
S(6) 93.5 as SO4
B 1.465
Li 0.0482
As 0.0186
C(4) 208.5 as CO3
Cl 101.5 charge
F 0.17
Ca 118.5
Mg 38.6
Na 55.45
K 6.125
Ba 0.1045
Si 8.115
P 0.023
Mn 0.1595
Fe 6.315
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.00125
Co 0.00083
Pb 0.0016
Mo 0.0078
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #21R (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #51 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2
```

```
SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

SOLUTION 3 #average background
redox pe
units mg/l
density 1
pH 7
pe 2.08
temp 12.55
S(6) 47.5
B 0.1
Li 0.0081
As 0.0022325
C(4) 327
Cl 70 charge
F 0.155
Ca 149.5
Mg 40.9
Na 48.75
K 0.435
Ba 0.10475
Si 12.2
P 0.119
Mn 1.21
Fe 5.825
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.00045
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 3

end

#FIRST REACTION

#21R (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#21R (C - UA) - Second Reaction
USE SOLUTION 3
```

```
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#51 (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#51 (C - UA) - Second Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end
```

804W - 75th Percentile Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file HEN_845_804W_75p_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #21R (C - UA)
redox pe
units mg/l
density 1
pH 7.44
pe 0.98
temp 14.9
S(6) 92.5 as SO4
B 2.01
Li 0.02135
As 0.0252
C(4) 227.5 as CO3
Cl 99
F 0.175
Ca 120.5
Mg 40.35
Na 47.2
K 2.905
Ba 0.298
Si 9.085
P 0.217
Mn 0.1105
Fe 5.52
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.002
Co 0.00135
Pb 0.0024
Mo 0.00885
Se 0.000395
end

SOLUTION 2 #51 (C - UA)
redox pe
```

```
units mg/l
density 1
pH 7.305
pe 1.42
temp 15.1
S(6) 93.5 as SO4
B 1.465
Li 0.0482
As 0.0186
C(4) 208.5 as CO3
Cl 101.5
F 0.17
Ca 118.5
Mg 38.6
Na 55.45
K 6.125
Ba 0.1045
Si 8.115
P 0.023
Mn 0.1595
Fe 6.315
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.00125
Co 0.00083
Pb 0.0016
Mo 0.0078
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #21R (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #51 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2
```

```
SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

SOLUTION 3 #average background
redox pe
units mg/l
density 1
pH 7
pe 2.08
temp 12.55
S(6) 47.5
B 0.1
Li 0.0081
As 0.0022325
C(4) 327
Cl 70 charge
F 0.155
Ca 149.5
Mg 40.9
Na 48.75
K 0.435
Ba 0.10475
Si 12.2
P 0.119
Mn 1.21
Fe 5.825
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.00045
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 3

end

#FIRST REACTION

#21R (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#21R (C - UA) - Second Reaction
USE SOLUTION 3
```

```
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#51 (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#51 (C - UA) - Second Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end
```

804W - 75th Percentile Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file HEN_845_804W_75p_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #21R (C - UA)
redox pe
units mg/l
density 1
pH 7.44
pe 0.98
temp 14.9
S(6) 92.5 as SO4
B 2.01
Li 0.02135
As 0.0252
C(4) 227.5 as CO3
Cl 99 charge
F 0.175
Ca 120.5
Mg 40.35
Na 47.2
K 2.905
Ba 0.298
Si 9.085
P 0.217
Mn 0.1105
Fe 5.52
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.002
Co 0.00135
Pb 0.0024
Mo 0.00885
Se 0.000395
end

SOLUTION 2 #51 (C - UA)
redox pe
```

```
units mg/l
density 1
pH 7.305
pe 1.42
temp 15.1
S(6) 93.5 as SO4
B 1.465
Li 0.0482
As 0.0186
C(4) 208.5 as CO3
Cl 101.5 charge
F 0.17
Ca 118.5
Mg 38.6
Na 55.45
K 6.125
Ba 0.1045
Si 8.115
P 0.023
Mn 0.1595
Fe 6.315
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.00125
Co 0.00083
Pb 0.0016
Mo 0.0078
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #21R (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #51 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2
```

```
SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

SOLUTION 3 #average background
redox pe
units mg/l
density 1
pH 7
pe 2.08
temp 12.55
S(6) 47.5
B 0.1
Li 0.0081
As 0.0022325
C(4) 327
Cl 70 charge
F 0.155
Ca 149.5
Mg 40.9
Na 48.75
K 0.435
Ba 0.10475
Si 12.2
P 0.119
Mn 1.21
Fe 5.825
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.00045
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 3

end

#FIRST REACTION

#21R (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#21R (C - UA) - Second Reaction
USE SOLUTION 3
```

```
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#51 (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#51 (C - UA) - Second Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end
```

804W - Median Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file HEN_845_804W_median_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #21R (C - UA)
redox pe
units mg/l
density 1
pH 7.44
pe 0.98
temp 14.9
S(6) 92.5 as SO4
B 2.01
Li 0.02135
As 0.0252
C(4) 227.5 as CO3
Cl 99
F 0.175
Ca 120.5
Mg 40.35
Na 47.2
K 2.905
Ba 0.298
Si 9.085
P 0.217
Mn 0.1105
Fe 5.52
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.002
Co 0.00135
Pb 0.0024
Mo 0.00885
Se 0.000395
end

SOLUTION 2 #51 (C - UA)
redox pe
```

```
units mg/l
density 1
pH 7.305
pe 1.42
temp 15.1
S(6) 93.5 as SO4
B 1.465
Li 0.0482
As 0.0186
C(4) 208.5 as CO3
Cl 101.5
F 0.17
Ca 118.5
Mg 38.6
Na 55.45
K 6.125
Ba 0.1045
Si 8.115
P 0.023
Mn 0.1595
Fe 6.315
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.00125
Co 0.00083
Pb 0.0016
Mo 0.0078
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #21R (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #51 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2
```

```
SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

SOLUTION 3 #average background
redox pe
units mg/l
density 1
pH 7
pe 2.08
temp 12.55
S(6) 47.5
B 0.1
Li 0.0081
As 0.0022325
C(4) 327
Cl 70 charge
F 0.155
Ca 149.5
Mg 40.9
Na 48.75
K 0.435
Ba 0.10475
Si 12.2
P 0.119
Mn 1.21
Fe 5.825
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.00045
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 3

end

#FIRST REACTION

#21R (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#21R (C - UA) - Second Reaction
USE SOLUTION 3
```

```
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#51 (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#51 (C - UA) - Second Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end
```

804W - Median Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file HEN_845_804W_median_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #21R (C - UA)
redox pe
units mg/l
density 1
pH 7.44
pe 0.98
temp 14.9
S(6) 92.5 as SO4
B 2.01
Li 0.02135
As 0.0252
C(4) 227.5 as CO3
Cl 99 charge
F 0.175
Ca 120.5
Mg 40.35
Na 47.2
K 2.905
Ba 0.298
Si 9.085
P 0.217
Mn 0.1105
Fe 5.52
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.002
Co 0.00135
Pb 0.0024
Mo 0.00885
Se 0.000395
end

SOLUTION 2 #51 (C - UA)
redox pe
```

```
units mg/l
density 1
pH 7.305
pe 1.42
temp 15.1
S(6) 93.5 as SO4
B 1.465
Li 0.0482
As 0.0186
C(4) 208.5 as CO3
Cl 101.5 charge
F 0.17
Ca 118.5
Mg 38.6
Na 55.45
K 6.125
Ba 0.1045
Si 8.115
P 0.023
Mn 0.1595
Fe 6.315
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.00125
Co 0.00083
Pb 0.0016
Mo 0.0078
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #21R (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #51 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2
```

```
SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

SOLUTION 3 #average background
redox pe
units mg/l
density 1
pH 7
pe 2.08
temp 12.55
S(6) 47.5
B 0.1
Li 0.0081
As 0.0022325
C(4) 327
Cl 70 charge
F 0.155
Ca 149.5
Mg 40.9
Na 48.75
K 0.435
Ba 0.10475
Si 12.2
P 0.119
Mn 1.21
Fe 5.825
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.00045
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 3

end

#FIRST REACTION

#21R (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#21R (C - UA) - Second Reaction
USE SOLUTION 3
```

```
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#51 (C - UA) - First Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#51 (C - UA) - Second Reaction
USE SOLUTION 3
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end
```

804E - 25th Percentile Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file HEN_845_804E_25p_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

SOLUTION 2 #23 (C - UA)
redox pe
```

units mg/l
density 1
pH 7.405
pe 1.545
temp 14
S(6) 455 as SO4
B 8.445
Li 0.003625
As 0.00262
C(4) 95.45 as CO3
Cl 54
F 0.185
Ca 107.5
Mg 77.75
Na 45
K 3.03
Ba 0.04505
Si 5.99
P 0.01
Mn 1.13
Fe 0.144
Al 0.009425
Sb 0.000425
Be 0.0002825
Cd 0.0001675
Cr 0.000975
Co 0.000435
Pb 0.0010475
Mo 0.0148
Se 0.000395
end

SOLUTION 3 #35 (C - UA)
redox pe
units mg/l
density 1
pH 6.955
pe 6.075
temp 14.55
S(6) 780 as SO4
B 12.3
Li 0.0275
As 0.0022325
C(4) 137.5 as CO3
Cl 34.5
F 0.155
Ca 305.5
Mg 36.85
Na 30.4
K 14
Ba 0.04255
Si 4.99
P 0.013
Mn 0.533

```
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.0013
Pb 0.0010475
Mo 0.0779
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #23 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #35 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
```

```
save surface 3
end

SOLUTION 4 #average background
redox pe
units mg/l
density 1
pH 7.005
pe 5.89
temp 12.4
S(6) 64.5
B 0.1415
Li 0.00385
As 0.00242
C(4) 194.5
Cl 69 charge
F 0.16
Ca 101
Mg 39.25
Na 39.05
K 2.16
Ba 0.04
Si 6.275
P 0.057
Mn 0.07075
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.00023
Cr 0.000975
Co 0.0016
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 4

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

```
#23 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#23 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#35 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#35 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end
```

804E - 25th Percentile Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file HEN_845_804E_25p_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93 charge
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

SOLUTION 2 #23 (C - UA)
redox pe
```

units mg/l
density 1
pH 7.405
pe 1.545
temp 14
S(6) 455 as SO4
B 8.445
Li 0.003625
As 0.00262
C(4) 95.45 as CO3
Cl 54 charge
F 0.185
Ca 107.5
Mg 77.75
Na 45
K 3.03
Ba 0.04505
Si 5.99
P 0.01
Mn 1.13
Fe 0.144
Al 0.009425
Sb 0.000425
Be 0.0002825
Cd 0.0001675
Cr 0.000975
Co 0.000435
Pb 0.0010475
Mo 0.0148
Se 0.000395
end

SOLUTION 3 #35 (C - UA)
redox pe
units mg/l
density 1
pH 6.955
pe 6.075
temp 14.55
S(6) 780 as SO4
B 12.3
Li 0.0275
As 0.0022325
C(4) 137.5 as CO3
Cl 34.5 charge
F 0.155
Ca 305.5
Mg 36.85
Na 30.4
K 14
Ba 0.04255
Si 4.99
P 0.013
Mn 0.533

```
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.0013
Pb 0.0010475
Mo 0.0779
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #23 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #35 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
```

```
save surface 3
end

SOLUTION 4 #average background
redox pe
units mg/l
density 1
pH 7.005
pe 5.89
temp 12.4
S(6) 64.5
B 0.1415
Li 0.00385
As 0.00242
C(4) 194.5
Cl 69 charge
F 0.16
Ca 101
Mg 39.25
Na 39.05
K 2.16
Ba 0.04
Si 6.275
P 0.057
Mn 0.07075
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.00023
Cr 0.000975
Co 0.0016
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 4

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

```
#23 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#23 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#35 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#35 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end
```

804E - 75th Percentile Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file HEN_845_804E_75p_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

SOLUTION 2 #23 (C - UA)
redox pe
```

units mg/l
density 1
pH 7.405
pe 1.545
temp 14
S(6) 455 as SO4
B 8.445
Li 0.003625
As 0.00262
C(4) 95.45 as CO3
Cl 54
F 0.185
Ca 107.5
Mg 77.75
Na 45
K 3.03
Ba 0.04505
Si 5.99
P 0.01
Mn 1.13
Fe 0.144
Al 0.009425
Sb 0.000425
Be 0.0002825
Cd 0.0001675
Cr 0.000975
Co 0.000435
Pb 0.0010475
Mo 0.0148
Se 0.000395
end

SOLUTION 3 #35 (C - UA)
redox pe
units mg/l
density 1
pH 6.955
pe 6.075
temp 14.55
S(6) 780 as SO4
B 12.3
Li 0.0275
As 0.0022325
C(4) 137.5 as CO3
Cl 34.5
F 0.155
Ca 305.5
Mg 36.85
Na 30.4
K 14
Ba 0.04255
Si 4.99
P 0.013
Mn 0.533

```
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.0013
Pb 0.0010475
Mo 0.0779
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #23 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #35 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
```

```
save surface 3
end

SOLUTION 4 #average background
redox pe
units mg/l
density 1
pH 7.005
pe 5.89
temp 12.4
S(6) 64.5
B 0.1415
Li 0.00385
As 0.00242
C(4) 194.5
Cl 69 charge
F 0.16
Ca 101
Mg 39.25
Na 39.05
K 2.16
Ba 0.04
Si 6.275
P 0.057
Mn 0.07075
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.00023
Cr 0.000975
Co 0.0016
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 4

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

```
#23 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#23 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#35 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#35 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end
```

804E - 75th Percentile Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file HEN_845_804E_75p_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93 charge
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

SOLUTION 2 #23 (C - UA)
redox pe
```

units mg/l
density 1
pH 7.405
pe 1.545
temp 14
S(6) 455 as SO4
B 8.445
Li 0.003625
As 0.00262
C(4) 95.45 as CO3
Cl 54 charge
F 0.185
Ca 107.5
Mg 77.75
Na 45
K 3.03
Ba 0.04505
Si 5.99
P 0.01
Mn 1.13
Fe 0.144
Al 0.009425
Sb 0.000425
Be 0.0002825
Cd 0.0001675
Cr 0.000975
Co 0.000435
Pb 0.0010475
Mo 0.0148
Se 0.000395
end

SOLUTION 3 #35 (C - UA)
redox pe
units mg/l
density 1
pH 6.955
pe 6.075
temp 14.55
S(6) 780 as SO4
B 12.3
Li 0.0275
As 0.0022325
C(4) 137.5 as CO3
Cl 34.5 charge
F 0.155
Ca 305.5
Mg 36.85
Na 30.4
K 14
Ba 0.04255
Si 4.99
P 0.013
Mn 0.533

```
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.0013
Pb 0.0010475
Mo 0.0779
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #23 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #35 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
```

```
save surface 3
end

SOLUTION 4 #average background
redox pe
units mg/l
density 1
pH 7.005
pe 5.89
temp 12.4
S(6) 64.5
B 0.1415
Li 0.00385
As 0.00242
C(4) 194.5
Cl 69 charge
F 0.16
Ca 101
Mg 39.25
Na 39.05
K 2.16
Ba 0.04
Si 6.275
P 0.057
Mn 0.07075
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.00023
Cr 0.000975
Co 0.0016
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 4

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

```
#23 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#23 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#35 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#35 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end
```

804E - Median Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file HEN_845_804E_median_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

SOLUTION 2 #23 (C - UA)
redox pe
```

units mg/l
density 1
pH 7.405
pe 1.545
temp 14
S(6) 455 as SO4
B 8.445
Li 0.003625
As 0.00262
C(4) 95.45 as CO3
Cl 54
F 0.185
Ca 107.5
Mg 77.75
Na 45
K 3.03
Ba 0.04505
Si 5.99
P 0.01
Mn 1.13
Fe 0.144
Al 0.009425
Sb 0.000425
Be 0.0002825
Cd 0.0001675
Cr 0.000975
Co 0.000435
Pb 0.0010475
Mo 0.0148
Se 0.000395
end

SOLUTION 3 #35 (C - UA)
redox pe
units mg/l
density 1
pH 6.955
pe 6.075
temp 14.55
S(6) 780 as SO4
B 12.3
Li 0.0275
As 0.0022325
C(4) 137.5 as CO3
Cl 34.5
F 0.155
Ca 305.5
Mg 36.85
Na 30.4
K 14
Ba 0.04255
Si 4.99
P 0.013
Mn 0.533

```
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.0013
Pb 0.0010475
Mo 0.0779
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #23 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #35 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
```

```
save surface 3
end

SOLUTION 4 #average background
redox pe
units mg/l
density 1
pH 7.005
pe 5.89
temp 12.4
S(6) 64.5
B 0.1415
Li 0.00385
As 0.00242
C(4) 194.5
Cl 69 charge
F 0.16
Ca 101
Mg 39.25
Na 39.05
K 2.16
Ba 0.04
Si 6.275
P 0.057
Mn 0.07075
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.00023
Cr 0.000975
Co 0.0016
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 4

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

```
#23 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#23 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#35 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#35 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end
```

804E - Median Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file HEN_845_804E_median_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93 charge
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

SOLUTION 2 #23 (C - UA)
redox pe
```

units mg/l
density 1
pH 7.405
pe 1.545
temp 14
S(6) 455 as SO4
B 8.445
Li 0.003625
As 0.00262
C(4) 95.45 as CO3
Cl 54 charge
F 0.185
Ca 107.5
Mg 77.75
Na 45
K 3.03
Ba 0.04505
Si 5.99
P 0.01
Mn 1.13
Fe 0.144
Al 0.009425
Sb 0.000425
Be 0.0002825
Cd 0.0001675
Cr 0.000975
Co 0.000435
Pb 0.0010475
Mo 0.0148
Se 0.000395
end

SOLUTION 3 #35 (C - UA)
redox pe
units mg/l
density 1
pH 6.955
pe 6.075
temp 14.55
S(6) 780 as SO4
B 12.3
Li 0.0275
As 0.0022325
C(4) 137.5 as CO3
Cl 34.5 charge
F 0.155
Ca 305.5
Mg 36.85
Na 30.4
K 14
Ba 0.04255
Si 4.99
P 0.013
Mn 0.533

```
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.0001675
Cr 0.000975
Co 0.0013
Pb 0.0010475
Mo 0.0779
Se 0.000395
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #23 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #35 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
```

```
save surface 3
end

SOLUTION 4 #average background
redox pe
units mg/l
density 1
pH 7.005
pe 5.89
temp 12.4
S(6) 64.5
B 0.1415
Li 0.00385
As 0.00242
C(4) 194.5
Cl 69 charge
F 0.16
Ca 101
Mg 39.25
Na 39.05
K 2.16
Ba 0.04
Si 6.275
P 0.057
Mn 0.07075
Fe 0.01675
Al 0.009425
Sb 0.000425
Be 0.0001825
Cd 0.00023
Cr 0.000975
Co 0.0016
Pb 0.0010475
Mo 0.00155
Se 0.000395

SAVE solution 4

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

```
#23 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#23 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#35 (C - UA) - First Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#35 (C - UA) - Second Reaction
USE SOLUTION 4
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end
```

804R - 25th Percentile Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file HEN_845_804R_25p_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - 25p
Barite 0 0
```

```
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

SOLUTION 2 #average background
redox pe
units mg/l
density 1
pH 7.665
pe 5.995
temp 10.73
S(6) 48.5
B 0.249
Li 0.01965
As 0.003
C(4) 248
Cl 8 charge
F 0.41
Ca 46.2
Mg 29
Na 102.025
K 3.775
Ba 0.0807
Si 8.49
P 0.009
Mn 0.02275
Fe 0.12425
Al 0.00635
Sb 0.0002
Be 0.0001
Cd 0.00025
Cr 0.0014
Co 0.00005
Pb 0.002
Mo 0.00355
Se 0.0003

SAVE solution 2

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
```

```
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

804R - 25th Percentile Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file HEN_845_804R_25p_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93 charge
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - 25p
Barite 0 0
```

```
Gypsum 0 0
Gibbsite 0 0.059
Ferrihydrite 0 0.072
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

SOLUTION 2 #average background
redox pe
units mg/l
density 1
pH 7.665
pe 5.995
temp 10.73
S(6) 48.5
B 0.249
Li 0.01965
As 0.003
C(4) 248
Cl 8 charge
F 0.41
Ca 46.2
Mg 29
Na 102.025
K 3.775
Ba 0.0807
Si 8.49
P 0.009
Mn 0.02275
Fe 0.12425
Al 0.00635
Sb 0.0002
Be 0.0001
Cd 0.00025
Cr 0.0014
Co 0.00005
Pb 0.002
Mo 0.00355
Se 0.0003

SAVE solution 2

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
```

```
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

804R - 75th Percentile Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file HEN_845_804R_75p_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - 75p
Barite 0 0
```

```
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

SOLUTION 2 #average background
redox pe
units mg/l
density 1
pH 7.665
pe 5.995
temp 10.73
S(6) 48.5
B 0.249
Li 0.01965
As 0.003
C(4) 248
Cl 8 charge
F 0.41
Ca 46.2
Mg 29
Na 102.025
K 3.775
Ba 0.0807
Si 8.49
P 0.009
Mn 0.02275
Fe 0.12425
Al 0.00635
Sb 0.0002
Be 0.0001
Cd 0.00025
Cr 0.0014
Co 0.00005
Pb 0.002
Mo 0.00355
Se 0.0003

SAVE solution 2

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
```

```
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

804R - 75th Percentile Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file HEN_845_804R_75p_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93 charge
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - 75p
Barite 0 0
```

```
Gypsum 0 0
Gibbsite 0 0.064
Ferrihydrite 0 0.1
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

SOLUTION 2 #average background
redox pe
units mg/l
density 1
pH 7.665
pe 5.995
temp 10.73
S(6) 48.5
B 0.249
Li 0.01965
As 0.003
C(4) 248
Cl 8 charge
F 0.41
Ca 46.2
Mg 29
Na 102.025
K 3.775
Ba 0.0807
Si 8.49
P 0.009
Mn 0.02275
Fe 0.12425
Al 0.00635
Sb 0.0002
Be 0.0001
Cd 0.00025
Cr 0.0014
Co 0.00005
Pb 0.002
Mo 0.00355
Se 0.0003

SAVE solution 2

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
```

```
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

804R - Median Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file HEN_845_804R_median_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - median
Barite 0 0
```

```
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

SOLUTION 2 #average background
redox pe
units mg/l
density 1
pH 7.665
pe 5.995
temp 10.73
S(6) 48.5
B 0.249
Li 0.01965
As 0.003
C(4) 248
Cl 8 charge
F 0.41
Ca 46.2
Mg 29
Na 102.025
K 3.775
Ba 0.0807
Si 8.49
P 0.009
Mn 0.02275
Fe 0.12425
Al 0.00635
Sb 0.0002
Be 0.0001
Cd 0.00025
Cr 0.0014
Co 0.00005
Pb 0.002
Mo 0.00355
Se 0.0003

SAVE solution 2

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
```

```
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

804R - Median Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file HEN_845_804R_median_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
Hfo_sH2AsO3 Hfo_sH2AsO4 Hfo_sHAsO4- Hfo_sOHAsO4-3
Hfo_wOHAsO4-3 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #22 (C - UA)
redox pe
units mg/l
density 1
pH 7.625
pe 4.815
temp 15.9
S(6) 121.5 as SO4
B 1.785
Li 0.0495
As 0.0022325
C(4) 145 as CO3
Cl 93 charge
F 0.175
Ca 55.05
Mg 19.55
Na 33.9
K 6.95
Ba 0.03575
Si 19.1
P 0.0025
Mn 0.035
Fe 0.01675
Al 0.009425
Sb 0.000725
Be 0.0001825
Cd 0.0026425
Cr 0.000975
Co 0.00158
Pb 0.0010475
Mo 0.04395
Se 0.01535
end

EQUILIBRIUM_PHASES 1 #22 (C - UA) - median
Barite 0 0
```

```
Gypsum 0 0
Gibbsite 0 0.061
Ferrihydrite 0 0.085
Calcite 0 6
Dolomite(ordered) 0 2

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

SOLUTION 2 #average background
redox pe
units mg/l
density 1
pH 7.665
pe 5.995
temp 10.73
S(6) 48.5
B 0.249
Li 0.01965
As 0.003
C(4) 248
Cl 8 charge
F 0.41
Ca 46.2
Mg 29
Na 102.025
K 3.775
Ba 0.0807
Si 8.49
P 0.009
Mn 0.02275
Fe 0.12425
Al 0.00635
Sb 0.0002
Be 0.0001
Cd 0.00025
Cr 0.0014
Co 0.00005
Pb 0.002
Mo 0.00355
Se 0.0003

SAVE solution 2

end

#FIRST REACTION

#22 (C - UA) - First Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
```

```
SAVE equilibrium_phases 1
SAVE surface 1
end

#22 (C - UA) - Second Reaction
USE SOLUTION 2
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end
```

Database

```
#$Id: minteq.v4.dat 12387 2017-02-09 16:41:47Z dlpark $
SOLUTION_MASTER_SPECIES
Alkalinity CO3-2 2.0 HCO3 61.0173
E e- 0 0 0
O H2O 0 O 16.00
O(-2) H2O 0 O
O(0) O2 0 O
Ag Ag+ 0.0 Ag 107.868
Al Al+3 0.0 Al 26.9815
As H3AsO4 -1.0 As 74.9216
As(3) H3AsO3 0.0 As
As(5) H3AsO4 -1.0 As
B H3BO3 0.0 B 10.81
Ba Ba+2 0.0 Ba 137.33
Be Be+2 0.0 Be 9.0122
Br Br- 0.0 Br 79.904
C CO3-2 2.0 CO3 12.0111
C(4) CO3-2 2.0 CO3 12.0111
Cyanide Cyanide- 1.0 Cyanide 26.0177
Dom_a Dom_a 0.0 C 12.0111
Dom_b Dom_b 0.0 C 12.0111
Dom_c Dom_c 0.0 C 12.0111
Ca Ca+2 0.0 Ca 40.078
Cd Cd+2 0.0 Cd 112.41
Cl Cl- 0.0 Cl 35.453
Co Co+3 -1.0 Co 58.9332
Co(2) Co+2 0.0 Co
Co(3) Co+3 -1.0 Co
Cr CrO4-2 1.0 Cr 51.996
Cr(2) Cr+2 0.0 Cr
Cr(3) Cr(OH)2+ 0.0 Cr
Cr(6) CrO4-2 1.0 Cr
Cu Cu+2 0.0 Cu 63.546
Cu(1) Cu+ 0.0 Cu
Cu(2) Cu+2 0.0 Cu
F F- 0.0 F 18.9984
Fe Fe+3 -2.0 Fe 55.847
Fe(2) Fe+2 0.0 Fe
Fe(3) Fe+3 -2.0 Fe
H H+ -1.0 H 1.0079
H(0) H2 0 H
H(1) H+ -1.0 H
Hg Hg(OH)2 0.0 Hg 200.59
Hg(0) Hg 0.0 Hg
Hg(1) Hg2+2 0.0 Hg
Hg(2) Hg(OH)2 0.0 Hg
I I- 0.0 I 126.904
K K+ 0.0 K 39.0983
Li Li+ 0.0 Li 6.941
Mg Mg+2 0.0 Mg 24.305
Mn Mn+3 0.0 Mn 54.938
```

Mn(2) Mn+2 0.0 Mn
Mn(3) Mn+3 0.0 Mn
Mn(6) MnO4-2 0.0 Mn
Mn(7) MnO4- 0.0 Mn
Mo MoO4-2 0.0 Mo 95.94
N NO3- 0.0 N 14.0067
N(-3) NH4+ 0.0 N
N(3) NO2- 0.0 N
N(5) NO3- 0.0 N
Na Na+ 0.0 Na 22.9898
Ni Ni+2 0.0 Ni 58.69
P PO4-3 2.0 P 30.9738
Pb Pb+2 0.0 Pb 207.2
S SO4-2 0.0 SO4 32.066
S(-2) HS- 1.0 S
#S(0) S 0.0 S
S(6) SO4-2 0.0 SO4
Sb Sb(OH)6- 0.0 Sb 121.75
Sb(3) Sb(OH)3 0.0 Sb
Sb(5) Sb(OH)6- 0.0 Sb
Se SeO4-2 0.0 Se 78.96
Se(-2) HSe- 0.0 Se
Se(4) HSeO3- 0.0 Se
Se(6) SeO4-2 0.0 Se
Si H4SiO4 0.0 SiO2 28.0843
Sn Sn(OH)6-2 0.0 Sn 118.71
Sn(2) Sn(OH)2 0.0 Sn
Sn(4) Sn(OH)6-2 0.0 Sn
Sr Sr+2 0.0 Sr 87.62
Tl Tl(OH)3 0.0 Tl 204.383
Tl(1) Tl+ 0.0 Tl
Tl(3) Tl(OH)3 0.0 Tl
U UO2+2 0.0 U 238.029
U(3) U+3 0.0 U
U(4) U+4 -4.0 U
U(5) UO2+ 0.0 U
U(6) UO2+2 0.0 U
V VO2+ -2.0 V 50.94
V(2) V+2 0.0 V
V(3) V+3 -3.0 V
V(4) VO+2 0.0 V
V(5) VO2+ -2.0 V
Zn Zn+2 0.0 Zn 65.39
Benzoate Benzoate- 0.0 121.116 121.116
Phenylacetate Phenylacetate- 0.0 135.142 135.142
Isophthalate Isophthalate-2 0.0 164.117 164.117
Diethylamine Diethylamine 1.0 73.138 73.138
Butylamine Butylamine 1.0 73.138 73.138
Methylamine Methylamine 1.0 31.057 31.057
Dimethylamine Dimethylamine 1.0 45.084 45.084
Hexylamine Hexylamine 1.0 101.192 101.192
Ethylenediamine Ethylenediamine 2.0 60.099 60.099
Propylamine Propylamine 1.0 59.111 59.111
Isopropylamine Isopropylamine 1.0 59.111 59.111

Trimethylamine Trimethylamine 1.0 59.111 59.111
Citrate Citrate-3 2.0 189.102 189.102
Nta Nta-3 1.0 188.117 188.117
Edta Edta-4 2.0 288.214 288.214
Propionate Propionate- 1.0 73.072 73.072
Butyrate Butyrate- 1.0 87.098 87.098
Isobutyrate Isobutyrate- 1.0 87.098 87.098
Two_picoline Two_picoline 1.0 93.128 93.128
Three_picoline Three_picoline 1.0 93.128 93.128
Four_picoline Four_picoline 1.0 93.128 93.128
Formate Formate- 0.0 45.018 45.018
Isovalerate Isovalerate- 1.0 101.125 101.125
Valerate Valerate- 1.0 101.125 101.125
Acetate Acetate- 1.0 59.045 59.045
Tartarate Tartarate-2 0.0 148.072 148.072
Glycine Glycine- 1.0 74.059 74.059
Salicylate Salicylate-2 1.0 136.107 136.107
Glutamate Glutamate-2 1.0 145.115 145.115
Phthalate Phthalate-2 1.0 164.117 164.117
SOLUTION_SPECIES
e- = e-
log_k 0
H2O = H2O
log_k 0
Ag+ = Ag+
log_k 0
Al+3 = Al+3
log_k 0
H3AsO4 = H3AsO4
log_k 0
H3BO3 = H3BO3
log_k 0
Ba+2 = Ba+2
log_k 0
Be+2 = Be+2
log_k 0
Br- = Br-
log_k 0
CO3-2 = CO3-2
log_k 0
Cyanide- = Cyanide-
log_k 0
Dom_a = Dom_a
log_k 0
Dom_b = Dom_b
log_k 0
Dom_c = Dom_c
log_k 0
Ca+2 = Ca+2
log_k 0
Cd+2 = Cd+2
log_k 0
Cl- = Cl-
log_k 0

Co+3 = Co+3
log_k 0
CrO4-2 = CrO4-2
log_k 0
Cu+2 = Cu+2
log_k 0
F- = F-
log_k 0
Fe+3 = Fe+3
log_k 0
H+ = H+
log_k 0
Hg(OH)2 = Hg(OH)2
log_k 0
I- = I-
log_k 0
K+ = K+
log_k 0
Li+ = Li+
log_k 0
Mg+2 = Mg+2
log_k 0
Mn+3 = Mn+3
log_k 0
MoO4-2 = MoO4-2
log_k 0
NO3- = NO3-
log_k 0
Na+ = Na+
log_k 0
Ni+2 = Ni+2
log_k 0
PO4-3 = PO4-3
log_k 0
Pb+2 = Pb+2
log_k 0
SO4-2 = SO4-2
log_k 0
Sb(OH)6- = Sb(OH)6-
log_k 0
SeO4-2 = SeO4-2
log_k 0
H4SiO4 = H4SiO4
log_k 0
Sn(OH)6-2 = Sn(OH)6-2
log_k 0
Sr+2 = Sr+2
log_k 0
Tl(OH)3 = Tl(OH)3
log_k 0
UO2+2 = UO2+2
log_k 0
VO2+ = VO2+
log_k 0

Benzoate- = Benzoate-
log_k 0
Phenylacetate- = Phenylacetate-
log_k 0
Isophthalate-2 = Isophthalate-2
log_k 0
Zn+2 = Zn+2
log_k 0
Diethylamine = Diethylamine
log_k 0
Butylamine = Butylamine
log_k 0
Methylamine = Methylamine
log_k 0
Dimethylamine = Dimethylamine
log_k 0
Hexylamine = Hexylamine
log_k 0
Ethylenediamine = Ethylenediamine
log_k 0
Propylamine = Propylamine
log_k 0
Isopropylamine = Isopropylamine
log_k 0
Trimethylamine = Trimethylamine
log_k 0
Citrate-3 = Citrate-3
log_k 0
Nta-3 = Nta-3
log_k 0
Edta-4 = Edta-4
log_k 0
Propionate- = Propionate-
log_k 0
Butyrate- = Butyrate-
log_k 0
Isobutyrate- = Isobutyrate-
log_k 0
Two_picoline = Two_picoline
log_k 0
Three_picoline = Three_picoline
log_k 0
Four_picoline = Four_picoline
log_k 0
Formate- = Formate-
log_k 0
Isovalerate- = Isovalerate-
log_k 0
Valerate- = Valerate-
log_k 0
Acetate- = Acetate-
log_k 0
Tartarate-2 = Tartarate-2
log_k 0

Glycine- = Glycine-
log_k 0
Salicylate-2 = Salicylate-2
log_k 0
Glutamate-2 = Glutamate-2
log_k 0
Phthalate-2 = Phthalate-2
log_k 0
SOLUTION_SPECIES
Fe+3 + e- = Fe+2
log_k 13.032
delta_h -42.7 kJ
-gamma 0 0
Id: 2802810
log K source: Bard85
Delta H source: Bard85
#T and ionic strength:
H3AsO4 + 2e- + 2H+ = H3AsO3 + H2O
log_k 18.898
delta_h -125.6 kJ
-gamma 0 0
Id: 600610
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
Sb(OH)6- + 2e- + 3H+ = Sb(OH)3 + 3H2O
log_k 24.31
delta_h 0 kJ
-gamma 0 0
Id: 7407410
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + 3e- + 4H+ = U+3 + 2H2O
log_k 0.42
delta_h -42 kJ
-gamma 0 0
Id: 8908930
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + 2e- + 4H+ = U+4 + 2H2O
log_k 9.216
delta_h -144.1 kJ
-gamma 0 0
Id: 8918930
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + e- = UO2+
log_k 2.785
delta_h -13.8 kJ
-gamma 0 0
Id: 8928930

log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
e- + Mn+3 = Mn+2
log_k 25.35
delta_h -107.8 kJ
-gamma 0 0
Id: 4704710
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
Co+3 + e- = Co+2
log_k 32.4
delta_h 0 kJ
-gamma 0 0
Id: 2002010
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
Cu+2 + e- = Cu+
log_k 2.69
delta_h 6.9 kJ
-gamma 0 0
Id: 2302310
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
V+3 + e- = V+2
log_k -4.31
delta_h 0 kJ
-gamma 0 0
Id: 9009010
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
VO+2 + e- + 2H+ = V+3 + H2O
log_k 5.696
delta_h 0 kJ
-gamma 0 0
Id: 9019020
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
VO2+ + e- + 2H+ = VO+2 + H2O
log_k 16.903
delta_h -122.7 kJ
-gamma 0 0
Id: 9029030
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
SO4-2 + 9H+ + 8e- = HS- + 4H2O
log_k 33.66
delta_h -60.14 kJ

-gamma 0 0
Id: 7307320
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Sn(OH)6-2 + 2e- + 4H+ = Sn(OH)2 + 4H2O
log_k 19.2
delta_h 0 kJ
-gamma 0 0
Id: 7907910
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
Tl(OH)3 + 2e- + 3H+ = Tl+ + 3H2O
log_k 45.55
delta_h 0 kJ
-gamma 0 0
Id: 8708710
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
HSeO3- + 6e- + 6H+ = HSe- + 3H2O
log_k 44.86
delta_h 0 kJ
-gamma 0 0
Id: 7607610
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
SeO4-2 + 2e- + 3H+ = HSeO3- + H2O
log_k 36.308
delta_h -201.2 kJ
-gamma 0 0
Id: 7617620
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
0.5Hg2+2 + e- = Hg
log_k 6.5667
delta_h -45.735 kJ
-gamma 0 0
Id: 3600000
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:

2Hg(OH)2 + 4H+ + 2e- = Hg2+2 + 4H2O
log_k 43.185
delta_h -63.59 kJ
-gamma 0 0
Id: 3603610
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:

Cr(OH)2+ + 2H+ + e- = Cr+2 + 2H2O
log_k 2.947
delta_h 6.36 kJ
-gamma 0 0
Id: 2102110
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
CrO4-2 + 6H+ + 3e- = Cr(OH)2+ + 2H2O
log_k 67.376
delta_h -103 kJ
-gamma 0 0
Id: 2112120
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:

2H2O = O2 + 4H+ + 4e-
# Adjusted for equation to aqueous species
log_k -85.9951
-analytic 38.0229 7.99407E-03 -2.7655e+004 -1.4506e+001 199838.45

2 H+ + 2 e- = H2
log_k -3.15
delta_h -1.759 kcal

NO3- + 2 H+ + 2 e- = NO2- + H2O
log_k 28.570
delta_h -43.760 kcal
-gamma 3.0000 0.0000

NO3- + 10 H+ + 8 e- = NH4+ + 3 H2O
log_k 119.077
delta_h -187.055 kcal
-gamma 2.5000 0.0000

Mn+2 + 4H2O = MnO4- + 8H+ + 5e-
log_k -127.794
delta_h 822.67 kJ
-gamma 3 0
Id: 4700020
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Mn+2 + 4H2O = MnO4-2 + 8H+ + 4e-
log_k -118.422
delta_h 711.07 kJ
-gamma 5 0
Id: 4700021
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
HS- = S-2 + H+
log_k -17.3
delta_h 49.4 kJ
-gamma 5 0
Id: 3307301

log K source: LMa1987
Delta H source: NIST2.1.1
#T and ionic strength: 0.00 25.0
HSe- = Se-2 + H+
log_k -15
delta_h 48.116 kJ
-gamma 0 0
Id: 3307601
log K source: SCD3.02 (1968 DKa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 3H+ = Tl+3 + 3H2O
log_k 3.291
delta_h 0 kJ
-gamma 0 0
Id: 8713300
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
0.5Hg2+2 + e- = Hg
log_k 6.5667
delta_h -45.735 kJ
-gamma 0 0
Id: 3600000
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Hg(OH)2 + 2H+ = Hg+2 + 2H2O
log_k 6.194
delta_h -39.72 kJ
-gamma 0 0
Id: 3613300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H+ = Cr+3 + 2H2O
log_k 9.5688
delta_h -129.62 kJ
-gamma 0 0
Id: 2113300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.10 20.0
H2O = OH- + H+
log_k -13.997
delta_h 55.81 kJ
-gamma 3.5 0
Id: 3300020
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ = Sn+2 + 2H2O
log_k 7.094
delta_h 0 kJ

-gamma 0 0
Id: 7903301
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Sn(OH)2 + H+ = SnOH+ + H2O
log_k 3.697
delta_h 0 kJ
-gamma 0 0
Id: 7903302
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Sn(OH)2 + H2O = Sn(OH)3- + H+
log_k -9.497
delta_h 0 kJ
-gamma 0 0
Id: 7903303
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Sn(OH)2 + 2H+ = Sn2(OH)2+2 + 2H2O
log_k 9.394
delta_h 0 kJ
-gamma 0 0
Id: 7903304
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
3Sn(OH)2 + 2H+ = Sn3(OH)4+2 + 2H2O
log_k 14.394
delta_h 0 kJ
-gamma 0 0
Id: 7903305
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Sn(OH)2 = HSnO2- + H+
log_k -8.9347
delta_h 0 kJ
-gamma 0 0
Id: 7903306
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
Sn(OH)6-2 + 6H+ = Sn+4 + 6H2O
log_k 21.2194
delta_h 0 kJ
-gamma 0 0
Id: 7913301
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
Sn(OH)6-2 = SnO3-2 + 3H2O

log_k -2.2099
delta_h 0 kJ
-gamma 0 0
Id: 7913302
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
Pb+2 + H2O = PbOH+ + H+
log_k -7.597
delta_h 0 kJ
-gamma 0 0
Id: 6003300
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Pb+2 + 2H2O = Pb(OH)2 + 2H+
log_k -17.094
delta_h 0 kJ
-gamma 0 0
Id: 6003301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Pb+2 + 3H2O = Pb(OH)3- + 3H+
log_k -28.091
delta_h 0 kJ
-gamma 0 0
Id: 6003302
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Pb+2 + H2O = Pb2OH+3 + H+
log_k -6.397
delta_h 0 kJ
-gamma 0 0
Id: 6003303
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
3Pb+2 + 4H2O = Pb3(OH)4+2 + 4H+
log_k -23.888
delta_h 115.24 kJ
-gamma 0 0
Id: 6003304
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 4H2O = Pb(OH)4-2 + 4H+
log_k -39.699
delta_h 0 kJ
-gamma 0 0
Id: 6003305
log K source: MTQ3.11
Delta H source: MTQ3.11

#T and ionic strength:
4Pb+2 + 4H2O = Pb4(OH)4+4 + 4H+
log_k -19.988
delta_h 88.24 kJ
-gamma 0 0
Id: 6003306
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H3BO3 + F- = BF(OH)3-
log_k -0.399
delta_h 7.7404 kJ
-gamma 2.5 0
Id: 902700
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
H3BO3 + 2F- + H+ = BF2(OH)2- + H2O
log_k 7.63
delta_h 6.8408 kJ
-gamma 2.5 0
Id: 902701
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
H3BO3 + 3F- + 2H+ = BF3OH- + 2H2O
log_k 13.22
delta_h -20.4897 kJ
-gamma 2.5 0
Id: 902702
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Al+3 + H2O = AlOH+2 + H+
log_k -4.997
delta_h 47.81 kJ
-gamma 5.4 0
Id: 303300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Al+3 + 2H2O = Al(OH)2+ + 2H+
log_k -10.094
delta_h 0 kJ
-gamma 5.4 0
Id: 303301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Al+3 + 3H2O = Al(OH)3 + 3H+
log_k -16.791
delta_h 0 kJ
-gamma 0 0
Id: 303303

log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Al+3 + 4H2O = Al(OH)4- + 4H+
log_k -22.688
delta_h 173.24 kJ
-gamma 4.5 0
Id: 303302
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl+ + H2O = TlOH + H+
log_k -13.207
delta_h 56.81 kJ
-gamma 0 0
Id: 8703300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 2H+ = TlOH+2 + 2H2O
log_k 2.694
delta_h 0 kJ
-gamma 0 0
Id: 8713301
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + H+ = Tl(OH)2+ + H2O
log_k 1.897
delta_h 0 kJ
-gamma 0 0
Id: 8713302
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Tl(OH)3 + H2O = Tl(OH)4- + H+
log_k -11.697
delta_h 0 kJ
-gamma 0 0
Id: 8713303
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + H2O = ZnOH+ + H+
log_k -8.997
delta_h 55.81 kJ
-gamma 0 0
Id: 9503300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Zn+2 + 2H2O = Zn(OH)2 + 2H+
log_k -17.794
delta_h 0 kJ

-gamma 0 0
Id: 9503301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 3H2O = Zn(OH)3- + 3H+
log_k -28.091
delta_h 0 kJ
-gamma 0 0
Id: 9503302
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 4H2O = Zn(OH)4-2 + 4H+
log_k -40.488
delta_h 0 kJ
-gamma 0 0
Id: 9503303
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cd+2 + H2O = CdOH+ + H+
log_k -10.097
delta_h 54.81 kJ
-gamma 0 0
Id: 1603300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2H2O = Cd(OH)2 + 2H+
log_k -20.294
delta_h 0 kJ
-gamma 0 0
Id: 1603301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cd+2 + 3H2O = Cd(OH)3- + 3H+
log_k -32.505
delta_h 0 kJ
-gamma 0 0
Id: 1603302
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Cd+2 + 4H2O = Cd(OH)4-2 + 4H+
log_k -47.288
delta_h 0 kJ
-gamma 0 0
Id: 1603303
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Cd+2 + H2O = Cd2OH+3 + H+

log_k -9.397
delta_h 45.81 kJ
-gamma 0 0
Id: 1603304
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + H+ = HgOH+ + H2O
log_k 2.797
delta_h -18.91 kJ
-gamma 0 0
Id: 3613302
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + H2O = Hg(OH)3- + H+
log_k -14.897
delta_h 0 kJ
-gamma 0 0
Id: 3613303
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+2 + H2O = CuOH+ + H+
log_k -7.497
delta_h 35.81 kJ
-gamma 4 0
Id: 2313300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cu+2 + 2H2O = Cu(OH)2 + 2H+
log_k -16.194
delta_h 0 kJ
-gamma 0 0
Id: 2313301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+2 + 3H2O = Cu(OH)3- + 3H+
log_k -26.879
delta_h 0 kJ
-gamma 0 0
Id: 2313302
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Cu+2 + 4H2O = Cu(OH)4-2 + 4H+
log_k -39.98
delta_h 0 kJ
-gamma 0 0
Id: 2313303
log K source: NIST46.3
Delta H source: MTQ3.11

#T and ionic strength: 1.00 25.0
2Cu+2 + 2H2O = Cu2(OH)2+2 + 2H+
log_k -10.594
delta_h 76.62 kJ
-gamma 0 0
Id: 2313304
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + H2O = AgOH + H+
log_k -11.997
delta_h 0 kJ
-gamma 0 0
Id: 203300
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + 2H2O = Ag(OH)2- + 2H+
log_k -24.004
delta_h 0 kJ
-gamma 0 0
Id: 203301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + H2O = NiOH+ + H+
log_k -9.897
delta_h 51.81 kJ
-gamma 0 0
Id: 5403300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ni+2 + 2H2O = Ni(OH)2 + 2H+
log_k -18.994
delta_h 0 kJ
-gamma 0 0
Id: 5403301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + 3H2O = Ni(OH)3- + 3H+
log_k -29.991
delta_h 0 kJ
-gamma 0 0
Id: 5403302
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + H2O = CoOH+ + H+
log_k -9.697
delta_h 0 kJ
-gamma 0 0
Id: 2003300

log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + 2H2O = Co(OH)2 + 2H+
log_k -18.794
delta_h 0 kJ
-gamma 0 0
Id: 2003301
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + 3H2O = Co(OH)3- + 3H+
log_k -31.491
delta_h 0 kJ
-gamma 0 0
Id: 2003302
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + 4H2O = Co(OH)4-2 + 4H+
log_k -46.288
delta_h 0 kJ
-gamma 0 0
Id: 2003303
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Co+2 + H2O = Co2OH+3 + H+
log_k -10.997
delta_h 0 kJ
-gamma 0 0
Id: 2003304
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
4Co+2 + 4H2O = Co4(OH)4+4 + 4H+
log_k -30.488
delta_h 0 kJ
-gamma 0 0
Id: 2003306
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + 2H2O = CoOOH- + 3H+
log_k -32.0915
delta_h 260.454 kJ
-gamma 0 0
Id: 2003305
log K source: NIST2.1.1
Delta H source: MTQ3.11
#T and ionic strength:
Co+3 + H2O = CoOH+2 + H+
log_k -1.291
delta_h 0 kJ

-gamma 0 0
Id: 2013300
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Fe+2 + H2O = FeOH+ + H+
log_k -9.397
delta_h 55.81 kJ
-gamma 5 0
Id: 2803300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+2 + 2H2O = Fe(OH)2 + 2H+
log_k -20.494
delta_h 119.62 kJ
-gamma 0 0
Id: 2803302
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+2 + 3H2O = Fe(OH)3- + 3H+
log_k -28.991
delta_h 126.43 kJ
-gamma 5 0
Id: 2803301
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+3 + H2O = FeOH+2 + H+
log_k -2.187
delta_h 41.81 kJ
-gamma 5 0
Id: 2813300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+3 + 2H2O = Fe(OH)2+ + 2H+
log_k -4.594
delta_h 0 kJ
-gamma 5.4 0
Id: 2813301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Fe+3 + 3H2O = Fe(OH)3 + 3H+
log_k -12.56
delta_h 103.8 kJ
-gamma 0 0
Id: 2813302
log K source: Nord90
Delta H source: Nord90
#T and ionic strength: 0.00 25.0
Fe+3 + 4H2O = Fe(OH)4- + 4H+

log_k -21.588
delta_h 0 kJ
-gamma 5.4 0
Id: 2813303
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Fe+3 + 2H2O = Fe2(OH)2+4 + 2H+
log_k -2.854
delta_h 57.62 kJ
-gamma 0 0
Id: 2813304
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
3Fe+3 + 4H2O = Fe3(OH)4+5 + 4H+
log_k -6.288
delta_h 65.24 kJ
-gamma 0 0
Id: 2813305
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Mn+2 + H2O = MnOH+ + H+
log_k -10.597
delta_h 55.81 kJ
-gamma 5 0
Id: 4703300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Mn+2 + 3H2O = Mn(OH)3- + 3H+
log_k -34.8
delta_h 0 kJ
-gamma 5 0
Id: 4703301
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Mn+2 + 4H2O = Mn(OH)4-2 + 4H+
log_k -48.288
delta_h 0 kJ
-gamma 5 0
Id: 4703302
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mn+2 + 4H2O = MnO4- + 8H+ + 5e-
log_k -127.794
delta_h 822.67 kJ
-gamma 3 0
Id: 4700020
log K source: NIST2.1.1
Delta H source: NIST2.1.1

#T and ionic strength:
Mn+2 + 4H2O = MnO4-2 + 8H+ + 4e-
log_k -118.422
delta_h 711.07 kJ
-gamma 5 0
Id: 4700021
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Cr(OH)2+ + H+ = Cr(OH)+2 + H2O
log_k 5.9118
delta_h -77.91 kJ
-gamma 0 0
Id: 2113301
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + H2O = Cr(OH)3 + H+
log_k -8.4222
delta_h 0 kJ
-gamma 0 0
Id: 2113302
log K source: SCD3.02 (1983 RCa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H2O = Cr(OH)4- + 2H+
log_k -17.8192
delta_h 0 kJ
-gamma 0 0
Id: 2113303
log K source: SCD3.02 (1983 RCa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cr(OH)2+ = CrO2- + 2H+
log_k -17.7456
delta_h 0 kJ
-gamma 0 0
Id: 2113304
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
V+2 + H2O = VOH+ + H+
log_k -6.487
delta_h 59.81 kJ
-gamma 0 0
Id: 9003300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
V+3 + H2O = VOH+2 + H+
log_k -2.297
delta_h 43.81 kJ
-gamma 0 0
Id: 9013300

log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
V+3 + 2H2O = V(OH)2+ + 2H+
log_k -6.274
delta_h 0 kJ
-gamma 0 0
Id: 9013301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
V+3 + 3H2O = V(OH)3 + 3H+
log_k -3.0843
delta_h 0 kJ
-gamma 0 0
Id: 9013302
log K source: SCD3.02 (1978 TKa)
Delta H source: MTQ3.11
#T and ionic strength: 0.10 20.0
2V+3 + 2H2O = V2(OH)2+4 + 2H+
log_k -3.794
delta_h 0 kJ
-gamma 0 0
Id: 9013304
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2V+3 + 3H2O = V2(OH)3+3 + 3H+
log_k -10.1191
delta_h 0 kJ
-gamma 0 0
Id: 9013303
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
VO+2 + 2H2O = V(OH)3+ + H+
log_k -5.697
delta_h 0 kJ
-gamma 0 0
Id: 9023300
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2VO+2 + 2H2O = H2V2O4+2 + 2H+
log_k -6.694
delta_h 53.62 kJ
-gamma 0 0
Id: 9023301
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
U+4 + H2O = UOH+3 + H+
log_k -0.597
delta_h 47.81 kJ

-gamma 0 0
Id: 8913300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
U+4 + 2H2O = U(OH)2+2 + 2H+
log_k -2.27
delta_h 74.1823 kJ
-gamma 0 0
Id: 8913301
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 3H2O = U(OH)3+ + 3H+
log_k -4.935
delta_h 94.7467 kJ
-gamma 0 0
Id: 8913302
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 4H2O = U(OH)4 + 4H+
log_k -8.498
delta_h 103.596 kJ
-gamma 0 0
Id: 8913303
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 5H2O = U(OH)5- + 5H+
log_k -13.12
delta_h 115.374 kJ
-gamma 0 0
Id: 8913304
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
6U+4 + 15H2O = U6(OH)15+9 + 15H+
log_k -17.155
delta_h 0 kJ
-gamma 0 0
Id: 8913305
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
UO2+2 + H2O = UO2OH+ + H+
log_k -5.897
delta_h 47.81 kJ
-gamma 0 0
Id: 8933300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
2UO2+2 + 2H2O = (UO2)2(OH)2+2 + 2H+

log_k -5.574
delta_h 41.82 kJ
-gamma 0 0
Id: 8933301
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
3UO2+2 + 5H2O = (UO2)3(OH)5+ + 5H+
log_k -15.585
delta_h 108.05 kJ
-gamma 0 0
Id: 8933302
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Be+2 + H2O = BeOH+ + H+
log_k -5.397
delta_h 0 kJ
-gamma 6.5 0
Id: 1103301
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Be+2 + 2H2O = Be(OH)2 + 2H+
log_k -13.594
delta_h 0 kJ
-gamma 6.5 0
Id: 1103302
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Be+2 + 3H2O = Be(OH)3- + 3H+
log_k -23.191
delta_h 0 kJ
-gamma 6.5 0
Id: 1103303
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Be+2 + 4H2O = Be(OH)4-2 + 4H+
log_k -37.388
delta_h 0 kJ
-gamma 6.5 0
Id: 1103304
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Be+2 + H2O = Be2OH+3 + H+
log_k -3.177
delta_h 0 kJ
-gamma 6.5 0
Id: 1103305
log K source: NIST46.4
Delta H source: MTQ3.11

#T and ionic strength: 0.10 25.0
3Be+2 + 3H2O = Be3(OH)3+3 + 3H+
log_k -8.8076
delta_h 0 kJ
-gamma 6.5 0
Id: 1103306
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
Mg+2 + H2O = MgOH+ + H+
log_k -11.397
delta_h 67.81 kJ
-gamma 6.5 0
Id: 4603300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ca+2 + H2O = CaOH+ + H+
log_k -12.697
delta_h 64.11 kJ
-gamma 6 0
Id: 1503300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Sr+2 + H2O = SrOH+ + H+
log_k -13.177
delta_h 60.81 kJ
-gamma 5 0
Id: 8003300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ba+2 + H2O = BaOH+ + H+
log_k -13.357
delta_h 60.81 kJ
-gamma 5 0
Id: 1003300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
H+ + F- = HF
log_k 3.17
delta_h 13.3 kJ
-gamma 0 0
Id: 3302700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
H+ + 2F- = HF2-
log_k 3.75
delta_h 17.4 kJ
-gamma 3.5 0
Id: 3302701

log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
2F- + 2H+ = H2F2
log_k 6.768
delta_h 0 kJ
-gamma 0 0
Id: 3302702
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Sb(OH)3 + F- + H+ = SbOF + 2H2O
log_k 6.1864
delta_h 0 kJ
-gamma 0 0
Id: 7402700
log K source: PNL89
Delta H source: PNL89
#T and ionic strength:
Sb(OH)3 + F- + H+ = Sb(OH)2F + H2O
log_k 6.1937
delta_h 0 kJ
-gamma 0 0
Id: 7402702
log K source: PNL89
Delta H source: PNL89
#T and ionic strength:
H4SiO4 + 4H+ + 6F- = SiF6-2 + 4H2O
log_k 30.18
delta_h -68 kJ
-gamma 5 0
Id: 7702700
log K source: Nord90
Delta H source: Nord90
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + F- = SnF+ + 2H2O
log_k 11.582
delta_h 0 kJ
-gamma 0 0
Id: 7902701
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Sn(OH)2 + 2H+ + 2F- = SnF2 + 2H2O
log_k 14.386
delta_h 0 kJ
-gamma 0 0
Id: 7902702
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Sn(OH)2 + 2H+ + 3F- = SnF3- + 2H2O
log_k 17.206
delta_h 0 kJ

-gamma 0 0
Id: 7902703
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Sn(OH)6-2 + 6H+ + 6F- = SnF6-2 + 6H2O
log_k 33.5844
delta_h 0 kJ
-gamma 0 0
Id: 7912701
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
Pb+2 + F- = PbF+
log_k 1.848
delta_h 0 kJ
-gamma 0 0
Id: 6002700
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Pb+2 + 2F- = PbF2
log_k 3.142
delta_h 0 kJ
-gamma 0 0
Id: 6002701
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Pb+2 + 3F- = PbF3-
log_k 3.42
delta_h 0 kJ
-gamma 0 0
Id: 6002702
log K source: SCD3.02 (1956 TKa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Pb+2 + 4F- = PbF4-2
log_k 3.1
delta_h 0 kJ
-gamma 0 0
Id: 6002703
log K source: SCD3.02 (1956 TKa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
H3BO3 + 3H+ + 4F- = BF4- + 3H2O
log_k 19.912
delta_h -18.67 kJ
-gamma 2.5 0
Id: 902703
log K source: NIST46.3
Delta H source: NIST2.1.1
#T and ionic strength: 1.00 25.0
Al+3 + F- = AlF+2

log_k 7
delta_h 4.6 kJ
-gamma 5.4 0
Id: 302700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Al+3 + 2F- = AlF2+
log_k 12.6
delta_h 8.3 kJ
-gamma 5.4 0
Id: 302701
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Al+3 + 3F- = AlF3
log_k 16.7
delta_h 8.7 kJ
-gamma 0 0
Id: 302702
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Al+3 + 4F- = AlF4-
log_k 19.4
delta_h 8.7 kJ
-gamma 4.5 0
Id: 302703
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl+ + F- = TlF
log_k 0.1
delta_h 0 kJ
-gamma 0 0
Id: 8702700
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + F- = ZnF+
log_k 1.3
delta_h 11 kJ
-gamma 0 0
Id: 9502700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + F- = CdF+
log_k 1.2
delta_h 5 kJ
-gamma 0 0
Id: 1602700
log K source: NIST46.3
Delta H source: NIST46.3

#T and ionic strength: 0.00 25.0
Cd+2 + 2F- = CdF2
log_k 1.5
delta_h 0 kJ
-gamma 0 0
Id: 1602701
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + 2H+ + F- = HgF+ + 2H2O
log_k 7.763
delta_h -35.72 kJ
-gamma 0 0
Id: 3612701
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Cu+2 + F- = CuF+
log_k 1.8
delta_h 13 kJ
-gamma 0 0
Id: 2312700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + F- = AgF
log_k 0.4
delta_h 12 kJ
-gamma 0 0
Id: 202700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ni+2 + F- = NiF+
log_k 1.4
delta_h 7.1 kJ
-gamma 0 0
Id: 5402700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Co+2 + F- = CoF+
log_k 1.5
delta_h 9.2 kJ
-gamma 0 0
Id: 2002700
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Fe+3 + F- = FeF+2
log_k 6.04
delta_h 10 kJ
-gamma 5 0
Id: 2812700

log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+3 + 2F- = FeF2+
log_k 10.4675
delta_h 17 kJ
-gamma 5 0
Id: 2812701
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Fe+3 + 3F- = FeF3
log_k 13.617
delta_h 29 kJ
-gamma 0 0
Id: 2812702
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Mn+2 + F- = MnF+
log_k 1.6
delta_h 11 kJ
-gamma 5 0
Id: 4702700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H+ + F- = CrF+2 + 2H2O
log_k 14.7688
delta_h -70.2452 kJ
-gamma 0 0
Id: 2112700
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
VO+2 + F- = VOF+
log_k 3.778
delta_h 7.9 kJ
-gamma 0 0
Id: 9022700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
VO+2 + 2F- = VOF2
log_k 6.352
delta_h 14 kJ
-gamma 0 0
Id: 9022701
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
VO+2 + 3F- = VOF3-
log_k 7.902
delta_h 20 kJ

-gamma 0 0
Id: 9022702
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
VO+2 + 4F- = VOF4-2
log_k 8.508
delta_h 26 kJ
-gamma 0 0
Id: 9022703
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
VO2+ + F- = VO2F
log_k 3.244
delta_h 0 kJ
-gamma 0 0
Id: 9032700
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
VO2+ + 2F- = VO2F2-
log_k 5.804
delta_h 0 kJ
-gamma 0 0
Id: 9032701
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
VO2+ + 3F- = VO2F3-2
log_k 6.9
delta_h 0 kJ
-gamma 0 0
Id: 9032702
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
VO2+ + 4F- = VO2F4-3
log_k 6.592
delta_h 0 kJ
-gamma 0 0
Id: 9032703
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
U+4 + F- = UF+3
log_k 9.3
delta_h 21.1292 kJ
-gamma 0 0
Id: 8912700
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
U+4 + 2F- = UF2+2

log_k 16.4
delta_h 30.1248 kJ
-gamma 0 0
Id: 8912701
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
U+4 + 3F- = UF3+
log_k 21.6
delta_h 29.9156 kJ
-gamma 0 0
Id: 8912702
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
U+4 + 4F- = UF4
log_k 23.64
delta_h 19.2464 kJ
-gamma 0 0
Id: 8912703
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 5F- = UF5-
log_k 25.238
delta_h 20.2924 kJ
-gamma 0 0
Id: 8912704
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 6F- = UF6-2
log_k 27.718
delta_h 13.8072 kJ
-gamma 0 0
Id: 8912705
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + F- = UO2F+
log_k 5.14
delta_h 1 kJ
-gamma 0 0
Id: 8932700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + 2F- = UO2F2
log_k 8.6
delta_h 2 kJ
-gamma 0 0
Id: 8932701
log K source: NIST46.3
Delta H source: NIST46.3

#T and ionic strength: 0.00 25.0
UO2+2 + 3F- = UO2F3-
log_k 11
delta_h 2 kJ
-gamma 0 0
Id: 8932702
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + 4F- = UO2F4-2
log_k 11.9
delta_h 0.4 kJ
-gamma 0 0
Id: 8932703
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Be+2 + F- = BeF+
log_k 5.249
delta_h 0 kJ
-gamma 0 0
Id: 1102701
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Be+2 + 2F- = BeF2
log_k 9.1285
delta_h -4 kJ
-gamma 0 0
Id: 1102702
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Be+2 + 3F- = BeF3-
log_k 11.9085
delta_h -8 kJ
-gamma 0 0
Id: 1102703
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Mg+2 + F- = MgF+
log_k 2.05
delta_h 13 kJ
-gamma 4.5 0
Id: 4602700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ca+2 + F- = CaF+
log_k 1.038
delta_h 14 kJ
-gamma 5 0
Id: 1502700

log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
Sr+2 + F- = SrF+
log_k 0.548
delta_h 16 kJ
-gamma 0 0
Id: 8002701
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 1.00 25.0
Na+ + F- = NaF
log_k -0.2
delta_h 12 kJ
-gamma 0 0
Id: 5002700
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + Cl- = SnCl+ + 2H2O
log_k 8.734
delta_h 0 kJ
-gamma 0 0
Id: 7901801
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + 2Cl- = SnCl2 + 2H2O
log_k 9.524
delta_h 0 kJ
-gamma 0 0
Id: 7901802
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + 3Cl- = SnCl3- + 2H2O
log_k 8.3505
delta_h 0 kJ
-gamma 0 0
Id: 7901803
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 2.00 25.0
Pb+2 + Cl- = PbCl+
log_k 1.55
delta_h 8.7 kJ
-gamma 0 0
Id: 6001800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 2Cl- = PbCl2
log_k 2.2
delta_h 12 kJ

-gamma 0 0
Id: 6001801
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 3Cl- = PbCl3-
log_k 1.8
delta_h 4 kJ
-gamma 0 0
Id: 6001802
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 4Cl- = PbCl4-2
log_k 1.46
delta_h 14.7695 kJ
-gamma 0 0
Id: 6001803
log K source: SCD3.02 (1984 SEa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Tl+ + Cl- = TlCl
log_k 0.51
delta_h -6.2 kJ
-gamma 0 0
Id: 8701800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl+ + 2Cl- = TlCl2-
log_k 0.28
delta_h 0 kJ
-gamma 0 0
Id: 8701801
log K source: SCD3.02 (1992 RAb)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 3H+ + Cl- = TlCl+2 + 3H2O
log_k 11.011
delta_h 0 kJ
-gamma 0 0
Id: 8711800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 3H+ + 2Cl- = TlCl2+ + 3H2O
log_k 16.771
delta_h 0 kJ
-gamma 0 0
Id: 8711801
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 3H+ + 3Cl- = TlCl3 + 3H2O

log_k 19.791
delta_h 0 kJ
-gamma 0 0
Id: 8711802
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 3H+ + 4Cl- = TlCl4- + 3H2O
log_k 21.591
delta_h 0 kJ
-gamma 0 0
Id: 8711803
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + Cl- + 2H+ = TlOHCl+ + 2H2O
log_k 10.629
delta_h 0 kJ
-gamma 0 0
Id: 8711804
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + Cl- = ZnCl+
log_k 0.4
delta_h 5.4 kJ
-gamma 4 0
Id: 9501800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Zn+2 + 2Cl- = ZnCl2
log_k 0.6
delta_h 37 kJ
-gamma 0 0
Id: 9501801
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Zn+2 + 3Cl- = ZnCl3-
log_k 0.5
delta_h 39.999 kJ
-gamma 4 0
Id: 9501802
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + 4Cl- = ZnCl4-2
log_k 0.199
delta_h 45.8566 kJ
-gamma 5 0
Id: 9501803
log K source: MTQ3.11
Delta H source: MTQ3.11

#T and ionic strength:
Zn+2 + H2O + Cl- = ZnOHCl + H+
log_k -7.48
delta_h 0 kJ
-gamma 0 0
Id: 9501804
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cd+2 + Cl- = CdCl+
log_k 1.98
delta_h 1 kJ
-gamma 0 0
Id: 1601800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2Cl- = CdCl2
log_k 2.6
delta_h 3 kJ
-gamma 0 0
Id: 1601801
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 3Cl- = CdCl3-
log_k 2.4
delta_h 10 kJ
-gamma 0 0
Id: 1601802
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + H2O + Cl- = CdOHCl + H+
log_k -7.404
delta_h 18.2213 kJ
-gamma 0 0
Id: 1601803
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + 2H+ + Cl- = HgCl+ + 2H2O
log_k 13.494
delta_h -62.72 kJ
-gamma 0 0
Id: 3611800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 2Cl- = HgCl2 + 2H2O
log_k 20.194
delta_h -92.42 kJ
-gamma 0 0
Id: 3611801

log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 3Cl- = HgCl3- + 2H2O
log_k 21.194
delta_h -94.02 kJ
-gamma 0 0
Id: 3611802
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 4Cl- = HgCl4-2 + 2H2O
log_k 21.794
delta_h -100.72 kJ
-gamma 0 0
Id: 3611803
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + Cl- + I- + 2H+ = HgClI + 2H2O
log_k 25.532
delta_h -135.3 kJ
-gamma 0 0
Id: 3611804
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Hg(OH)2 + H+ + Cl- = HgClOH + H2O
log_k 10.444
delta_h -42.72 kJ
-gamma 0 0
Id: 3611805
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
Cu+2 + Cl- = CuCl+
log_k 0.2
delta_h 8.3 kJ
-gamma 4 0
Id: 2311800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cu+2 + 2Cl- = CuCl2
log_k -0.26
delta_h 44.183 kJ
-gamma 0 0
Id: 2311801
log K source: SCD3.02 (1989 IPa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+2 + 3Cl- = CuCl3-
log_k -2.29
delta_h 57.279 kJ

-gamma 4 0
Id: 2311802
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cu+2 + 4Cl- = CuCl4-2
log_k -4.59
delta_h 32.5515 kJ
-gamma 5 0
Id: 2311803
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cu+ + 2Cl- = CuCl2-
log_k 5.42
delta_h -1.7573 kJ
-gamma 4 0
Id: 2301800
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+ + 3Cl- = CuCl3-2
log_k 4.75
delta_h 1.0878 kJ
-gamma 5 0
Id: 2301801
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+ + Cl- = CuCl
log_k 3.1
delta_h 0 kJ
-gamma 0 0
Id: 2301802
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + Cl- = AgCl
log_k 3.31
delta_h -12 kJ
-gamma 0 0
Id: 201800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + 2Cl- = AgCl2-
log_k 5.25
delta_h -16 kJ
-gamma 0 0
Id: 201801
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + 3Cl- = AgCl3-2

log_k 5.2
delta_h 0 kJ
-gamma 0 0
Id: 201802
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + 4Cl- = AgCl4-3
log_k 5.51
delta_h 0 kJ
-gamma 0 0
Id: 201803
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Ni+2 + Cl- = NiCl+
log_k 0.408
delta_h 2 kJ
-gamma 0 0
Id: 5401800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
Ni+2 + 2Cl- = NiCl2
log_k -1.89
delta_h 0 kJ
-gamma 0 0
Id: 5401801
log K source: SCD3.02 (1989 IPa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + Cl- = CoCl+
log_k 0.539
delta_h 2 kJ
-gamma 0 0
Id: 2001800
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Co+3 + Cl- = CoCl+2
log_k 2.3085
delta_h 16 kJ
-gamma 0 0
Id: 2011800
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Fe+3 + Cl- = FeCl+2
log_k 1.48
delta_h 23 kJ
-gamma 5 0
Id: 2811800
log K source: NIST46.3
Delta H source: NIST46.3

#T and ionic strength: 0.00 25.0
Fe+3 + 2Cl- = FeCl2+
log_k 2.13
delta_h 0 kJ
-gamma 5 0
Id: 2811801
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Fe+3 + 3Cl- = FeCl3
log_k 1.13
delta_h 0 kJ
-gamma 0 0
Id: 2811802
log K source: Nord90
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mn+2 + Cl- = MnCl+
log_k 0.1
delta_h 0 kJ
-gamma 5 0
Id: 4701800
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 20.0
Mn+2 + 2Cl- = MnCl2
log_k 0.25
delta_h 0 kJ
-gamma 0 0
Id: 4701801
log K source: Nord90
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mn+2 + 3Cl- = MnCl3-
log_k -0.31
delta_h 0 kJ
-gamma 5 0
Id: 4701802
log K source: Nord90
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H+ + Cl- = CrCl+2 + 2H2O
log_k 9.6808
delta_h -103.62 kJ
-gamma 0 0
Id: 2111800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
Cr(OH)2+ + 2Cl- + 2H+ = CrCl2+ + 2H2O
log_k 8.658
delta_h -39.2208 kJ
-gamma 0 0
Id: 2111801

log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cr(OH)2+ + 2Cl- + H+ = CrOHCl2 + H2O
log_k 2.9627
delta_h 0 kJ
-gamma 0 0
Id: 2111802
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
VO+2 + Cl- = VOCl+
log_k 0.448
delta_h 0 kJ
-gamma 0 0
Id: 9021800
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
U+4 + Cl- = UCl+3
log_k 1.7
delta_h -20 kJ
-gamma 0 0
Id: 8911800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + Cl- = UO2Cl+
log_k 0.21
delta_h 16 kJ
-gamma 0 0
Id: 8931800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Be+2 + Cl- = BeCl+
log_k 0.2009
delta_h 0 kJ
-gamma 5 0
Id: 1101801
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.70 20.0
Sn(OH)2 + 2H+ + Br- = SnBr+ + 2H2O
log_k 8.254
delta_h 0 kJ
-gamma 0 0
Id: 7901301
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + 2Br- = SnBr2 + 2H2O
log_k 8.794
delta_h 0 kJ

-gamma 0 0
Id: 7901302
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + 3Br- = SnBr3- + 2H2O
log_k 7.48
delta_h 0 kJ
-gamma 0 0
Id: 7901303
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 3.00 25.0
Pb+2 + Br- = PbBr+
log_k 1.7
delta_h 8 kJ
-gamma 0 0
Id: 6001300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 2Br- = PbBr2
log_k 2.6
delta_h -4 kJ
-gamma 0 0
Id: 6001301
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl+ + Br- = TlBr
log_k 0.91
delta_h -12 kJ
-gamma 0 0
Id: 8701300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl+ + 2Br- = TlBr2-
log_k -0.384
delta_h 12.36 kJ
-gamma 0 0
Id: 8701301
log K source: NIST46.3
Delta H source: NIST2.1.1
#T and ionic strength: 4.00 25.0
Tl+ + Br- + Cl- = TlBrCl-
log_k 0.8165
delta_h 0 kJ
-gamma 0 0
Id: 8701302
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Tl+ + I- + Br- = TlIBr-

log_k 2.185
delta_h 0 kJ
-gamma 0 0
Id: 8703802
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Tl(OH)3 + 3H+ + Br- = TlBr+2 + 3H2O
log_k 12.803
delta_h 0 kJ
-gamma 0 0
Id: 8711300
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Tl(OH)3 + 3H+ + 2Br- = TlBr2+ + 3H2O
log_k 20.711
delta_h 0 kJ
-gamma 0 0
Id: 8711301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Tl(OH)3 + 3Br- + 3H+ = TlBr3 + 3H2O
log_k 27.0244
delta_h 0 kJ
-gamma 0 0
Id: 8711302
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Tl(OH)3 + 4Br- + 3H+ = TlBr4- + 3H2O
log_k 31.1533
delta_h 0 kJ
-gamma 0 0
Id: 8711303
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + Br- = ZnBr+
log_k -0.07
delta_h 1 kJ
-gamma 0 0
Id: 9501300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Zn+2 + 2Br- = ZnBr2
log_k -0.98
delta_h 0 kJ
-gamma 0 0
Id: 9501301
log K source: MTQ3.11
Delta H source: MTQ3.11

#T and ionic strength:
Cd+2 + Br- = CdBr+
log_k 2.15
delta_h -3 kJ
-gamma 0 0
Id: 1601300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2Br- = CdBr2
log_k 3
delta_h -3 kJ
-gamma 0 0
Id: 1601301
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + Br- = HgBr+ + 2H2O
log_k 15.803
delta_h -81.92 kJ
-gamma 0 0
Id: 3611301
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 2Br- = HgBr2 + 2H2O
log_k 24.2725
delta_h -127.12 kJ
-gamma 0 0
Id: 3611302
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 3Br- = HgBr3- + 2H2O
log_k 26.7025
delta_h -138.82 kJ
-gamma 0 0
Id: 3611303
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 4Br- = HgBr4-2 + 2H2O
log_k 27.933
delta_h -153.72 kJ
-gamma 0 0
Id: 3611304
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Hg(OH)2 + Br- + Cl- + 2H+ = HgBrCl + 2H2O
log_k 22.1811
delta_h -113.77 kJ
-gamma 0 0
Id: 3611305

log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Hg(OH)2 + Br- + I- + 2H+ = HgBrI + 2H2O
log_k 27.3133
delta_h -151.27 kJ
-gamma 0 0
Id: 3611306
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Hg(OH)2 + Br- + 3I- + 2H+ = HgBrI3-2 + 2H2O
log_k 34.2135
delta_h 0 kJ
-gamma 0 0
Id: 3611307
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + 2Br- + 2I- + 2H+ = HgBr2I2-2 + 2H2O
log_k 32.3994
delta_h 0 kJ
-gamma 0 0
Id: 3611308
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + 3Br- + I- + 2H+ = HgBr3I-2 + 2H2O
log_k 30.1528
delta_h 0 kJ
-gamma 0 0
Id: 3611309
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + H+ + Br- = HgBrOH + H2O
log_k 12.433
delta_h 0 kJ
-gamma 0 0
Id: 3613301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Ag+ + Br- = AgBr
log_k 4.6
delta_h 0 kJ
-gamma 0 0
Id: 201300
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + 2Br- = AgBr2-
log_k 7.5
delta_h 0 kJ

-gamma 0 0
Id: 201301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + 3Br- = AgBr3-2
log_k 8.1
delta_h 0 kJ
-gamma 0 0
Id: 201302
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + Br- = NiBr+
log_k 0.5
delta_h 0 kJ
-gamma 0 0
Id: 5401300
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cr(OH)2+ + Br- + 2H+ = CrBr+2 + 2H2O
log_k 7.5519
delta_h -46.9068 kJ
-gamma 0 0
Id: 2111300
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Be+2 + Br- = BeBr+
log_k 0.1009
delta_h 0 kJ
-gamma 5 0
Id: 1101301
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.70 20.0
Pb+2 + I- = PbI+
log_k 2
delta_h 0 kJ
-gamma 0 0
Id: 6003800
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Pb+2 + 2I- = PbI2
log_k 3.2
delta_h 0 kJ
-gamma 0 0
Id: 6003801
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Tl+ + I- = TlI

log_k 1.4279
delta_h 0 kJ
-gamma 0 0
Id: 8703800
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Tl+ + 2I- = TlI2-
log_k 1.8588
delta_h 0 kJ
-gamma 0 0
Id: 8703801
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Tl(OH)3 + 4I- + 3H+ = TlI4- + 3H2O
log_k 34.7596
delta_h 0 kJ
-gamma 0 0
Id: 8713800
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + I- = ZnI+
log_k -2.0427
delta_h -4 kJ
-gamma 0 0
Id: 9503800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 3.00 25.0
Zn+2 + 2I- = ZnI2
log_k -1.69
delta_h 0 kJ
-gamma 0 0
Id: 9503801
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cd+2 + I- = CdI+
log_k 2.28
delta_h -9.6 kJ
-gamma 0 0
Id: 1603800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2I- = CdI2
log_k 3.92
delta_h -12 kJ
-gamma 0 0
Id: 1603801
log K source: NIST46.3
Delta H source: NIST46.3

#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + I- = HgI+ + 2H2O
log_k 19.603
delta_h -111.22 kJ
-gamma 0 0
Id: 3613801
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 2I- = HgI2 + 2H2O
log_k 30.8225
delta_h -182.72 kJ
-gamma 0 0
Id: 3613802
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 3I- = HgI3- + 2H2O
log_k 34.6025
delta_h -194.22 kJ
-gamma 0 0
Id: 3613803
log K source: NIST46.4
Delta H source: NIST2.1.1
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 4I- = HgI4-2 + 2H2O
log_k 36.533
delta_h -220.72 kJ
-gamma 0 0
Id: 3613804
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Ag+ + I- = AgI
log_k 6.6
delta_h 0 kJ
-gamma 0 0
Id: 203800
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 18.0
Ag+ + 2I- = AgI2-
log_k 11.7
delta_h 0 kJ
-gamma 0 0
Id: 203801
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 18.0
Ag+ + 3I- = AgI3-2
log_k 12.6
delta_h -122 kJ
-gamma 0 0
Id: 203802

log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + 4I- = AgI4-3
log_k 14.229
delta_h 0 kJ
-gamma 0 0
Id: 203803
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 2.00 25.0
Cr(OH)2+ + I- + 2H+ = CrI+2 + 2H2O
log_k 4.8289
delta_h 0 kJ
-gamma 0 0
Id: 2113800
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
H+ + HS- = H2S
log_k 7.02
delta_h -22 kJ
-gamma 0 0
Id: 3307300
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 2HS- = Pb(HS)2
log_k 15.27
delta_h 0 kJ
-gamma 0 0
Id: 6007300
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Pb+2 + 3HS- = Pb(HS)3-
log_k 16.57
delta_h 0 kJ
-gamma 0 0
Id: 6007301
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Tl+ + HS- = TlHS
log_k 2.474
delta_h 0 kJ
-gamma 0 0
Id: 8707300
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
2Tl+ + HS- = Tl2HS+
log_k 5.974
delta_h 0 kJ

-gamma 0 0
Id: 8707301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
2Tl+ + 3HS- + H2O = Tl2OH(HS)3-2 + H+
log_k 1.0044
delta_h 0 kJ
-gamma 0 0
Id: 8707302
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
2Tl+ + 2HS- + 2H2O = Tl2(OH)2(HS)2-2 + 2H+
log_k -11.0681
delta_h 0 kJ
-gamma 0 0
Id: 8707303
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + 2HS- = Zn(HS)2
log_k 12.82
delta_h 0 kJ
-gamma 0 0
Id: 9507300
log K source: DHa1993
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 3HS- = Zn(HS)3-
log_k 16.1
delta_h 0 kJ
-gamma 0 0
Id: 9507301
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + 3HS- = ZnS(HS)2-2 + H+
log_k 6.12
delta_h 0 kJ
-gamma 0 0
Id: 9507302
log K source: DHa1993
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 2HS- + 2HS- = Zn(HS)4-2
log_k 14.64
delta_h 0 kJ
-gamma 0 0
Id: 9507303
log K source: DHa1993
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 2HS- = ZnS(HS)- + H+

log_k 6.81
delta_h 0 kJ
-gamma 0 0
Id: 9507304
log K source: DHa1993
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cd+2 + HS- = CdHS+
log_k 8.008
delta_h 0 kJ
-gamma 0 0
Id: 1607300
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Cd+2 + 2HS- = Cd(HS)2
log_k 15.212
delta_h 0 kJ
-gamma 0 0
Id: 1607301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Cd+2 + 3HS- = Cd(HS)3-
log_k 17.112
delta_h 0 kJ
-gamma 0 0
Id: 1607302
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Cd+2 + 4HS- = Cd(HS)4-2
log_k 19.308
delta_h 0 kJ
-gamma 0 0
Id: 1607303
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Hg(OH)2 + 2HS- = HgS2-2 + 2H2O
log_k 29.414
delta_h 0 kJ
-gamma 0 0
Id: 3617300
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
Hg(OH)2 + 2H+ + 2HS- = Hg(HS)2 + 2H2O
log_k 44.516
delta_h 0 kJ
-gamma 0 0
Id: 3617301
log K source: NIST46.3
Delta H source: MTQ3.11

#T and ionic strength: 1.00 20.0
Hg(OH)2 + H+ + 2HS- = HgHS2- + 2H2O
log_k 38.122
delta_h 0 kJ
-gamma 0 0
Id: 3617302
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
Cu+2 + 3HS- = Cu(HS)3-
log_k 25.899
delta_h 0 kJ
-gamma 0 0
Id: 2317300
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Ag+ + HS- = AgHS
log_k 13.8145
delta_h 0 kJ
-gamma 0 0
Id: 207300
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.10 20.0
Ag+ + 2HS- = Ag(HS)2-
log_k 17.9145
delta_h 0 kJ
-gamma 0 0
Id: 207301
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.10 20.0
Fe+2 + 2HS- = Fe(HS)2
log_k 8.95
delta_h 0 kJ
-gamma 0 0
Id: 2807300
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Fe+2 + 3HS- = Fe(HS)3-
log_k 10.987
delta_h 0 kJ
-gamma 0 0
Id: 2807301
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
HS- = S2-2 + H+
log_k -11.7828
delta_h 46.4 kJ
-gamma 0 0
-no_check

```
# Id: 7317300
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
HS- = S3-2 + H+
log_k -10.7667
delta_h 42.2 kJ
-gamma 0 0
-no_check
# Id: 7317301
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
HS- = S4-2 + H+
log_k -9.9608
delta_h 39.3 kJ
-gamma 0 0
-no_check
# Id: 7317302
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
HS- = S5-2 + H+
log_k -9.3651
delta_h 37.6 kJ
-gamma 0 0
-no_check
# Id: 7317303
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
HS- = S6-2 + H+
log_k -9.881
delta_h 0 kJ
-gamma 0 0
-no_check
# Id: 7317304
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
2Sb(OH)3 + 4HS- + 2H+ = Sb2S4-2 + 6H2O
log_k 49.3886
delta_h -321.78 kJ
-gamma 0 0
# Id: 7407300
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Cu+ + 2HS- = Cu(S4)2-3 + 2H+
log_k 3.39
delta_h 0 kJ
-gamma 23 0
-no_check
# Id: 2307300
```

log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cu+ + 2HS- = CuS4S5-3 + 2H+
log_k 2.66
delta_h 0 kJ
-gamma 25 0
-no_check
Id: 2307301
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Ag+ + 2HS- = Ag(S4)2-3 + 2H+
log_k 0.991
delta_h 0 kJ
-gamma 22 0
-no_check
Id: 207302
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Ag+ + 2HS- = AgS4S5-3 + 2H+
log_k 0.68
delta_h 0 kJ
-gamma 24 0
-no_check
Id: 207303
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Ag+ + 2HS- = Ag(HS)S4-2 + H+
log_k 10.431
delta_h 0 kJ
-gamma 15 0
-no_check
Id: 207304
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
H+ + SO4-2 = HSO4-
log_k 1.99
delta_h 22 kJ
-gamma 4.5 0
Id: 3307320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
NH4+ + SO4-2 = NH4SO4-
log_k 1.03
delta_h 0 kJ
-gamma 5 0
Id: 4907320
log K source: NIST46.3
Delta H source: MTQ3.11

#T and ionic strength: 0.00 25.0
Pb+2 + SO4-2 = PbSO4
log_k 2.69
delta_h 0 kJ
-gamma 0 0
Id: 6007320
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Pb+2 + 2SO4-2 = Pb(SO4)2-2
log_k 3.47
delta_h 0 kJ
-gamma 0 0
Id: 6007321
log K source: SCD3.02 (1960 RKa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Al+3 + SO4-2 = AlSO4+
log_k 3.89
delta_h 28 kJ
-gamma 4.5 0
Id: 307320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Al+3 + 2SO4-2 = Al(SO4)2-
log_k 4.92
delta_h 11.9 kJ
-gamma 4.5 0
Id: 307321
log K source: Nord90
Delta H source: Nord90
#T and ionic strength: 0.00 25.0
Tl+ + SO4-2 = TlSO4-
log_k 1.37
delta_h -0.8 kJ
-gamma 0 0
Id: 8707320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Zn+2 + SO4-2 = ZnSO4
log_k 2.34
delta_h 6.2 kJ
-gamma 0 0
Id: 9507320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Zn+2 + 2SO4-2 = Zn(SO4)2-2
log_k 3.28
delta_h 0 kJ
-gamma 0 0
Id: 9507321

log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cd+2 + SO4-2 = CdSO4
log_k 2.37
delta_h 8.7 kJ
-gamma 0 0
Id: 1607320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2SO4-2 = Cd(SO4)2-2
log_k 3.5
delta_h 0 kJ
-gamma 0 0
Id: 1607321
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + 2H+ + SO4-2 = HgSO4 + 2H2O
log_k 8.612
delta_h 0 kJ
-gamma 0 0
Id: 3617320
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Cu+2 + SO4-2 = CuSO4
log_k 2.36
delta_h 8.7 kJ
-gamma 0 0
Id: 2317320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + SO4-2 = AgSO4-
log_k 1.3
delta_h 6.2 kJ
-gamma 0 0
Id: 207320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ni+2 + SO4-2 = NiSO4
log_k 2.3
delta_h 5.8 kJ
-gamma 0 0
Id: 5407320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ni+2 + 2SO4-2 = Ni(SO4)2-2
log_k 0.82
delta_h 0 kJ

-gamma 0 0
Id: 5407321
log K source: SCD3.02 (1978 BLa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + SO4-2 = CoSO4
log_k 2.3
delta_h 6.2 kJ
-gamma 0 0
Id: 2007320
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Fe+2 + SO4-2 = FeSO4
log_k 2.39
delta_h 8 kJ
-gamma 0 0
Id: 2807320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+3 + SO4-2 = FeSO4+
log_k 4.05
delta_h 25 kJ
-gamma 5 0
Id: 2817320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+3 + 2SO4-2 = Fe(SO4)2-
log_k 5.38
delta_h 19.2 kJ
-gamma 0 0
Id: 2817321
log K source: Nord90
Delta H source: Nord90
#T and ionic strength: 0.00 25.0
Mn+2 + SO4-2 = MnSO4
log_k 2.25
delta_h 8.7 kJ
-gamma 0 0
Id: 4707320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H+ + SO4-2 = CrSO4+ + 2H2O
log_k 12.9371
delta_h -98.62 kJ
-gamma 0 0
Id: 2117320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 50.0
Cr(OH)2+ + H+ + SO4-2 = CrOHSO4 + H2O

log_k 8.2871
delta_h 0 kJ
-gamma 0 0
Id: 2117321
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
2Cr(OH)2+ + SO4-2 + 2H+ = Cr2(OH)2SO4+2 + 2H2O
log_k 16.155
delta_h 0 kJ
-gamma 0 0
Id: 2117323
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
2Cr(OH)2+ + 2SO4-2 + 2H+ = Cr2(OH)2(SO4)2 + 2H2O
log_k 17.9288
delta_h 0 kJ
-gamma 0 0
Id: 2117324
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
U+4 + SO4-2 = USO4+2
log_k 6.6
delta_h 8 kJ
-gamma 0 0
Id: 8917320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
U+4 + 2SO4-2 = U(SO4)2
log_k 10.5
delta_h 33 kJ
-gamma 0 0
Id: 8917321
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + SO4-2 = UO2SO4
log_k 3.18
delta_h 20 kJ
-gamma 0 0
Id: 8937320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + 2SO4-2 = UO2(SO4)2-2
log_k 4.3
delta_h 38 kJ
-gamma 0 0
Id: 8937321
log K source: NIST46.3
Delta H source: NIST46.3

#T and ionic strength: 0.00 25.0
V+3 + SO4-2 = VSO4+
log_k 2.674
delta_h 0 kJ
-gamma 0 0
Id: 9017320
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
VO+2 + SO4-2 = VOSO4
log_k 2.44
delta_h 17 kJ
-gamma 0 0
Id: 9027320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
VO2+ + SO4-2 = VO2SO4-
log_k 1.378
delta_h 0 kJ
-gamma 0 0
Id: 9037320
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
Be+2 + SO4-2 = BeSO4
log_k 2.19
delta_h 29 kJ
-gamma 0 0
Id: 1107321
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Be+2 + 2SO4-2 = Be(SO4)2-2
log_k 2.596
delta_h 0 kJ
-gamma 0 0
Id: 1107322
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Mg+2 + SO4-2 = MgSO4
log_k 2.26
delta_h 5.8 kJ
-gamma 0 0
Id: 4607320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ca+2 + SO4-2 = CaSO4
log_k 2.36
delta_h 7.1 kJ
-gamma 0 0
Id: 1507320

log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Sr+2 + SO4-2 = SrSO4
log_k 2.3
delta_h 8 kJ
-gamma 0 0
Id: 8007321
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Li+ + SO4-2 = LiSO4-
log_k 0.64
delta_h 0 kJ
-gamma 5 0
Id: 4407320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Na+ + SO4-2 = NaSO4-
log_k 0.73
delta_h 1 kJ
-gamma 5.4 0
Id: 5007320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
K+ + SO4-2 = KSO4-
log_k 0.85
delta_h 4.1 kJ
-gamma 5.4 0
Id: 4107320
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
HSe- + H+ = H2Se
log_k 3.89
delta_h 3.3 kJ
-gamma 0 0
Id: 3307600
log K source: NIST46.3
Delta H source: NIST2.1.1
#T and ionic strength: 0.00 25.0
2Ag+ + HSe- = Ag2Se + H+
log_k 34.911
delta_h 0 kJ
-gamma 0 0
Id: 207600
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Ag+ + H2O + 2HSe- = AgOH(Se)2-4 + 3H+
log_k -20.509
delta_h 0 kJ

-gamma 0 0
Id: 207601
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Mn+2 + HSe- = MnSe + H+
log_k -5.385
delta_h 0 kJ
-gamma 0 0
Id: 4707600
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
HSeO3- = SeO3-2 + H+
log_k -8.4
delta_h 5.02 kJ
-gamma 0 0
Id: 3307611
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
HSeO3- + H+ = H2SeO3
log_k 2.63
delta_h 6.2 kJ
-gamma 0 0
Id: 3307610
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2HSeO3- = Cd(SeO3)2-2 + 2H+
log_k -10.884
delta_h 0 kJ
-gamma 0 0
Id: 1607610
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Ag+ + HSeO3- = AgSeO3- + H+
log_k -5.592
delta_h 0 kJ
-gamma 0 0
Id: 207610
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Ag+ + 2HSeO3- = Ag(SeO3)2-3 + 2H+
log_k -13.04
delta_h 0 kJ
-gamma 0 0
Id: 207611
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Fe+3 + HSeO3- = FeHSeO3+2

log_k 3.422
delta_h 25 kJ
-gamma 0 0
Id: 2817610
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
SeO4-2 + H+ = HSeO4-
log_k 1.7
delta_h 23 kJ
-gamma 0 0
Id: 3307620
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Zn+2 + SeO4-2 = ZnSeO4
log_k 2.19
delta_h 0 kJ
-gamma 0 0
Id: 9507620
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 2SeO4-2 = Zn(SeO4)2-2
log_k 2.196
delta_h 0 kJ
-gamma 0 0
Id: 9507621
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Cd+2 + SeO4-2 = CdSeO4
log_k 2.27
delta_h 0 kJ
-gamma 0 0
Id: 1607620
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + SeO4-2 = NiSeO4
log_k 2.67
delta_h 14 kJ
-gamma 0 0
Id: 5407620
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + SeO4-2 = CoSeO4
log_k 2.7
delta_h 12 kJ
-gamma 0 0
Id: 2007621
log K source: NIST46.4
Delta H source: NIST46.4

#T and ionic strength: 0.00 25.0
Mn+2 + SeO4-2 = MnSeO4
log_k 2.43
delta_h 14 kJ
-gamma 0 0
Id: 4707620
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
NH4+ = NH3 + H+
log_k -9.244
delta_h 52 kJ
-gamma 0 0
Id: 3304900
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + NH4+ = AgNH3+ + H+
log_k -5.934
delta_h -72 kJ
-gamma 0 0
Id: 204901
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + 2NH4+ = Ag(NH3)2+ + 2H+
log_k -11.268
delta_h -160 kJ
-gamma 0 0
Id: 204902
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Hg(OH)2 + H+ + NH4+ = HgNH3+2 + 2H2O
log_k 5.75
delta_h 0 kJ
-gamma 0 0
Id: 3614900
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 2.00 22.0
Hg(OH)2 + 2NH4+ = Hg(NH3)2+2 + 2H2O
log_k 5.506
delta_h -246.72 kJ
-gamma 0 0
Id: 3614901
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
Hg(OH)2 + 3NH4+ = Hg(NH3)3+2 + 2H2O + H+
log_k -3.138
delta_h -312.72 kJ
-gamma 0 0
Id: 3614902

log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 2.00 25.0
Hg(OH)2 + 4NH4+ = Hg(NH3)4+2 + 2H2O + 2H+
log_k -11.482
delta_h -379.72 kJ
-gamma 0 0
Id: 3614903
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.10 25.0
Cu+2 + NH4+ = CuNH3+2 + H+
log_k -5.234
delta_h -72 kJ
-gamma 0 0
Id: 2314901
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ni+2 + NH4+ = NiNH3+2 + H+
log_k -6.514
delta_h -67 kJ
-gamma 0 0
Id: 5404901
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Ni+2 + 2NH4+ = Ni(NH3)2+2 + 2H+
log_k -13.598
delta_h -111.6 kJ
-gamma 0 0
Id: 5404902
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + NH4+ = Co(NH3)+2 + H+
log_k -7.164
delta_h -65 kJ
-gamma 0 0
Id: 2004900
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + 2NH4+ = Co(NH3)2+2 + 2H+
log_k -14.778
delta_h 0 kJ
-gamma 0 0
Id: 2004901
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 2.00 25.0
Co+2 + 3NH4+ = Co(NH3)3+2 + 3H+
log_k -22.922
delta_h 0 kJ

-gamma 0 0
Id: 2004902
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 2.00 25.0
Co+2 + 4NH4+ = Co(NH3)4+2 + 4H+
log_k -31.446
delta_h 0 kJ
-gamma 0 0
Id: 2004903
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 2.00 30.0
Co+2 + 5NH4+ = Co(NH3)5+2 + 5H+
log_k -40.47
delta_h 0 kJ
-gamma 0 0
Id: 2004904
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 2.00 30.0
Co+3 + 6NH4+ + H2O = Co(NH3)6OH+2 + 7H+
log_k -43.7148
delta_h 0 kJ
-gamma 0 0
Id: 2014901
log K source: NIST2.1.1
Delta H source: MTQ3.11
#T and ionic strength:
Co+3 + 5NH4+ + Cl- = Co(NH3)5Cl+2 + 5H+
log_k -17.9584
delta_h 113.38 kJ
-gamma 0 0
Id: 2014902
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Co+3 + 6NH4+ + Cl- = Co(NH3)6Cl+2 + 6H+
log_k -33.9179
delta_h 104.34 kJ
-gamma 0 0
Id: 2014903
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Co+3 + 6NH4+ + Br- = Co(NH3)6Br+2 + 6H+
log_k -33.8884
delta_h 110.57 kJ
-gamma 0 0
Id: 2014904
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Co+3 + 6NH4+ + I- = Co(NH3)6I+2 + 6H+

log_k -33.4808
delta_h 115.44 kJ
-gamma 0 0
Id: 2014905
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Co+3 + 6NH4+ + SO4-2 = Co(NH3)6SO4+ + 6H+
log_k -28.9926
delta_h 124.5 kJ
-gamma 0 0
Id: 2014906
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Cr(OH)2+ + 6NH4+ = Cr(NH3)6+3 + 2H2O + 4H+
log_k -32.8952
delta_h 0 kJ
-gamma 0 0
Id: 2114900
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 4.50 25.0
Cr(OH)2+ + 5NH4+ = Cr(NH3)5OH+2 + 4H+ + H2O
log_k -30.2759
delta_h 0 kJ
-gamma 0 0
Id: 2114901
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cr(OH)2+ + 6NH4+ + Cl- = Cr(NH3)6Cl+2 + 2H2O + 4H+
log_k -31.7932
delta_h 0 kJ
-gamma 0 0
Id: 2114904
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cr(OH)2+ + 6NH4+ + Br- = Cr(NH3)6Br+2 + 4H+ + 2H2O
log_k -31.887
delta_h 0 kJ
-gamma 0 0
Id: 2114905
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cr(OH)2+ + 6NH4+ + I- = Cr(NH3)6I+2 + 4H+ + 2H2O
log_k -32.008
delta_h 0 kJ
-gamma 0 0
Id: 2114906
log K source: MTQ3.11
Delta H source: MTQ3.11

#T and ionic strength:
#Cr(OH)2+ + 4NH4+ = cis+ + 4H+
log_k -29.8574
delta_h 0 kJ
-gamma 0 0
Id: 4902113
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
#Cr(OH)2+ + 4NH4+ = trans+ + 4H+
log_k -30.5537
delta_h 0 kJ
-gamma 0 0
Id: 4902114
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Ca+2 + NH4+ = CaNH3+2 + H+
log_k -9.144
delta_h 0 kJ
-gamma 0 0
Id: 1504901
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Ca+2 + 2NH4+ = Ca(NH3)2+2 + 2H+
log_k -18.788
delta_h 0 kJ
-gamma 0 0
Id: 1504902
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Sr+2 + NH4+ = SrNH3+2 + H+
log_k -9.344
delta_h 0 kJ
-gamma 0 0
Id: 8004901
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Ba+2 + NH4+ = BaNH3+2 + H+
log_k -9.444
delta_h 0 kJ
-gamma 0 0
Id: 1004901
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Tl+ + NO2- = TlNO2
log_k 0.83
delta_h 0 kJ
-gamma 0 0
Id: 8704910

log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + NO2- = AgNO2
log_k 2.32
delta_h -29 kJ
-gamma 0 0
Id: 204911
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + 2NO2- = Ag(NO2)2-
log_k 2.51
delta_h -46 kJ
-gamma 0 0
Id: 204910
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cu+2 + NO2- = CuNO2+
log_k 2.02
delta_h 0 kJ
-gamma 0 0
Id: 2314911
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+2 + 2NO2- = Cu(NO2)2
log_k 3.03
delta_h 0 kJ
-gamma 0 0
Id: 2314912
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + NO2- = CoNO2+
log_k 0.848
delta_h 0 kJ
-gamma 0 0
Id: 2004911
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Sn(OH)2 + 2H+ + NO3- = SnNO3+ + 2H2O
log_k 7.942
delta_h 0 kJ
-gamma 0 0
Id: 7904921
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Pb+2 + NO3- = PbNO3+
log_k 1.17
delta_h 2 kJ

-gamma 0 0
Id: 6004920
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 2NO3- = Pb(NO3)2
log_k 1.4
delta_h -6.6 kJ
-gamma 0 0
Id: 6004921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Tl+ + NO3- = TlNO3
log_k 0.33
delta_h -2 kJ
-gamma 0 0
Id: 8704920
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + NO3- + 3H+ = TlNO3+2 + 3H2O
log_k 7.0073
delta_h 0 kJ
-gamma 0 0
Id: 8714920
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cd+2 + NO3- = CdNO3+
log_k 0.5
delta_h -21 kJ
-gamma 0 0
Id: 1604920
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2NO3- = Cd(NO3)2
log_k 0.2
delta_h 0 kJ
-gamma 0 0
Id: 1604921
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + NO3- = HgNO3+ + 2H2O
log_k 5.7613
delta_h 0 kJ
-gamma 0 0
Id: 3614920
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Hg(OH)2 + 2H+ + 2NO3- = Hg(NO3)2 + 2H2O

log_k 5.38
delta_h 0 kJ
-gamma 0 0
Id: 3614921
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Cu+2 + NO3- = CuNO3+
log_k 0.5
delta_h -4.1 kJ
-gamma 0 0
Id: 2314921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+2 + 2NO3- = Cu(NO3)2
log_k -0.4
delta_h 0 kJ
-gamma 0 0
Id: 2314922
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + NO3- = ZnNO3+
log_k 0.4
delta_h -4.6 kJ
-gamma 0 0
Id: 9504921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Zn+2 + 2NO3- = Zn(NO3)2
log_k -0.3
delta_h 0 kJ
-gamma 0 0
Id: 9504922
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + NO3- = AgNO3
log_k -0.1
delta_h 22.6 kJ
-gamma 0 0
Id: 204920
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ni+2 + NO3- = NiNO3+
log_k 0.4
delta_h 0 kJ
-gamma 0 0
Id: 5404921
log K source: NIST46.4
Delta H source: MTQ3.11

#T and ionic strength: 0.00 25.0
Co+2 + NO3- = CoNO3+
log_k 0.2
delta_h 0 kJ
-gamma 0 0
Id: 2004921
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + 2NO3- = Co(NO3)2
log_k 0.5085
delta_h 0 kJ
-gamma 0 0
Id: 2004922
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Fe+3 + NO3- = FeNO3+2
log_k 1
delta_h -37 kJ
-gamma 0 0
Id: 2814921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Mn+2 + NO3- = MnNO3+
log_k 0.2
delta_h 0 kJ
-gamma 0 0
Id: 4704921
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mn+2 + 2NO3- = Mn(NO3)2
log_k 0.6
delta_h -1.6569 kJ
-gamma 0 0
Id: 4704920
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + NO3- + 2H+ = CrNO3+2 + 2H2O
log_k 8.2094
delta_h -65.4378 kJ
-gamma 0 0
Id: 2114920
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + NO3- = UO2NO3+
log_k 0.3
delta_h -12 kJ
-gamma 0 0
Id: 8934921

log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
VO2+ + NO3- = VO2NO3
log_k -0.296
delta_h 0 kJ
-gamma 0 0
Id: 9034920
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
Ca+2 + NO3- = CaNO3+
log_k 0.5
delta_h -5.4 kJ
-gamma 0 0
Id: 1504921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sr+2 + NO3- = SrNO3+
log_k 0.6
delta_h -10 kJ
-gamma 0 0
Id: 8004921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + NO3- = BaNO3+
log_k 0.7
delta_h -13 kJ
-gamma 0 0
Id: 1004921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H+ + Cyanide- = HCyanide
log_k 9.21
delta_h -43.63 kJ
-gamma 0 0
Id: 3301431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cd+2 + Cyanide- = CdCyanide+
log_k 6.01
delta_h -30 kJ
-gamma 0 0
Id: 1601431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cd+2 + 2Cyanide- = Cd(Cyanide)2
log_k 11.12
delta_h -54.3 kJ

-gamma 0 0
Id: 1601432
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cd+2 + 3Cyanide- = Cd(Cyanide)3-
log_k 15.65
delta_h -90.3 kJ
-gamma 0 0
Id: 1601433
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cd+2 + 4Cyanide- = Cd(Cyanide)4-2
log_k 17.92
delta_h -112 kJ
-gamma 0 0
Id: 1601434
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + Cyanide- = HgCyanide+ + 2H2O
log_k 23.194
delta_h -136.72 kJ
-gamma 0 0
Id: 3611431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 2Cyanide- = Hg(Cyanide)2 + 2H2O
log_k 38.944
delta_h 154.28 kJ
-gamma 0 0
Id: 3611432
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 3Cyanide- = Hg(Cyanide)3- + 2H2O
log_k 42.504
delta_h -262.72 kJ
-gamma 0 0
Id: 3611433
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 4Cyanide- = Hg(Cyanide)4-2 + 2H2O
log_k 45.164
delta_h -288.72 kJ
-gamma 0 0
Id: 3611434
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+ + 2Cyanide- = Cu(Cyanide)2-

log_k 21.9145
delta_h -121 kJ
-gamma 0 0
Id: 2301432
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Cu+ + 3Cyanide- = Cu(Cyanide)3-2
log_k 27.2145
delta_h -167.4 kJ
-gamma 0 0
Id: 2301433
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+ + 4Cyanide- = Cu(Cyanide)4-3
log_k 28.7145
delta_h -214.2 kJ
-gamma 0 0
Id: 2301431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + 2Cyanide- = Ag(Cyanide)2-
log_k 20.48
delta_h -137 kJ
-gamma 0 0
Id: 201432
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + 3Cyanide- = Ag(Cyanide)3-2
log_k 21.7
delta_h -140 kJ
-gamma 0 0
Id: 201433
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + H2O + Cyanide- = Ag(Cyanide)OH- + H+
log_k -0.777
delta_h 0 kJ
-gamma 0 0
Id: 201431
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + 4Cyanide- = Ni(Cyanide)4-2
log_k 30.2
delta_h -180 kJ
-gamma 0 0
Id: 5401431
log K source: NIST46.4
Delta H source: NIST46.4

#T and ionic strength: 0.00 25.0
Ni+2 + 4Cyanide- + H+ = NiH(Cyanide)4-
log_k 36.0289
delta_h 0 kJ
-gamma 0 0
Id: 5401432
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
Ni+2 + 4Cyanide- + 2H+ = NiH2Cyanide4
log_k 40.7434
delta_h 0 kJ
-gamma 0 0
Id: 5401433
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
Ni+2 + 4Cyanide- + 3H+ = NiH3(Cyanide)4+
log_k 43.3434
delta_h 0 kJ
-gamma 0 0
Id: 5401434
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
Co+2 + 3Cyanide- = Co(Cyanide)3-
log_k 14.312
delta_h 0 kJ
-gamma 0 0
Id: 2001431
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Co+2 + 5Cyanide- = Co(Cyanide)5-3
log_k 23
delta_h -257 kJ
-gamma 0 0
Id: 2001432
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 1.00 25.0
Fe+2 + 6Cyanide- = Fe(Cyanide)6-4
log_k 35.4
delta_h -358 kJ
-gamma 0 0
Id: 2801431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H+ + Fe+2 + 6Cyanide- = HFe(Cyanide)6-3
log_k 39.71
delta_h -356 kJ
-gamma 0 0
Id: 2801432

log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
2H+ + Fe+2 + 6Cyanide- = H2Fe(Cyanide)6-2
log_k 42.11
delta_h -352 kJ
-gamma 0 0
Id: 2801433
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Fe+3 + 6Cyanide- = Fe(Cyanide)6-3
log_k 43.6
delta_h -293 kJ
-gamma 0 0
Id: 2811431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
2Fe+3 + 6Cyanide- = Fe2(Cyanide)6
log_k 47.6355
delta_h -218 kJ
-gamma 0 0
Id: 2811432
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Sn(OH)2 + Fe+3 + 6Cyanide- + 2H+ = SnFe(Cyanide)6- + 2H2O
log_k 53.54
delta_h 0 kJ
-gamma 0 0
Id: 7901431
log K source: Ba1987
Delta H source:
#T and ionic strength: 0.00 25.0
NH4+ + Fe+2 + 6Cyanide- = NH4Fe(Cyanide)6-3
log_k 37.7
delta_h -354 kJ
-gamma 0 0
Id: 4901431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Tl+ + Fe+2 + 6Cyanide- = TlFe(Cyanide)6-3
log_k 38.4
delta_h -365.5 kJ
-gamma 0 0
Id: 8701432
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Mg+2 + Fe+3 + 6Cyanide- = MgFe(Cyanide)6-
log_k 46.39
delta_h -290 kJ

-gamma 0 0
Id: 4601431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Mg+2 + Fe+2 + 6Cyanide- = MgFe(Cyanide)6-2
log_k 39.21
delta_h -346 kJ
-gamma 0 0
Id: 4601432
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ca+2 + Fe+3 + 6Cyanide- = CaFe(Cyanide)6-
log_k 46.43
delta_h -291 kJ
-gamma 0 0
Id: 1501431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ca+2 + Fe+2 + 6Cyanide- = CaFe(Cyanide)6-2
log_k 39.1
delta_h -347 kJ
-gamma 0 0
Id: 1501432
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
2Ca+2 + Fe+2 + 6Cyanide- = Ca2Fe(Cyanide)6
log_k 40.6
delta_h -350.201 kJ
-gamma 0 0
Id: 1501433
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Sr+2 + Fe+3 + 6Cyanide- = SrFe(Cyanide)6-
log_k 46.45
delta_h -292 kJ
-gamma 0 0
Id: 8001431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sr+2 + Fe+2 + 6Cyanide- = SrFe(Cyanide)6-2
log_k 39.1
delta_h -350 kJ
-gamma 0 0
Id: 8001432
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + Fe+2 + 6Cyanide- = BaFe(Cyanide)6-2

log_k 39.19
delta_h -342 kJ
-gamma 0 0
Id: 1001430
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + Fe+3 + 6Cyanide- = BaFe(Cyanide)6-
log_k 46.48
delta_h -292 kJ
-gamma 0 0
Id: 1001431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Na+ + Fe+2 + 6Cyanide- = NaFe(Cyanide)6-3
log_k 37.6
delta_h -354 kJ
-gamma 0 0
Id: 5001431
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
K+ + Fe+2 + 6Cyanide- = KFe(Cyanide)6-3
log_k 37.75
delta_h -353.9 kJ
-gamma 0 0
Id: 4101433
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
K+ + Fe+3 + 6Cyanide- = KFe(Cyanide)6-2
log_k 45.04
delta_h -291 kJ
-gamma 0 0
Id: 4101430
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H+ + PO4-3 = HPO4-2
log_k 12.375
delta_h -15 kJ
-gamma 5 0
Id: 3305800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
2H+ + PO4-3 = H2PO4-
log_k 19.573
delta_h -18 kJ
-gamma 5.4 0
Id: 3305801
log K source: NIST46.3
Delta H source: NIST46.3

#T and ionic strength: 0.00 25.0
3H+ + PO4-3 = H3PO4
log_k 21.721
delta_h -10.1 kJ
-gamma 0 0
Id: 3305802
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Co+2 + H+ + PO4-3 = CoHPO4
log_k 15.4128
delta_h 0 kJ
-gamma 0 0
Id: 2005800
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
Fe+2 + 2H+ + PO4-3 = FeH2PO4+
log_k 22.273
delta_h 0 kJ
-gamma 5.4 0
Id: 2805800
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Fe+2 + H+ + PO4-3 = FeHPO4
log_k 15.975
delta_h 0 kJ
-gamma 0 0
Id: 2805801
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Fe+3 + 2H+ + PO4-3 = FeH2PO4+2
log_k 23.8515
delta_h 0 kJ
-gamma 5.4 0
Id: 2815801
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Fe+3 + H+ + PO4-3 = FeHPO4+
log_k 22.292
delta_h -30.5432 kJ
-gamma 5.4 0
Id: 2815800
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Cr(OH)2+ + 4H+ + PO4-3 = CrH2PO4+2 + 2H2O
log_k 31.9068
delta_h 0 kJ
-gamma 0 0
Id: 2115800

log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
U+4 + PO4-3 + H+ = UHPO4+2
log_k 24.443
delta_h 31.38 kJ
-gamma 0 0
Id: 8915800
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 2PO4-3 + 2H+ = U(HPO4)2
log_k 46.833
delta_h 7.1128 kJ
-gamma 0 0
Id: 8915801
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 3PO4-3 + 3H+ = U(HPO4)3-2
log_k 67.564
delta_h -32.6352 kJ
-gamma 0 0
Id: 8915802
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 4PO4-3 + 4H+ = U(HPO4)4-4
log_k 88.483
delta_h -110.876 kJ
-gamma 0 0
Id: 8915803
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + H+ + PO4-3 = UO2HPO4
log_k 19.655
delta_h -8.7864 kJ
-gamma 0 0
Id: 8935800
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
UO2+2 + 2PO4-3 + 2H+ = UO2(HPO4)2-2
log_k 42.988
delta_h -47.6934 kJ
-gamma 0 0
Id: 8935801
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + 2H+ + PO4-3 = UO2H2PO4+
log_k 22.833
delta_h -15.4808 kJ

-gamma 0 0
Id: 8935802
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
UO2+2 + 2PO4-3 + 4H+ = UO2(H2PO4)2
log_k 44.7
delta_h -69.036 kJ
-gamma 0 0
Id: 8935803
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + 3PO4-3 + 6H+ = UO2(H2PO4)3-
log_k 66.245
delta_h -119.662 kJ
-gamma 0 0
Id: 8935804
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + PO4-3 = UO2PO4-
log_k 13.25
delta_h 0 kJ
-gamma 0 0
Id: 8935805
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mg+2 + PO4-3 = MgPO4-
log_k 4.654
delta_h 12.9704 kJ
-gamma 5.4 0
Id: 4605800
log K source: SCD3.02 (1993 GMa)
Delta H source: MTQ3.11
#T and ionic strength: 0.20 25.0
Mg+2 + 2H+ + PO4-3 = MgH2PO4+
log_k 21.2561
delta_h -4.6861 kJ
-gamma 5.4 0
Id: 4605801
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 37.0
Mg+2 + H+ + PO4-3 = MgHPO4
log_k 15.175
delta_h -3 kJ
-gamma 0 0
Id: 4605802
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ca+2 + H+ + PO4-3 = CaHPO4

log_k 15.035
delta_h -3 kJ
-gamma 0 0
Id: 1505800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ca+2 + PO4-3 = CaPO4-
log_k 6.46
delta_h 12.9704 kJ
-gamma 5.4 0
Id: 1505801
log K source: SCD3.02 (1993 GMa)
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ca+2 + 2H+ + PO4-3 = CaH2PO4+
log_k 20.923
delta_h -6 kJ
-gamma 5.4 0
Id: 1505802
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Sr+2 + H+ + PO4-3 = SrHPO4
log_k 14.8728
delta_h 0 kJ
-gamma 0 0
Id: 8005800
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
Sr+2 + 2H+ + PO4-3 = SrH2PO4+
log_k 20.4019
delta_h 0 kJ
-gamma 0 0
Id: 8005801
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 20.0
Na+ + H+ + PO4-3 = NaHPO4-
log_k 13.445
delta_h 0 kJ
-gamma 5.4 0
Id: 5005800
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
K+ + H+ + PO4-3 = KHPO4-
log_k 13.255
delta_h 0 kJ
-gamma 5.4 0
Id: 4105800
log K source: NIST46.3
Delta H source: MTQ3.11

#T and ionic strength: 0.00 25.0
H3AsO3 = AsO3-3 + 3H+
log_k -34.744
delta_h 84.726 kJ
-gamma 0 0
Id: 3300602
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
H3AsO3 = HAsO3-2 + 2H+
log_k -21.33
delta_h 59.4086 kJ
-gamma 0 0
Id: 3300601
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
H3AsO3 = H2AsO3- + H+
log_k -9.29
delta_h 27.41 kJ
-gamma 0 0
Id: 3300600
log K source: NIST46.4
Delta H source: NIST2.1.1
#T and ionic strength: 0.00 25.0
H3AsO3 + H+ = H4AsO3+
log_k -0.305
delta_h 0 kJ
-gamma 0 0
Id: 3300603
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
H3AsO4 = AsO4-3 + 3H+
log_k -20.7
delta_h 12.9 kJ
-gamma 0 0
Id: 3300613
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H3AsO4 = HAsO4-2 + 2H+
log_k -9.2
delta_h -4.1 kJ
-gamma 0 0
Id: 3300612
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H3AsO4 = H2AsO4- + H+
log_k -2.24
delta_h -7.1 kJ
-gamma 0 0
Id: 3300611

log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sb(OH)3 + H2O = Sb(OH)4- + H+
log_k -12.0429
delta_h 69.8519 kJ
-gamma 0 0
Id: 7400020
log K source: PNL89
Delta H source: PNL89
#T and ionic strength:
Sb(OH)3 + H+ = Sb(OH)2+ + H2O
log_k 1.3853
delta_h 0 kJ
-gamma 0 0
Id: 7403302
log K source: PNL89
Delta H source: PNL89
#T and ionic strength:
Sb(OH)3 = HSbO2 + H2O
log_k -0.0105
delta_h -0.13 kJ
-gamma 0 0
Id: 7400021
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Sb(OH)3 = SbO2- + H2O + H+
log_k -11.8011
delta_h 70.1866 kJ
-gamma 0 0
Id: 7403301
log K source: PNL89
Delta H source: PNL89
#T and ionic strength:
Sb(OH)3 + H+ = SbO+ + 2H2O
log_k 0.9228
delta_h 8.2425 kJ
-gamma 0 0
Id: 7403300
log K source: PNL89
Delta H source: PNL89
#T and ionic strength:
Sb(OH)6- = SbO3- + 3H2O
log_k 2.9319
delta_h 0 kJ
-gamma 0 0
Id: 7410021
log K source: PNL89
Delta H source: PNL89
#T and ionic strength:
Sb(OH)6- + 2H+ = SbO2+ + 4H2O
log_k 2.3895
delta_h 0 kJ

-gamma 0 0
Id: 7413300
log K source: PNL89
Delta H source: PNL89
#T and ionic strength:
H+ + CO3-2 = HCO3-
log_k 10.329
delta_h -14.6 kJ
-gamma 5.4 0
Id: 3301400
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
2H+ + CO3-2 = H2CO3
log_k 16.681
delta_h -23.76 kJ
-gamma 0 0
Id: 3301401
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Pb+2 + 2CO3-2 = Pb(CO3)2-2
log_k 9.938
delta_h 0 kJ
-gamma 0 0
Id: 6001400
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Pb+2 + CO3-2 = PbCO3
log_k 6.478
delta_h 0 kJ
-gamma 0 0
Id: 6001401
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Pb+2 + CO3-2 + H+ = PbHCO3+
log_k 13.2
delta_h 0 kJ
-gamma 0 0
Id: 6001402
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + CO3-2 = ZnCO3
log_k 4.76
delta_h 0 kJ
-gamma 0 0
Id: 9501401
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + H+ + CO3-2 = ZnHCO3+

log_k 11.829
delta_h 0 kJ
-gamma 0 0
Id: 9501400
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + CO3-2 = HgCO3 + 2H2O
log_k 18.272
delta_h 0 kJ
-gamma 0 0
Id: 3611401
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 2CO3-2 = Hg(CO3)2-2 + 2H2O
log_k 21.772
delta_h 0 kJ
-gamma 0 0
Id: 3611402
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 3H+ + CO3-2 = HgHCO3+ + 2H2O
log_k 22.542
delta_h 0 kJ
-gamma 0 0
Id: 3611403
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Cd+2 + CO3-2 = CdCO3
log_k 4.3578
delta_h 0 kJ
-gamma 0 0
Id: 1601401
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
Cd+2 + H+ + CO3-2 = CdHCO3+
log_k 10.6863
delta_h 0 kJ
-gamma 0 0
Id: 1601400
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Cd+2 + 2CO3-2 = Cd(CO3)2-2
log_k 7.2278
delta_h 0 kJ
-gamma 0 0
Id: 1601403
log K source: NIST46.4
Delta H source: MTQ3.11

#T and ionic strength: 0.10 20.0
Cu+2 + CO3-2 = CuCO3
log_k 6.77
delta_h 0 kJ
-gamma 0 0
Id: 2311400
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+2 + H+ + CO3-2 = CuHCO3+
log_k 12.129
delta_h 0 kJ
-gamma 0 0
Id: 2311402
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+2 + 2CO3-2 = Cu(CO3)2-2
log_k 10.2
delta_h 0 kJ
-gamma 0 0
Id: 2311401
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + CO3-2 = NiCO3
log_k 4.5718
delta_h 0 kJ
-gamma 0 0
Id: 5401401
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.70 25.0
Ni+2 + H+ + CO3-2 = NiHCO3+
log_k 12.4199
delta_h 0 kJ
-gamma 0 0
Id: 5401400
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.70 25.0
Co+2 + CO3-2 = CoCO3
log_k 4.228
delta_h 0 kJ
-gamma 0 0
Id: 2001400
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Co+2 + H+ + CO3-2 = CoHCO3+
log_k 12.2199
delta_h 0 kJ
-gamma 0 0
Id: 2001401

log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.70 25.0
Fe+2 + H+ + CO3-2 = FeHCO3+
log_k 11.429
delta_h 0 kJ
-gamma 6 0
Id: 2801400
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mn+2 + H+ + CO3-2 = MnHCO3+
log_k 11.629
delta_h -10.6 kJ
-gamma 5 0
Id: 4701400
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
UO2+2 + CO3-2 = UO2CO3
log_k 9.6
delta_h 4 kJ
-gamma 0 0
Id: 8931400
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + 2CO3-2 = UO2(CO3)2-2
log_k 16.9
delta_h 16 kJ
-gamma 0 0
Id: 8931401
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + 3CO3-2 = UO2(CO3)3-4
log_k 21.6
delta_h -40 kJ
-gamma 0 0
Id: 8931402
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Be+2 + CO3-2 = BeCO3
log_k 6.2546
delta_h 0 kJ
-gamma 0 0
Id: 1101401
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Mg+2 + CO3-2 = MgCO3
log_k 2.92
delta_h 12 kJ

-gamma 0 0
Id: 4601400
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Mg+2 + H+ + CO3-2 = MgHCO3+
log_k 11.339
delta_h -10.6 kJ
-gamma 4 0
Id: 4601401
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ca+2 + H+ + CO3-2 = CaHCO3+
log_k 11.599
delta_h 5.4 kJ
-gamma 6 0
Id: 1501400
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
CO3-2 + Ca+2 = CaCO3
log_k 3.2
delta_h 16 kJ
-gamma 0 0
Id: 1501401
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Sr+2 + CO3-2 = SrCO3
log_k 2.81
delta_h 20 kJ
-gamma 0 0
Id: 8001401
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sr+2 + H+ + CO3-2 = SrHCO3+
log_k 11.539
delta_h 10.4 kJ
-gamma 6 0
Id: 8001400
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + CO3-2 = BaCO3
log_k 2.71
delta_h 16 kJ
-gamma 0 0
Id: 1001401
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + H+ + CO3-2 = BaHCO3+

log_k 11.309
delta_h 10.4 kJ
-gamma 6 0
Id: 1001400
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Na+ + CO3-2 = NaCO3-
log_k 1.27
delta_h -20.35 kJ
-gamma 5.4 0
Id: 5001400
log K source: NIST46.3
Delta H source: NIST2.1.1
#T and ionic strength: 0.00 25.0
Na+ + H+ + CO3-2 = NaHCO3
log_k 10.079
delta_h -28.3301 kJ
-gamma 0 0
Id: 5001401
log K source: NIST46.3
Delta H source: NIST2.1.1
#T and ionic strength: 0.00 25.0
H4SiO4 = H2SiO4-2 + 2H+
log_k -23.04
delta_h 61 kJ
-gamma 5.4 0
Id: 3307701
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H4SiO4 = H3SiO4- + H+
log_k -9.84
delta_h 20 kJ
-gamma 4 0
Id: 3307700
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
UO2+2 + H4SiO4 = UO2H3SiO4+ + H+
log_k -1.9111
delta_h 0 kJ
-gamma 0 0
Id: 8937700
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
H3BO3 = H2BO3- + H+
log_k -9.236
delta_h 13 kJ
-gamma 2.5 0
Id: 3300900
log K source: NIST46.4
Delta H source: NIST46.4

#T and ionic strength: 0.00 25.0
2H3BO3 = H5(BO3)2- + H+
log_k -9.306
delta_h 8.4 kJ
-gamma 2.5 0
Id: 3300901
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
3H3BO3 = H8(BO3)3- + H+
log_k -7.306
delta_h 29.4 kJ
-gamma 2.5 0
Id: 3300902
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + H3BO3 = AgH2BO3 + H+
log_k -8.036
delta_h 0 kJ
-gamma 2.5 0
Id: 200901
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mg+2 + H3BO3 = MgH2BO3+ + H+
log_k -7.696
delta_h 13 kJ
-gamma 2.5 0
Id: 4600901
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ca+2 + H3BO3 = CaH2BO3+ + H+
log_k -7.476
delta_h 17 kJ
-gamma 2.5 0
Id: 1500901
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sr+2 + H3BO3 = SrH2BO3+ + H+
log_k -7.686
delta_h 17 kJ
-gamma 2.5 0
Id: 8000901
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + H3BO3 = BaH2BO3+ + H+
log_k -7.746
delta_h 17 kJ
-gamma 2.5 0
Id: 1000901

log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Na+ + H3BO3 = NaH2BO3 + H+
log_k -9.036
delta_h 0 kJ
-gamma 2.5 0
Id: 5000901
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
CrO4-2 + H+ = HCrO4-
log_k 6.51
delta_h 2 kJ
-gamma 0 0
Id: 2123300
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
CrO4-2 + 2H+ = H2CrO4
log_k 6.4188
delta_h 39 kJ
-gamma 0 0
Id: 2123301
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 20.0
2CrO4-2 + 2H+ = Cr2O7-2 + H2O
log_k 14.56
delta_h -15 kJ
-gamma 0 0
Id: 2123302
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
CrO4-2 + Cl- + 2H+ = CrO3Cl- + H2O
log_k 7.3086
delta_h 0 kJ
-gamma 0 0
Id: 2121800
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
CrO4-2 + SO4-2 + 2H+ = CrO3SO4-2 + H2O
log_k 8.9937
delta_h 0 kJ
-gamma 0 0
Id: 2127320
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
CrO4-2 + 4H+ + PO4-3 = CrO3H2PO4- + H2O
log_k 29.3634
delta_h 0 kJ

-gamma 0 0
Id: 2125800
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
CrO4-2 + 3H+ + PO4-3 = CrO3HPO4-2 + H2O
log_k 26.6806
delta_h 0 kJ
-gamma 0 0
Id: 2125801
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
CrO4-2 + Na+ = NaCrO4-
log_k 0.6963
delta_h 0 kJ
-gamma 0 0
Id: 5002120
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
K+ + CrO4-2 = KCrO4-
log_k 0.57
delta_h 0 kJ
-gamma 0 0
Id: 4102120
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 18.0
MoO4-2 + H+ = HMoO4-
log_k 4.2988
delta_h 20 kJ
-gamma 0 0
Id: 3304801
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 20.0
MoO4-2 + 2H+ = H2MoO4
log_k 8.1636
delta_h -26 kJ
-gamma 0 0
Id: 3304802
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 20.0
7MoO4-2 + 8H+ = Mo7O24-6 + 4H2O
log_k 52.99
delta_h -228 kJ
-gamma 0 0
Id: 3304803
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
7MoO4-2 + 9H+ = HMo7O24-5 + 4H2O

log_k 59.3768
delta_h -218 kJ
-gamma 0 0
Id: 3304804
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
7MoO4-2 + 10H+ = H2Mo7O24-4 + 4H2O
log_k 64.159
delta_h -215 kJ
-gamma 0 0
Id: 3304805
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
7MoO4-2 + 11H+ = H3Mo7O24-3 + 4H2O
log_k 67.405
delta_h -217 kJ
-gamma 0 0
Id: 3304806
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 1.00 25.0
6MoO4-2 + Al+3 + 6H+ = AlMo6O21-3 + 3H2O
log_k 54.9925
delta_h 0 kJ
-gamma 0 0
Id: 304801
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
MoO4-2 + 2Ag+ = Ag2MoO4
log_k -0.4219
delta_h -1.18 kJ
-gamma 0 0
Id: 204801
log K source: Bard85
Delta H source: Bard85
#T and ionic strength:
VO2+ + 2H2O = VO4-3 + 4H+
log_k -30.2
delta_h -25 kJ
-gamma 0 0
Id: 9033303
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
VO2+ + 2H2O = HVO4-2 + 3H+
log_k -15.9
delta_h 0 kJ
-gamma 0 0
Id: 9033302
log K source: NIST46.3
Delta H source: NIST46.3

#T and ionic strength: 0.00 25.0
VO2+ + 2H2O = H2VO4- + 2H+
log_k -7.3
delta_h 0 kJ
-gamma 0 0
Id: 9033301
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
VO2+ + 2H2O = H3VO4 + H+
log_k -3.3
delta_h 44.4759 kJ
-gamma 0 0
Id: 9033300
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
2VO2+ + 3H2O = V2O7-4 + 6H+
log_k -31.24
delta_h -28 kJ
-gamma 0 0
Id: 9030020
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
2VO2+ + 3H2O = HV2O7-3 + 5H+
log_k -20.67
delta_h 0 kJ
-gamma 0 0
Id: 9030021
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2VO2+ + 3H2O = H3V2O7- + 3H+
log_k -3.79
delta_h 0 kJ
-gamma 0 0
Id: 9030022
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
3VO2+ + 3H2O = V3O9-3 + 6H+
log_k -15.88
delta_h 0 kJ
-gamma 0 0
Id: 9030023
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
4VO2+ + 4H2O = V4O12-4 + 8H+
log_k -20.56
delta_h -87 kJ
-gamma 0 0
Id: 9030024

log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
10VO2+ + 8H2O = V10O28-6 + 16H+
log_k -24.0943
delta_h 0 kJ
-gamma 0 0
Id: 9030025
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 20.0
10VO2+ + 8H2O = HV10O28-5 + 15H+
log_k -15.9076
delta_h 90.0397 kJ
-gamma 0 0
Id: 9030026
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.10 20.0
10VO2+ + 8H2O = H2V10O28-4 + 14H+
log_k -10.7
delta_h 0 kJ
-gamma 0 0
Id: 9030027
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Benzoate- + H+ = H(Benzoate)
log_k 4.202
delta_h -0.4602 kJ
-gamma 0 0
Id: 3309171
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Pb+2 = Pb(Benzoate)+
log_k 2.4
delta_h 0 kJ
-gamma 0 0
Id: 6009171
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Al+3 = Al(Benzoate)+2
log_k 2.05
delta_h 0 kJ
-gamma 0 0
Id: 309171
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Al+3 + H2O = AlOH(Benzoate)+ + H+
log_k -0.56
delta_h 0 kJ

-gamma 0 0
Id: 309172
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Zn+2 = Zn(Benzoate)+
log_k 1.7
delta_h 0 kJ
-gamma 0 0
Id: 9509171
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Benzoate- + Cd+2 = Cd(Benzoate)+
log_k 1.8
delta_h 0 kJ
-gamma 0 0
Id: 1609171
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2Benzoate- + Cd+2 = Cd(Benzoate)2
log_k 1.82
delta_h 0 kJ
-gamma 0 0
Id: 1609172
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Benzoate- + Cu+2 = Cu(Benzoate)+
log_k 2.19
delta_h 0 kJ
-gamma 0 0
Id: 2319171
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Ag+ = Ag(Benzoate)
log_k 0.91
delta_h 0 kJ
-gamma 0 0
Id: 209171
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Ni+2 = Ni(Benzoate)+
log_k 1.86
delta_h 0 kJ
-gamma 0 0
Id: 5409171
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Co+2 + Benzoate- = Co(Benzoate)+

log_k 1.0537
delta_h 12 kJ
-gamma 0 0
Id: 2009171
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 30.0
Benzoate- + Mn+2 = Mn(Benzoate)+
log_k 2.06
delta_h 0 kJ
-gamma 0 0
Id: 4709171
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Mg+2 = Mg(Benzoate)+
log_k 1.26
delta_h 0 kJ
-gamma 0 0
Id: 4609171
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Benzoate- + Ca+2 = Ca(Benzoate)+
log_k 1.55
delta_h 0 kJ
-gamma 0 0
Id: 1509171
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Phenylacetate- + H+ = H(Phenylacetate)
log_k 4.31
delta_h 2.1757 kJ
-gamma 0 0
Id: 3309181
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Phenylacetate- + Zn+2 = Zn(Phenylacetate)+
log_k 1.57
delta_h 0 kJ
-gamma 0 0
Id: 9509181
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Phenylacetate- + Cu+2 = Cu(Phenylacetate)+
log_k 1.97
delta_h 0 kJ
-gamma 0 0
Id: 2319181
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
Co+2 + Phenylacetate- = Co(Phenylacetate)+
log_k 0.591
delta_h 0 kJ
-gamma 0 0
Id: 2009181
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Co+2 + 2Phenylacetate- = Co(Phenylacetate)2
log_k 0.4765
delta_h 0 kJ
-gamma 0 0
Id: 2009182
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Isophthalate-2 + H+ = H(Isophthalate)-
log_k 4.5
delta_h 1.6736 kJ
-gamma 0 0
Id: 3309201
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + 2H+ = H2(Isophthalate)
log_k 8
delta_h 1.6736 kJ
-gamma 0 0
Id: 3309202
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Pb+2 = Pb(Isophthalate)
log_k 2.99
delta_h 0 kJ
-gamma 0 0
Id: 6009201
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2Isophthalate-2 + Pb+2 = Pb(Isophthalate)2-2
log_k 4.18
delta_h 0 kJ
-gamma 0 0
Id: 6009202
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Pb+2 + H+ = PbH(Isophthalate)+
log_k 6.69
delta_h 0 kJ
-gamma 0 0
Id: 6009203

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Cd+2 = Cd(Isophthalate)
log_k 2.15
delta_h 0 kJ
-gamma 0 0
Id: 1609201
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2Isophthalate-2 + Cd+2 = Cd(Isophthalate)2-2
log_k 2.99
delta_h 0 kJ
-gamma 0 0
Id: 1609202
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Cd+2 + H+ = CdH(Isophthalate)+
log_k 5.73
delta_h 0 kJ
-gamma 0 0
Id: 1609203
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Ca+2 = Ca(Isophthalate)
log_k 2
delta_h 0 kJ
-gamma 0 0
Id: 1509200
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Ba+2 = Ba(Isophthalate)
log_k 1.55
delta_h 0 kJ
-gamma 0 0
Id: 1009201
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Diethylamine = H(Diethylamine)+
log_k 10.933
delta_h -53.1368 kJ
-gamma 0 0
Id: 3309551
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Diethylamine = Zn(Diethylamine)+2
log_k 2.74
delta_h 0 kJ

-gamma 0 0
Id: 9509551
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 2Diethylamine = Zn(Diethylamine)2+2
log_k 5.27
delta_h 0 kJ
-gamma 0 0
Id: 9509552
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 3Diethylamine = Zn(Diethylamine)3+2
log_k 7.71
delta_h 0 kJ
-gamma 0 0
Id: 9509553
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 4Diethylamine = Zn(Diethylamine)4+2
log_k 9.84
delta_h 0 kJ
-gamma 0 0
Id: 9509554
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + Diethylamine = Cd(Diethylamine)+2
log_k 2.73
delta_h 0 kJ
-gamma 0 0
Id: 1609551
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 2Diethylamine = Cd(Diethylamine)2+2
log_k 4.86
delta_h 0 kJ
-gamma 0 0
Id: 1609552
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 3Diethylamine = Cd(Diethylamine)3+2
log_k 6.37
delta_h 0 kJ
-gamma 0 0
Id: 1609553
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 4Diethylamine = Cd(Diethylamine)4+2

log_k 7.32
delta_h 0 kJ
-gamma 0 0
Id: 1609554
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ag+ + Diethylamine = Ag(Diethylamine)+
log_k 2.98
delta_h 0 kJ
-gamma 0 0
Id: 209551
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Diethylamine = Ag(Diethylamine)2+
log_k 6.38
delta_h -44.7688 kJ
-gamma 0 0
Id: 209552
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Diethylamine = Ni(Diethylamine)+2
log_k 2.78
delta_h 0 kJ
-gamma 0 0
Id: 5409551
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 2Diethylamine = Ni(Diethylamine)2+2
log_k 4.97
delta_h 0 kJ
-gamma 0 0
Id: 5409552
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 3Diethylamine = Ni(Diethylamine)3+2
log_k 6.72
delta_h 0 kJ
-gamma 0 0
Id: 5409553
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 4Diethylamine = Ni(Diethylamine)4+2
log_k 7.93
delta_h 0 kJ
-gamma 0 0
Id: 5409554
log K source: SCD2.62
Delta H source: SCD2.62

#T and ionic strength:
Ni+2 + 5Diethylamine = Ni(Diethylamine)5+2
log_k 8.87
delta_h 0 kJ
-gamma 0 0
Id: 5409555
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
H+ + Butylamine = H(Butylamine)+
log_k 10.64
delta_h -58.2831 kJ
-gamma 0 0
Id: 3309561
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Butylamine + 2H+ = Hg(Butylamine)+2 + 2H2O
log_k 14.84
delta_h 0 kJ
-gamma 0 0
Id: 3619561
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 2Butylamine + 2H+ = Hg(Butylamine)2+2 + 2H2O
log_k 24.24
delta_h 0 kJ
-gamma 0 0
Id: 3619562
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 3Butylamine + 2H+ = Hg(Butylamine)3+2 + 2H2O
log_k 25.1
delta_h 0 kJ
-gamma 0 0
Id: 3619563
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 4Butylamine + 2H+ = Hg(Butylamine)4+2 + 2H2O
log_k 26.1
delta_h 0 kJ
-gamma 0 0
Id: 3619564
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Butylamine = Ag(Butylamine)+
log_k 3.42
delta_h -16.736 kJ
-gamma 0 0
Id: 209561

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Butylamine = Ag(Butylamine)2+
log_k 7.47
delta_h -52.7184 kJ
-gamma 0 0
Id: 209562
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Methylamine = H(Methylamine)+
log_k 10.64
delta_h -55.2288 kJ
-gamma 0 0
Id: 3309581
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Methylamine = Cd(Methylamine)+2
log_k 2.75
delta_h 0 kJ
-gamma 0 0
Id: 1609581
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Methylamine = Cd(Methylamine)2+2
log_k 4.81
delta_h -29.288 kJ
-gamma 0 0
Id: 1609582
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 3Methylamine = Cd(Methylamine)3+2
log_k 5.94
delta_h 0 kJ
-gamma 0 0
Id: 1609583
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 4Methylamine = Cd(Methylamine)4+2
log_k 6.55
delta_h -58.576 kJ
-gamma 0 0
Id: 1609584
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Methylamine + 2H+ = Hg(Methylamine)+2 + 2H2O
log_k 14.76
delta_h 0 kJ

-gamma 0 0
Id: 3619581
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 2Methylamine + 2H+ = Hg(Methylamine)2+2 + 2H2O
log_k 23.96
delta_h 0 kJ
-gamma 0 0
Id: 3619582
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 3Methylamine + 2H+ = Hg(Methylamine)3+2 + 2H2O
log_k 24.3
delta_h 0 kJ
-gamma 0 0
Id: 3619583
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 4Methylamine + 2H+ = Hg(Methylamine)4+2 + 2H2O
log_k 24.6
delta_h 0 kJ
-gamma 0 0
Id: 3619584
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Methylamine = Cu(Methylamine)+2
log_k 4.11
delta_h 0 kJ
-gamma 0 0
Id: 2319581
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Methylamine = Cu(Methylamine)2+2
log_k 7.51
delta_h 0 kJ
-gamma 0 0
Id: 2319582
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 3Methylamine = Cu(Methylamine)3+2
log_k 10.21
delta_h 0 kJ
-gamma 0 0
Id: 2319583
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 4Methylamine = Cu(Methylamine)4+2

log_k 12.08
delta_h 0 kJ
-gamma 0 0
Id: 2319584
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Methylamine = Ag(Methylamine)+
log_k 3.07
delta_h -12.552 kJ
-gamma 0 0
Id: 209581
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Methylamine = Ag(Methylamine)2+
log_k 6.89
delta_h -48.9528 kJ
-gamma 0 0
Id: 209582
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Methylamine = Ni(Methylamine)+2
log_k 2.23
delta_h 0 kJ
-gamma 0 0
Id: 5409581
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Dimethylamine = H(Dimethylamine)+
log_k 10.774
delta_h -50.208 kJ
-gamma 0 0
Id: 3309591
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Dimethylamine = Ag(Dimethylamine)2+
log_k 5.37
delta_h -40.5848 kJ
-gamma 0 0
Id: 209591
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Dimethylamine = Ni(Dimethylamine)+2
log_k 1.47
delta_h 0 kJ
-gamma 0 0
Id: 5409591
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
H+ + Hexylamine = H(Hexylamine)+
log_k 10.63
delta_h -58.576 kJ
-gamma 0 0
Id: 3309611
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Hexylamine = Ag(Hexylamine)+
log_k 3.54
delta_h -25.104 kJ
-gamma 0 0
Id: 209611
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Hexylamine = Ag(Hexylamine)2+
log_k 7.55
delta_h -53.1368 kJ
-gamma 0 0
Id: 209612
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Ethylenediamine = H(Ethylenediamine)+
log_k 9.928
delta_h -49.7896 kJ
-gamma 0 0
Id: 3309631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2H+ + Ethylenediamine = H2(Ethylenediamine)+2
log_k 16.776
delta_h -95.3952 kJ
-gamma 0 0
Id: 3309632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Ethylenediamine = Pb(Ethylenediamine)+2
log_k 5.04
delta_h 0 kJ
-gamma 0 0
Id: 6009631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + 2Ethylenediamine = Pb(Ethylenediamine)2+2
log_k 8.5
delta_h 0 kJ
-gamma 0 0
Id: 6009632

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Ethylenediamine = Zn(Ethylenediamine)+2
log_k 5.66
delta_h -29.288 kJ
-gamma 0 0
Id: 9509631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Ethylenediamine = Zn(Ethylenediamine)2+2
log_k 10.6
delta_h -48.116 kJ
-gamma 0 0
Id: 9509632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 3Ethylenediamine = Zn(Ethylenediamine)3+2
log_k 13.9
delta_h -71.5464 kJ
-gamma 0 0
Id: 9509633
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Ethylenediamine = Cd(Ethylenediamine)+2
log_k 5.41
delta_h -28.4512 kJ
-gamma 0 0
Id: 1609631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Ethylenediamine = Cd(Ethylenediamine)2+2
log_k 9.9
delta_h -55.6472 kJ
-gamma 0 0
Id: 1609632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 3Ethylenediamine = Cd(Ethylenediamine)3+2
log_k 11.6
delta_h -82.4248 kJ
-gamma 0 0
Id: 1609633
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Ethylenediamine + 2H+ = Hg(Ethylenediamine)+2 + 2H2O
log_k 20.4
delta_h 0 kJ

-gamma 0 0
Id: 3619631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 2Ethylenediamine + 2H+ = Hg(Ethylenediamine)2+2 + 2H2O
log_k 29.3
delta_h -173.218 kJ
-gamma 0 0
Id: 3619632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 2Ethylenediamine + 3H+ = HgH(Ethylenediamine)2+3 + 2H2O
log_k 34.7
delta_h 0 kJ
-gamma 0 0
Id: 3619633
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 2Ethylenediamine = Cu(Ethylenediamine)2+
log_k 11.2
delta_h 0 kJ
-gamma 0 0
Id: 2309631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Ethylenediamine = Cu(Ethylenediamine)+2
log_k 10.5
delta_h -52.7184 kJ
-gamma 0 0
Id: 2319631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Ethylenediamine = Cu(Ethylenediamine)2+2
log_k 19.6
delta_h -105.437 kJ
-gamma 0 0
Id: 2319632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Ethylenediamine = Ag(Ethylenediamine)+
log_k 4.6
delta_h -48.9528 kJ
-gamma 0 0
Id: 209631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Ethylenediamine = Ag(Ethylenediamine)2+

log_k 7.5
delta_h -52.3 kJ
-gamma 0 0
Id: 209632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Ethylenediamine + H+ = AgH(Ethylenediamine)+2
log_k 11.99
delta_h -75.312 kJ
-gamma 0 0
Id: 209633
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2Ag+ + Ethylenediamine = Ag2(Ethylenediamine)+2
log_k 6.5
delta_h 0 kJ
-gamma 0 0
Id: 209634
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2Ag+ + 2Ethylenediamine = Ag2(Ethylenediamine)2+2
log_k 12.7
delta_h -97.0688 kJ
-gamma 0 0
Id: 209635
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Ethylenediamine + 2H+ = Ag(HEthylenediamine)2+3
log_k 24
delta_h -150.206 kJ
-gamma 0 0
Id: 209636
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Ethylenediamine + H+ = AgH(Ethylenediamine)2+2
log_k 8.4
delta_h -47.6976 kJ
-gamma 0 0
Id: 209637
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Ethylenediamine = Ni(Ethylenediamine)+2
log_k 7.32
delta_h -37.656 kJ
-gamma 0 0
Id: 5409631
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
Ni+2 + 2Ethylenediamine = Ni(Ethylenediamine)2+2
log_k 13.5
delta_h -76.5672 kJ
-gamma 0 0
Id: 5409632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 3Ethylenediamine = Ni(Ethylenediamine)3+2
log_k 17.6
delta_h -117.152 kJ
-gamma 0 0
Id: 5409633
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Ethylenediamine = Co(Ethylenediamine)+2
log_k 5.5
delta_h -28 kJ
-gamma 0 0
Id: 2009631
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + 2Ethylenediamine = Co(Ethylenediamine)2+2
log_k 10.1
delta_h -58.5 kJ
-gamma 0 0
Id: 2009632
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + 3Ethylenediamine = Co(Ethylenediamine)3+2
log_k 13.2
delta_h -92.8 kJ
-gamma 0 0
Id: 2009633
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+3 + 2Ethylenediamine = Co(Ethylenediamine)2+3
log_k 34.7
delta_h 0 kJ
-gamma 0 0
Id: 2019631
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Co+3 + 3Ethylenediamine = Co(Ethylenediamine)3+3
log_k 48.69
delta_h 0 kJ
-gamma 0 0
Id: 2019632

log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.50 30.0
Fe+2 + Ethylenediamine = Fe(Ethylenediamine)+2
log_k 4.26
delta_h 0 kJ
-gamma 0 0
Id: 2809631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + 2Ethylenediamine = Fe(Ethylenediamine)2+2
log_k 7.73
delta_h 0 kJ
-gamma 0 0
Id: 2809632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + 3Ethylenediamine = Fe(Ethylenediamine)3+2
log_k 10.17
delta_h 0 kJ
-gamma 0 0
Id: 2809633
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Ethylenediamine = Mn(Ethylenediamine)+2
log_k 2.74
delta_h -11.7152 kJ
-gamma 0 0
Id: 4709631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + 2Ethylenediamine = Mn(Ethylenediamine)2+2
log_k 4.8
delta_h -25.104 kJ
-gamma 0 0
Id: 4709632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + 2Ethylenediamine + 2H+ = Cr(Ethylenediamine)2+3 + 2H2O
log_k 22.57
delta_h 0 kJ
-gamma 0 0
Id: 2119631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + 3Ethylenediamine + 2H+ = Cr(Ethylenediamine)3+3 + 2H2O
log_k 29
delta_h 0 kJ

-gamma 0 0
Id: 2119632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Ethylenediamine = Mg(Ethylenediamine)+2
log_k 0.37
delta_h 0 kJ
-gamma 0 0
Id: 4609631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Ethylenediamine = Ca(Ethylenediamine)+2
log_k 0.11
delta_h 0 kJ
-gamma 0 0
Id: 1509631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Propylamine = H(Propylamine)+
log_k 10.566
delta_h -57.53 kJ
-gamma 0 0
Id: 3309641
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Propylamine = Zn(Propylamine)+2
log_k 2.42
delta_h 0 kJ
-gamma 0 0
Id: 9509641
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 2Propylamine = Zn(Propylamine)2+2
log_k 4.85
delta_h 0 kJ
-gamma 0 0
Id: 9509642
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 3Propylamine = Zn(Propylamine)3+2
log_k 7.38
delta_h 0 kJ
-gamma 0 0
Id: 9509643
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 4Propylamine = Zn(Propylamine)4+2

log_k 9.49
delta_h 0 kJ
-gamma 0 0
Id: 9509644
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + Propylamine = Cd(Propylamine)+2
log_k 2.62
delta_h 0 kJ
-gamma 0 0
Id: 1609641
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 2Propylamine = Cd(Propylamine)2+2
log_k 4.64
delta_h 0 kJ
-gamma 0 0
Id: 1609642
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 3Propylamine = Cd(Propylamine)3+2
log_k 6.03
delta_h 0 kJ
-gamma 0 0
Id: 1609643
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ag+ + Propylamine = Ag(Propylamine)+
log_k 3.45
delta_h -12.552 kJ
-gamma 0 0
Id: 209641
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Propylamine = Ag(Propylamine)2+
log_k 7.44
delta_h -53.1368 kJ
-gamma 0 0
Id: 209642
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Propylamine = Ni(Propylamine)+2
log_k 2.81
delta_h 0 kJ
-gamma 0 0
Id: 5409641
log K source: SCD2.62
Delta H source: SCD2.62

#T and ionic strength:
Ni+2 + 2Propylamine = Ni(Propylamine)2+2
log_k 5.02
delta_h 0 kJ
-gamma 0 0
Id: 5409642
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 3Propylamine = Ni(Propylamine)3+2
log_k 6.79
delta_h 0 kJ
-gamma 0 0
Id: 5409643
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 4Propylamine = Ni(Propylamine)4+2
log_k 8.31
delta_h 0 kJ
-gamma 0 0
Id: 5409644
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
H+ + Isopropylamine = H(Isopropylamine)+
log_k 10.67
delta_h -58.3668 kJ
-gamma 0 0
Id: 3309651
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Isopropylamine = Zn(Isopropylamine)+2
log_k 2.37
delta_h 0 kJ
-gamma 0 0
Id: 9509651
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 2Isopropylamine = Zn(Isopropylamine)2+2
log_k 4.67
delta_h 0 kJ
-gamma 0 0
Id: 9509652
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 3Isopropylamine = Zn(Isopropylamine)3+2
log_k 7.14
delta_h 0 kJ
-gamma 0 0
Id: 9509653

log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 4Isopropylamine = Zn(Isopropylamine)4+2
log_k 9.44
delta_h 0 kJ
-gamma 0 0
Id: 9509654
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + Isopropylamine = Cd(Isopropylamine)+2
log_k 2.55
delta_h 0 kJ
-gamma 0 0
Id: 1609651
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 2Isopropylamine = Cd(Isopropylamine)2+2
log_k 4.57
delta_h 0 kJ
-gamma 0 0
Id: 1609652
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 3Isopropylamine = Cd(Isopropylamine)3+2
log_k 6.07
delta_h 0 kJ
-gamma 0 0
Id: 1609653
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 4Isopropylamine = Cd(Isopropylamine)4+2
log_k 6.9
delta_h 0 kJ
-gamma 0 0
Id: 1609654
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Hg(OH)2 + Isopropylamine + 2H+ = Hg(Isopropylamine)+2 + 2H2O
log_k 14.85
delta_h 0 kJ
-gamma 0 0
Id: 3619651
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 2Isopropylamine + 2H+ = Hg(Isopropylamine)2+2 + 2H2O
log_k 24.37
delta_h 0 kJ

-gamma 0 0
Id: 3619652
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Isopropylamine = Ag(Isopropylamine)+
log_k 3.67
delta_h -23.8488 kJ
-gamma 0 0
Id: 209651
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Isopropylamine = Ag(Isopropylamine)2+
log_k 7.77
delta_h -59.8312 kJ
-gamma 0 0
Id: 209652
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Isopropylamine = Ni(Isopropylamine)+2
log_k 2.71
delta_h 0 kJ
-gamma 0 0
Id: 5409651
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 2Isopropylamine = Ni(Isopropylamine)2+2
log_k 4.86
delta_h 0 kJ
-gamma 0 0
Id: 5409652
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 3Isopropylamine = Ni(Isopropylamine)3+2
log_k 6.57
delta_h 0 kJ
-gamma 0 0
Id: 5409653
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 4Isopropylamine = Ni(Isopropylamine)4+2
log_k 7.83
delta_h 0 kJ
-gamma 0 0
Id: 5409654
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 5Isopropylamine = Ni(Isopropylamine)5+2

log_k 8.43
delta_h 0 kJ
-gamma 0 0
Id: 5409655
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
H+ + Trimethylamine = H(Trimethylamine)+
log_k 9.8
delta_h -36.8192 kJ
-gamma 0 0
Id: 3309661
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Trimethylamine = Ag(Trimethylamine)+
log_k 1.701
delta_h 0 kJ
-gamma 0 0
Id: 209661
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
H+ + Citrate-3 = H(Citrate)-2
log_k 6.396
delta_h 3.3472 kJ
-gamma 0 0
Id: 3309671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2H+ + Citrate-3 = H2(Citrate)-
log_k 11.157
delta_h 1.297 kJ
-gamma 0 0
Id: 3309672
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
3H+ + Citrate-3 = H3(Citrate)
log_k 14.285
delta_h -2.7614 kJ
-gamma 0 0
Id: 3309673
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Citrate-3 = Pb(Citrate)-
log_k 7.27
delta_h 0 kJ
-gamma 0 0
Id: 6009671
log K source: SCD2.62
Delta H source: SCD2.62

#T and ionic strength:
Pb+2 + 2Citrate-3 = Pb(Citrate)2-4
log_k 6.53
delta_h 0 kJ
-gamma 0 0
Id: 6009672
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Citrate-3 = Al(Citrate)
log_k 9.97
delta_h 0 kJ
-gamma 0 0
Id: 309671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + 2Citrate-3 = Al(Citrate)2-3
log_k 14.8
delta_h 0 kJ
-gamma 0 0
Id: 309672
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Citrate-3 + H+ = AlH(Citrate)+
log_k 12.85
delta_h 0 kJ
-gamma 0 0
Id: 309673
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Citrate-3 = Tl(Citrate)-2
log_k 1.48
delta_h 0 kJ
-gamma 0 0
Id: 8709671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Citrate-3 = Zn(Citrate)-
log_k 6.21
delta_h 8.368 kJ
-gamma 0 0
Id: 9509671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Citrate-3 = Zn(Citrate)2-4
log_k 7.4
delta_h 25.104 kJ
-gamma 0 0
Id: 9509672

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Citrate-3 + H+ = ZnH(Citrate)
log_k 10.2
delta_h 3.3472 kJ
-gamma 0 0
Id: 9509673
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Citrate-3 + 2H+ = ZnH2(Citrate)+
log_k 12.84
delta_h 0 kJ
-gamma 0 0
Id: 9509674
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + Citrate-3 = Cd(Citrate)-
log_k 4.98
delta_h 8.368 kJ
-gamma 0 0
Id: 1609671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Citrate-3 + H+ = CdH(Citrate)
log_k 9.44
delta_h 3.3472 kJ
-gamma 0 0
Id: 1609672
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Citrate-3 + 2H+ = CdH2(Citrate)+
log_k 12.9
delta_h 0 kJ
-gamma 0 0
Id: 1609673
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Citrate-3 = Cd(Citrate)2-4
log_k 5.9
delta_h 20.92 kJ
-gamma 0 0
Id: 1609674
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Citrate-3 + 2H+ = Hg(Citrate)- + 2H2O
log_k 18.3
delta_h 0 kJ

-gamma 0 0
Id: 3619671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Citrate-3 = Cu(Citrate)-
log_k 7.57
delta_h 0 kJ
-gamma 0 0
Id: 2319671
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cu+2 + 2Citrate-3 = Cu(Citrate)2-4
log_k 8.9
delta_h 0 kJ
-gamma 0 0
Id: 2319672
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cu+2 + Citrate-3 + H+ = CuH(Citrate)
log_k 10.87
delta_h 11.7152 kJ
-gamma 0 0
Id: 2319673
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Citrate-3 + 2H+ = CuH2(Citrate)+
log_k 13.23
delta_h 0 kJ
-gamma 0 0
Id: 2319674
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
2Cu+2 + 2Citrate-3 = Cu2(Citrate)2-2
log_k 16.9
delta_h 41.84 kJ
-gamma 0 0
Id: 2319675
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Citrate-3 = Ni(Citrate)-
log_k 6.59
delta_h 16.736 kJ
-gamma 0 0
Id: 5409671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Citrate-3 + H+ = NiH(Citrate)

log_k 10.5
delta_h 15.8992 kJ
-gamma 0 0
Id: 5409672
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Citrate-3 + 2H+ = NiH2(Citrate)+
log_k 13.3
delta_h 0 kJ
-gamma 0 0
Id: 5409673
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Citrate-3 = Ni(Citrate)2-4
log_k 8.77
delta_h 12.552 kJ
-gamma 0 0
Id: 5409674
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Citrate-3 + H+ = NiH(Citrate)2-3
log_k 14.9
delta_h 32.6352 kJ
-gamma 0 0
Id: 5409675
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Citrate-3 = Co(Citrate)-
log_k 6.1867
delta_h 0 kJ
-gamma 0 0
Id: 2009671
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Co+2 + H+ + Citrate-3 = CoHCitrate
log_k 10.4438
delta_h 0 kJ
-gamma 0 0
Id: 2009672
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Co+2 + 2H+ + Citrate-3 = CoH2Citrate+
log_k 12.7859
delta_h 0 kJ
-gamma 0 0
Id: 2009673
log K source: NIST46.4
Delta H source: NIST46.2

#T and ionic strength: 0.10 20.0
Fe+2 + Citrate-3 = Fe(Citrate)-
log_k 6.1
delta_h 0 kJ
-gamma 0 0
Id: 2809671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + Citrate-3 + H+ = FeH(Citrate)
log_k 10.2
delta_h 0 kJ
-gamma 0 0
Id: 2809672
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Citrate-3 = Fe(Citrate)
log_k 13.1
delta_h 0 kJ
-gamma 0 0
Id: 2819671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Citrate-3 + H+ = FeH(Citrate)+
log_k 14.4
delta_h 0 kJ
-gamma 0 0
Id: 2819672
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Citrate-3 = Mn(Citrate)-
log_k 4.28
delta_h 0 kJ
-gamma 0 0
Id: 4709671
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Mn+2 + Citrate-3 + H+ = MnH(Citrate)
log_k 9.6
delta_h 0 kJ
-gamma 0 0
Id: 4709672
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Be+2 + Citrate-3 = Be(Citrate)-
log_k 5.534
delta_h 0 kJ
-gamma 0 0
Id: 1109671

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# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Be+2 + H+ + Citrate-3 = BeH(Citrate)
log_k 9.442
delta_h 0 kJ
-gamma 0 0
# Id: 1109672
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Ca+2 + Citrate-3 = Ca(Citrate)-
log_k 4.87
delta_h -8.368 kJ
-gamma 0 0
# Id: 1509671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Citrate-3 + H+ = CaH(Citrate)
log_k 9.26
delta_h -0.8368 kJ
-gamma 0 0
# Id: 1509672
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Citrate-3 + 2H+ = CaH2(Citrate)+
log_k 12.257
delta_h 0 kJ
-gamma 0 0
# Id: 1509673
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Mg+2 + Citrate-3 = Mg(Citrate)-
log_k 4.89
delta_h 8.368 kJ
-gamma 0 0
# Id: 4609671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Citrate-3 + H+ = MgH(Citrate)
log_k 8.91
delta_h 3.3472 kJ
-gamma 0 0
# Id: 4609672
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Citrate-3 + 2H+ = MgH2(Citrate)+
log_k 12.2
delta_h 0 kJ
```

-gamma 0 0
Id: 4609673
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Sr+2 + Citrate-3 = Sr(Citrate)-
log_k 4.3367
delta_h 0 kJ
-gamma 0 0
Id: 8009671
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Sr+2 + H+ + Citrate-3 = SrH(Citrate)
log_k 8.9738
delta_h 0 kJ
-gamma 0 0
Id: 8009672
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Sr+2 + 2H+ + Citrate-3 = SrH2(Citrate)+
log_k 12.4859
delta_h 0 kJ
-gamma 0 0
Id: 8009673
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Ba+2 + Citrate-3 = Ba(Citrate)-
log_k 4.1
delta_h 0 kJ
-gamma 0 0
Id: 1009671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ba+2 + Citrate-3 + H+ = BaH(Citrate)
log_k 8.74
delta_h 0 kJ
-gamma 0 0
Id: 1009672
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ba+2 + Citrate-3 + 2H+ = BaH2(Citrate)+
log_k 12.3
delta_h 0 kJ
-gamma 0 0
Id: 1009673
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Na+ + Citrate-3 = Na(Citrate)-2

log_k 1.03
delta_h -2.8033 kJ
-gamma 0 0
Id: 5009671
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
2Na+ + Citrate-3 = Na2(Citrate)-
log_k 1.5
delta_h -5.1045 kJ
-gamma 0 0
Id: 5009672
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Na+ + Citrate-3 + H+ = NaH(Citrate)-
log_k 6.45
delta_h -3.5982 kJ
-gamma 0 0
Id: 5009673
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
K+ + Citrate-3 = K(Citrate)-2
log_k 1.1
delta_h 5.4392 kJ
-gamma 0 0
Id: 4109671
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Nta-3 = H(Nta)-2
log_k 10.278
delta_h -18.828 kJ
-gamma 0 0
Id: 3309681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2H+ + Nta-3 = H2(Nta)-
log_k 13.22
delta_h -17.9912 kJ
-gamma 0 0
Id: 3309682
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
3H+ + Nta-3 = H3(Nta)
log_k 15.22
delta_h -16.3176 kJ
-gamma 0 0
Id: 3309683
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
4H+ + Nta-3 = H4(Nta)+
log_k 16.22
delta_h -16.3176 kJ
-gamma 0 0
Id: 3309684
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Nta-3 = Pb(Nta)-
log_k 12.7
delta_h -15.8992 kJ
-gamma 0 0
Id: 6009681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Nta-3 + H+ = PbH(Nta)
log_k 15.3
delta_h 0 kJ
-gamma 0 0
Id: 6009682
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Nta-3 = Al(Nta)
log_k 13.3
delta_h 0 kJ
-gamma 0 0
Id: 309681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Nta-3 + H+ = AlH(Nta)+
log_k 15.2
delta_h 0 kJ
-gamma 0 0
Id: 309682
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Nta-3 + H2O = AlOH(Nta)- + H+
log_k 8
delta_h 0 kJ
-gamma 0 0
Id: 309683
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Nta-3 = Tl(Nta)-2
log_k 5.39
delta_h 0 kJ
-gamma 0 0
Id: 8709681

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Nta-3 = Zn(Nta)-
log_k 11.95
delta_h -3.7656 kJ
-gamma 0 0
Id: 9509681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Nta-3 = Zn(Nta)2-4
log_k 14.88
delta_h -15.0624 kJ
-gamma 0 0
Id: 9509682
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Nta-3 + H2O = ZnOH(Nta)-2 + H+
log_k 1.46
delta_h 46.4424 kJ
-gamma 0 0
Id: 9509683
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Nta-3 = Cd(Nta)-
log_k 11.07
delta_h -16.736 kJ
-gamma 0 0
Id: 1609681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Nta-3 = Cd(Nta)2-4
log_k 15.03
delta_h -38.0744 kJ
-gamma 0 0
Id: 1609682
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Nta-3 + H2O = CdOH(Nta)-2 + H+
log_k -0.61
delta_h 29.288 kJ
-gamma 0 0
Id: 1609683
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Nta-3 + 2H+ = Hg(Nta)- + 2H2O
log_k 21.7
delta_h 0 kJ

-gamma 0 0
Id: 3619681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Nta-3 = Cu(Nta)-
log_k 14.4
delta_h -7.9496 kJ
-gamma 0 0
Id: 2319681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Nta-3 = Cu(Nta)2-4
log_k 18.1
delta_h -37.2376 kJ
-gamma 0 0
Id: 2319682
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Nta-3 + H+ = CuH(Nta)
log_k 16.2
delta_h 0 kJ
-gamma 0 0
Id: 2319683
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Nta-3 + H2O = CuOH(Nta)-2 + H+
log_k 4.8
delta_h 25.5224 kJ
-gamma 0 0
Id: 2319684
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Nta-3 = Ag(Nta)-2
log_k 6
delta_h -26.3592 kJ
-gamma 0 0
Id: 209681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Nta-3 = Ni(Nta)-
log_k 12.79
delta_h -10.0416 kJ
-gamma 0 0
Id: 5409681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Nta-3 = Ni(Nta)2-4

log_k 16.96
delta_h -32.6352 kJ
-gamma 0 0
Id: 5409682
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Nta-3 + H2O = NiOH(Nta)-2 + H+
log_k 1.5
delta_h 15.0624 kJ
-gamma 0 0
Id: 5409683
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Nta-3 = Co(Nta)-
log_k 11.6667
delta_h -0.4 kJ
-gamma 0 0
Id: 2009681
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + 2Nta-3 = Co(Nta)2-4
log_k 14.9734
delta_h -20 kJ
-gamma 0 0
Id: 2009682
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + Nta-3 + H2O = CoOH(Nta)-2 + H+
log_k 0.4378
delta_h 45.6 kJ
-gamma 0 0
Id: 2009683
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Fe+2 + Nta-3 = Fe(Nta)-
log_k 10.19
delta_h 0 kJ
-gamma 0 0
Id: 2809681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + 2Nta-3 = Fe(Nta)2-4
log_k 12.62
delta_h 0 kJ
-gamma 0 0
Id: 2809682
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
Fe+2 + Nta-3 + H+ = FeH(Nta)
log_k 12.29
delta_h 0 kJ
-gamma 0 0
Id: 2809683
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + Nta-3 + H2O = FeOH(Nta)-2 + H+
log_k -1.06
delta_h 0 kJ
-gamma 0 0
Id: 2809684
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Nta-3 = Fe(Nta)
log_k 17.8
delta_h 13.3888 kJ
-gamma 0 0
Id: 2819681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + 2Nta-3 = Fe(Nta)2-3
log_k 25.9
delta_h 0 kJ
-gamma 0 0
Id: 2819682
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Nta-3 + H2O = FeOH(Nta)- + H+
log_k 13.23
delta_h 0 kJ
-gamma 0 0
Id: 2819683
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Nta-3 = Mn(Nta)-
log_k 8.573
delta_h 5.8576 kJ
-gamma 0 0
Id: 4709681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + 2Nta-3 = Mn(Nta)2-4
log_k 11.58
delta_h -17.1544 kJ
-gamma 0 0
Id: 4709682

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + Nta-3 + 2H+ = Cr(Nta) + 2H2O
log_k 21.2
delta_h 0 kJ
-gamma 0 0
Id: 2119681
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 2Nta-3 + 2H+ = Cr(Nta)2-3 + 2H2O
log_k 29.5
delta_h 0 kJ
-gamma 0 0
Id: 2119682
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
MoO4-2 + 2H+ + Nta-3 = MoO3(Nta)-3 + H2O
log_k 19.5434
delta_h -69 kJ
-gamma 0 0
Id: 4809681
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
MoO4-2 + 3H+ + Nta-3 = MoO3H(Nta)-2 + H2O
log_k 23.3954
delta_h -71 kJ
-gamma 0 0
Id: 4809682
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 1.00 25.0
MoO4-2 + 4H+ + Nta-3 = MoO3H2(Nta)- + H2O
log_k 25.3534
delta_h -71 kJ
-gamma 0 0
Id: 4809683
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 1.00 25.0
Be+2 + Nta-3 = Be(Nta)-
log_k 9.0767
delta_h 25 kJ
-gamma 0 0
Id: 1109681
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Mg+2 + Nta-3 = Mg(Nta)-
log_k 6.5
delta_h 17.9912 kJ

-gamma 0 0
Id: 4609681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Nta-3 = Ca(Nta)-
log_k 7.608
delta_h -5.6902 kJ
-gamma 0 0
Id: 1509681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + 2Nta-3 = Ca(Nta)2-4
log_k 8.81
delta_h -32.6352 kJ
-gamma 0 0
Id: 1509682
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Nta-3 = Sr(Nta)-
log_k 6.2767
delta_h -2.2 kJ
-gamma 0 0
Id: 8009681
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Ba+2 + Nta-3 = Ba(Nta)-
log_k 5.875
delta_h -6.025 kJ
-gamma 0 0
Id: 1009681
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Edta-4 = H(Edta)-3
log_k 10.948
delta_h -23.4304 kJ
-gamma 0 0
Id: 3309691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2H+ + Edta-4 = H2(Edta)-2
log_k 17.221
delta_h -41.0032 kJ
-gamma 0 0
Id: 3309692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
3H+ + Edta-4 = H3(Edta)-

log_k 20.34
delta_h -35.564 kJ
-gamma 0 0
Id: 3309693
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
4H+ + Edta-4 = H4(Edta)
log_k 22.5
delta_h -34.3088 kJ
-gamma 0 0
Id: 3309694
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
5H+ + Edta-4 = H5(Edta)+
log_k 24
delta_h -32.2168 kJ
-gamma 0 0
Id: 3309695
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Sn(OH)2 + 2H+ + Edta-4 = Sn(Edta)-2 + 2H2O
log_k 27.026
delta_h 0 kJ
-gamma 0 0
Id: 7909691
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 20.0
Sn(OH)2 + 3H+ + Edta-4 = SnH(Edta)- + 2H2O
log_k 29.934
delta_h 0 kJ
-gamma 0 0
Id: 7909692
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 20.0
Sn(OH)2 + 4H+ + Edta-4 = SnH2(Edta) + 2H2O
log_k 31.638
delta_h 0 kJ
-gamma 0 0
Id: 7909693
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 20.0
Pb+2 + Edta-4 = Pb(Edta)-2
log_k 19.8
delta_h -54.8104 kJ
-gamma 0 0
Id: 6009691
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
Pb+2 + Edta-4 + H+ = PbH(Edta)-
log_k 23
delta_h 0 kJ
-gamma 0 0
Id: 6009692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Edta-4 + 2H+ = PbH2(Edta)
log_k 24.9
delta_h 0 kJ
-gamma 0 0
Id: 6009693
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Edta-4 = Al(Edta)-
log_k 19.1
delta_h 52.7184 kJ
-gamma 0 0
Id: 309690
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Edta-4 + H+ = AlH(Edta)
log_k 21.8
delta_h 36.4008 kJ
-gamma 0 0
Id: 309691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Edta-4 + H2O = AlOH(Edta)-2 + H+
log_k 12.8
delta_h 73.6384 kJ
-gamma 0 0
Id: 309692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Edta-4 = Tl(Edta)-3
log_k 7.27
delta_h -43.5136 kJ
-gamma 0 0
Id: 8709691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Edta-4 + H+ = TlH(Edta)-2
log_k 13.68
delta_h 0 kJ
-gamma 0 0
Id: 8709692

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Edta-4 = Zn(Edta)-2
log_k 18
delta_h -19.2464 kJ
-gamma 0 0
Id: 9509691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Edta-4 + H+ = ZnH(Edta)-
log_k 21.4
delta_h -28.4512 kJ
-gamma 0 0
Id: 9509692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Edta-4 + H2O = ZnOH(Edta)-3 + H+
log_k 5.8
delta_h 0 kJ
-gamma 0 0
Id: 9509693
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Edta-4 = Cd(Edta)-2
log_k 18.2
delta_h -38.0744 kJ
-gamma 0 0
Id: 1609691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Edta-4 + H+ = CdH(Edta)-
log_k 21.5
delta_h -39.748 kJ
-gamma 0 0
Id: 1609692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Edta-4 + 2H+ = Hg(Edta)-2 + 2H2O
log_k 29.3
delta_h -125.102 kJ
-gamma 0 0
Id: 3619691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Edta-4 + 3H+ = HgH(Edta)- + 2H2O
log_k 32.9
delta_h -128.449 kJ

-gamma 0 0
Id: 3619692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Edta-4 = Cu(Edta)-2
log_k 20.5
delta_h -34.7272 kJ
-gamma 0 0
Id: 2319691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Edta-4 + H+ = CuH(Edta)-
log_k 24
delta_h -43.0952 kJ
-gamma 0 0
Id: 2319692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Edta-4 + 2H+ = CuH2(Edta)
log_k 26.2
delta_h 0 kJ
-gamma 0 0
Id: 2319693
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Edta-4 + H2O = CuOH(Edta)-3 + H+
log_k 8.5
delta_h 0 kJ
-gamma 0 0
Id: 2319694
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Edta-4 = Ag(Edta)-3
log_k 8.08
delta_h -31.38 kJ
-gamma 0 0
Id: 209691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Edta-4 + H+ = AgH(Edta)-2
log_k 15.21
delta_h 0 kJ
-gamma 0 0
Id: 209693
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + Edta-4 = Ni(Edta)-2

log_k 20.1
delta_h -30.9616 kJ
-gamma 0 0
Id: 5409691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Edta-4 + H+ = NiH(Edta)-
log_k 23.6
delta_h -38.4928 kJ
-gamma 0 0
Id: 5409692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Edta-4 + H2O = NiOH(Edta)-3 + H+
log_k 7.6
delta_h 0 kJ
-gamma 0 0
Id: 5409693
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Edta-4 = Co(Edta)-2
log_k 18.1657
delta_h -15 kJ
-gamma 0 0
Id: 2009691
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + Edta-4 + H+ = CoH(Edta)-
log_k 21.5946
delta_h -22.9 kJ
-gamma 0 0
Id: 2009692
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + Edta-4 + 2H+ = CoH2(Edta)
log_k 23.4986
delta_h 0 kJ
-gamma 0 0
Id: 2009693
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Co+3 + Edta-4 = Co(Edta)-
log_k 43.9735
delta_h 0 kJ
-gamma 0 0
Id: 2019691
log K source: NIST46.4
Delta H source: NIST46.2

#T and ionic strength: 0.10 25.0
Co+3 + Edta-4 + H+ = CoH(Edta)
log_k 47.168
delta_h 0 kJ
-gamma 0 0
Id: 2019692
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Fe+2 + Edta-4 = Fe(Edta)-2
log_k 16
delta_h -16.736 kJ
-gamma 0 0
Id: 2809690
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + Edta-4 + H+ = FeH(Edta)-
log_k 19.06
delta_h -27.6144 kJ
-gamma 0 0
Id: 2809691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + Edta-4 + H2O = FeOH(Edta)-3 + H+
log_k 6.5
delta_h 0 kJ
-gamma 0 0
Id: 2809692
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Fe+2 + Edta-4 + 2H2O = Fe(OH)2(Edta)-4 + 2H+
log_k -4
delta_h 0 kJ
-gamma 0 0
Id: 2809693
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Fe+3 + Edta-4 = Fe(Edta)-
log_k 27.7
delta_h -11.2968 kJ
-gamma 0 0
Id: 2819690
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Edta-4 + H+ = FeH(Edta)
log_k 29.2
delta_h -11.7152 kJ
-gamma 0 0
Id: 2819691

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Edta-4 + H2O = FeOH(Edta)-2 + H+
log_k 19.9
delta_h 0 kJ
-gamma 0 0
Id: 2819692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Edta-4 + 2H2O = Fe(OH)2(Edta)-3 + 2H+
log_k 9.85
delta_h 0 kJ
-gamma 0 0
Id: 2819693
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Mn+2 + Edta-4 = Mn(Edta)-2
log_k 15.6
delta_h -19.2464 kJ
-gamma 0 0
Id: 4709691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Edta-4 + H+ = MnH(Edta)-
log_k 19.1
delta_h -24.2672 kJ
-gamma 0 0
Id: 4709692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cr+2 + Edta-4 = Cr(Edta)-2
log_k 15.3
delta_h 0 kJ
-gamma 0 0
Id: 2109691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cr+2 + Edta-4 + H+ = CrH(Edta)-
log_k 19.1
delta_h 0 kJ
-gamma 0 0
Id: 2109692
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + Edta-4 + 2H+ = Cr(Edta)- + 2H2O
log_k 35.5
delta_h 0 kJ

-gamma 0 0
Id: 2119691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + Edta-4 + 3H+ = CrH(Edta) + 2H2O
log_k 37.4
delta_h 0 kJ
-gamma 0 0
Id: 2119692
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + Edta-4 + H+ = CrOH(Edta)-2 + H2O
log_k 27.7
delta_h 0 kJ
-gamma 0 0
Id: 2119693
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Be+2 + Edta-4 = Be(Edta)-2
log_k 11.4157
delta_h 41 kJ
-gamma 0 0
Id: 1109691
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Mg+2 + Edta-4 = Mg(Edta)-2
log_k 10.57
delta_h 13.8072 kJ
-gamma 0 0
Id: 4609690
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Edta-4 + H+ = MgH(Edta)-
log_k 14.97
delta_h 0 kJ
-gamma 0 0
Id: 4609691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Edta-4 = Ca(Edta)-2
log_k 12.42
delta_h -25.5224 kJ
-gamma 0 0
Id: 1509690
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Edta-4 + H+ = CaH(Edta)-

log_k 15.9
delta_h 0 kJ
-gamma 0 0
Id: 1509691
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Edta-4 = Sr(Edta)-2
log_k 10.4357
delta_h -17 kJ
-gamma 0 0
Id: 8009691
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Sr+2 + Edta-4 + H+ = SrH(Edta)-
log_k 14.7946
delta_h 0 kJ
-gamma 0 0
Id: 8009692
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Ba+2 + Edta-4 = Ba(Edta)-2
log_k 7.72
delta_h -20.5016 kJ
-gamma 0 0
Id: 1009691
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Na+ + Edta-4 = Na(Edta)-3
log_k 2.7
delta_h -5.8576 kJ
-gamma 0 0
Id: 5009690
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
K+ + Edta-4 = K(Edta)-3
log_k 1.7
delta_h 0 kJ
-gamma 0 0
Id: 4109690
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Propionate- = H(Propionate)
log_k 4.874
delta_h 0.66 kJ
-gamma 0 0
Id: 3309711
log K source: NIST46.4
Delta H source: NIST46.4

#T and ionic strength: 0.00 25.0
Pb+2 + Propionate- = Pb(Propionate)+
log_k 2.64
delta_h 0 kJ
-gamma 0 0
Id: 6009711
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.00 35.0
Pb+2 + 2Propionate- = Pb(Propionate)2
log_k 3.1765
delta_h 0 kJ
-gamma 0 0
Id: 6009712
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 2.00 25.0
Zn+2 + Propionate- = Zn(Propionate)+
log_k 1.4389
delta_h 0 kJ
-gamma 0 0
Id: 9509711
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Zn+2 + 2Propionate- = Zn(Propionate)2
log_k 1.842
delta_h 0 kJ
-gamma 0 0
Id: 9509712
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Cd+2 + Propionate- = Cd(Propionate)+
log_k 1.598
delta_h 0 kJ
-gamma 0 0
Id: 1609711
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Cd+2 + 2Propionate- = Cd(Propionate)2
log_k 2.472
delta_h 0 kJ
-gamma 0 0
Id: 1609712
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Hg(OH)2 + 2H+ + Propionate- = Hg(Propionate)+ + 2H2O
log_k 10.594
delta_h 0 kJ
-gamma 0 0
Id: 3619711

log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Cu+2 + Propionate- = Cu(Propionate)+
log_k 2.22
delta_h 4.1 kJ
-gamma 0 0
Id: 2319711
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+2 + 2Propionate- = Cu(Propionate)2
log_k 3.5
delta_h 0 kJ
-gamma 0 0
Id: 2319712
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Ni+2 + Propionate- = Ni(Propionate)+
log_k 0.908
delta_h 0 kJ
-gamma 0 0
Id: 5409711
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 1.00 25.0
Co+2 + Propionate- = Co(Propionate)+
log_k 0.671
delta_h 4.6 kJ
-gamma 0 0
Id: 2009711
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 2.00 25.0
Co+2 + 2Propionate- = Co(Propionate)2
log_k 0.5565
delta_h 16 kJ
-gamma 0 0
Id: 2009712
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 2.00 25.0
Fe+3 + Propionate- = Fe(Propionate)+2
log_k 4.012
delta_h 0 kJ
-gamma 0 0
Id: 2819711
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 20.0
Cr(OH)2+ + 2H+ + Propionate- = Cr(Propionate)+2 + 2H2O
log_k 15.0773
delta_h 0 kJ

-gamma 0 0
Id: 2119711
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.50 25.0
Cr(OH)2+ + 2H+ + 2Propionate- = Cr(Propionate)2+ + 2H2O
log_k 17.9563
delta_h 0 kJ
-gamma 0 0
Id: 2119712
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.50 25.0
Cr(OH)2+ + 2H+ + 3Propionate- = Cr(Propionate)3 + 2H2O
log_k 20.8858
delta_h 0 kJ
-gamma 0 0
Id: 2119713
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.50 25.0
Mg+2 + Propionate- = Mg(Propionate)+
log_k 0.9689
delta_h 4.2677 kJ
-gamma 0 0
Id: 4609710
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Ca+2 + Propionate- = Ca(Propionate)+
log_k 0.9289
delta_h 3.3472 kJ
-gamma 0 0
Id: 1509710
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Sr+2 + Propionate- = Sr(Propionate)+
log_k 0.8589
delta_h 0 kJ
-gamma 0 0
Id: 8009711
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Ba+2 + Propionate- = Ba(Propionate)+
log_k 0.7689
delta_h 0 kJ
-gamma 0 0
Id: 1009711
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Ba+2 + 2Propionate- = Ba(Propionate)2

log_k 0.9834
delta_h 0 kJ
-gamma 0 0
Id: 1009712
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
H+ + Butyrate- = H(Butyrate)
log_k 4.819
delta_h 2.8 kJ
-gamma 0 0
Id: 3309721
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Pb+2 + Butyrate- = Pb(Butyrate)+
log_k 2.101
delta_h 0 kJ
-gamma 0 0
Id: 6009721
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 2.00 25.0
Zn+2 + Butyrate- = Zn(Butyrate)+
log_k 1.4289
delta_h 0 kJ
-gamma 0 0
Id: 9509721
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Hg(OH)2 + 2H+ + Butyrate- = Hg(Butyrate)+ + 2H2O
log_k 10.3529
delta_h 0 kJ
-gamma 0 0
Id: 3619721
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Cu+2 + Butyrate- = Cu(Butyrate)+
log_k 2.14
delta_h 0 kJ
-gamma 0 0
Id: 2319721
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Ni+2 + Butyrate- = Ni(Butyrate)+
log_k 0.691
delta_h 0 kJ
-gamma 0 0
Id: 5409721
log K source: NIST46.4
Delta H source: SCD2.62

#T and ionic strength: 2.00 25.0
Co+2 + Butyrate- = Co(Butyrate)+
log_k 0.591
delta_h 0 kJ
-gamma 0 0
Id: 2009721
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Co+2 + 2Butyrate- = Co(Butyrate)2
log_k 0.7765
delta_h 0 kJ
-gamma 0 0
Id: 2009722
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Mg+2 + Butyrate- = Mg(Butyrate)+
log_k 0.9589
delta_h 0 kJ
-gamma 0 0
Id: 4609720
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Ca+2 + Butyrate- = Ca(Butyrate)+
log_k 0.9389
delta_h 3.3472 kJ
-gamma 0 0
Id: 1509720
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Sr+2 + Butyrate- = Sr(Butyrate)+
log_k 0.7889
delta_h 0 kJ
-gamma 0 0
Id: 8009721
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Ba+2 + Butyrate- = Ba(Butyrate)+
log_k 0.7389
delta_h 0 kJ
-gamma 0 0
Id: 1009721
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Ba+2 + 2Butyrate- = Ba(Butyrate)2
log_k 0.88
delta_h 0 kJ
-gamma 0 0
Id: 1009722

log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
H+ + Isobutyrate- = H(Isobutyrate)
log_k 4.849
delta_h 3.2217 kJ
-gamma 0 0
Id: 3309731
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Isobutyrate- = Zn(Isobutyrate)+
log_k 1.44
delta_h 0 kJ
-gamma 0 0
Id: 9509731
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Isobutyrate- = Cu(Isobutyrate)+
log_k 2.17
delta_h 0 kJ
-gamma 0 0
Id: 2319731
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Isobutyrate- = Cu(Isobutyrate)2
log_k 3.3
delta_h 0 kJ
-gamma 0 0
Id: 2319732
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Isobutyrate- = Fe(Isobutyrate)+2
log_k 4.2
delta_h 0 kJ
-gamma 0 0
Id: 2819731
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Isobutyrate- = Ca(Isobutyrate)+
log_k 0.51
delta_h 0 kJ
-gamma 0 0
Id: 1509731
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
H+ + Two_picoline = H(Two_picoline)+
log_k 5.95
delta_h -25.5224 kJ

-gamma 0 0
Id: 3309801
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Two_picoline = Cu(Two_picoline)+2
log_k 1.3
delta_h 0 kJ
-gamma 0 0
Id: 2319801
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Two_picoline = Cu(Two_picoline)2+2
log_k 2.8
delta_h 0 kJ
-gamma 0 0
Id: 2319802
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + Two_picoline = Cu(Two_picoline)+
log_k 5.4
delta_h 0 kJ
-gamma 0 0
Id: 2309801
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 2Two_picoline = Cu(Two_picoline)2+
log_k 7.65
delta_h 0 kJ
-gamma 0 0
Id: 2309802
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 3Two_picoline = Cu(Two_picoline)3+
log_k 8.5
delta_h 0 kJ
-gamma 0 0
Id: 2309803
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Two_picoline = Ag(Two_picoline)+
log_k 2.32
delta_h -24.2672 kJ
-gamma 0 0
Id: 209801
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Two_picoline = Ag(Two_picoline)2+

log_k 4.68
delta_h -42.6768 kJ
-gamma 0 0
Id: 209802
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Two_picoline = Ni(Two_picoline)+2
log_k 0.4
delta_h 0 kJ
-gamma 0 0
Id: 5409801
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Three_picoline = H(Three_picoline)+
log_k 5.7
delta_h -23.8488 kJ
-gamma 0 0
Id: 3309811
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Three_picoline = Zn(Three_picoline)+2
log_k 1
delta_h 0 kJ
-gamma 0 0
Id: 9509811
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Three_picoline = Zn(Three_picoline)2+2
log_k 2.1
delta_h 0 kJ
-gamma 0 0
Id: 9509812
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 3Three_picoline = Zn(Three_picoline)3+2
log_k 2.6
delta_h 0 kJ
-gamma 0 0
Id: 9509813
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 4Three_picoline = Zn(Three_picoline)4+2
log_k 3.7
delta_h 0 kJ
-gamma 0 0
Id: 9509814
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
Cd+2 + Three_picoline = Cd(Three_picoline)+2
log_k 1.42
delta_h 0 kJ
-gamma 0 0
Id: 1609811
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 2Three_picoline = Cd(Three_picoline)2+2
log_k 2.27
delta_h 0 kJ
-gamma 0 0
Id: 1609812
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 3Three_picoline = Cd(Three_picoline)3+2
log_k 3.6
delta_h 0 kJ
-gamma 0 0
Id: 1609813
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 4Three_picoline = Cd(Three_picoline)4+2
log_k 4
delta_h 0 kJ
-gamma 0 0
Id: 1609814
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + Three_picoline = Cu(Three_picoline)+
log_k 5.6
delta_h 0 kJ
-gamma 0 0
Id: 2309811
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 2Three_picoline = Cu(Three_picoline)2+
log_k 7.78
delta_h 0 kJ
-gamma 0 0
Id: 2309812
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 3Three_picoline = Cu(Three_picoline)3+
log_k 8.6
delta_h 0 kJ
-gamma 0 0
Id: 2309813

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 4Three_picoline = Cu(Three_picoline)4+
log_k 9
delta_h 0 kJ
-gamma 0 0
Id: 2309814
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Three_picoline = Cu(Three_picoline)+2
log_k 2.77
delta_h 0 kJ
-gamma 0 0
Id: 2319811
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Three_picoline = Cu(Three_picoline)2+2
log_k 4.8
delta_h 0 kJ
-gamma 0 0
Id: 2319812
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 3Three_picoline = Cu(Three_picoline)3+2
log_k 6.3
delta_h 0 kJ
-gamma 0 0
Id: 2319813
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 4Three_picoline = Cu(Three_picoline)4+2
log_k 7.2
delta_h 0 kJ
-gamma 0 0
Id: 2319814
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Three_picoline = Ag(Three_picoline)+
log_k 2.2
delta_h -21.7568 kJ
-gamma 0 0
Id: 209811
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Three_picoline = Ag(Three_picoline)2+
log_k 4.46
delta_h -49.7896 kJ

-gamma 0 0
Id: 209812
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Three_picoline = Ni(Three_picoline)+2
log_k 1.87
delta_h 0 kJ
-gamma 0 0
Id: 5409811
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Three_picoline = Ni(Three_picoline)2+2
log_k 3.3
delta_h 0 kJ
-gamma 0 0
Id: 5409812
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 3Three_picoline = Ni(Three_picoline)3+2
log_k 4.1
delta_h 0 kJ
-gamma 0 0
Id: 5409813
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 4Three_picoline = Ni(Three_picoline)4+2
log_k 4.6
delta_h 0 kJ
-gamma 0 0
Id: 5409814
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Three_picoline = Co(Three_picoline)+2
log_k 1.4
delta_h 0 kJ
-gamma 0 0
Id: 2009811
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Co+2 + 2Three_picoline = Co(Three_picoline)2+2
log_k 2.2
delta_h 0 kJ
-gamma 0 0
Id: 2009812
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Co+2 + 3Three_picoline = Co(Three_picoline)3+2

log_k 2.5
delta_h 0 kJ
-gamma 0 0
Id: 2009813
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
H+ + Four_picoline = H(Four_picoline)+
log_k 6.03
delta_h -25.3132 kJ
-gamma 0 0
Id: 3309821
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Four_picoline = Zn(Four_picoline)+2
log_k 1.4
delta_h 0 kJ
-gamma 0 0
Id: 9509821
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Four_picoline = Zn(Four_picoline)2+2
log_k 2.11
delta_h 0 kJ
-gamma 0 0
Id: 9509822
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 3Four_picoline = Zn(Four_picoline)3+2
log_k 2.85
delta_h 0 kJ
-gamma 0 0
Id: 9509823
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Four_picoline = Cd(Four_picoline)+2
log_k 1.59
delta_h 0 kJ
-gamma 0 0
Id: 1609821
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 2Four_picoline = Cd(Four_picoline)2+2
log_k 2.4
delta_h 0 kJ
-gamma 0 0
Id: 1609822
log K source: SCD2.62
Delta H source: SCD2.62

#T and ionic strength:
Cd+2 + 3Four_picoline = Cd(Four_picoline)3+2
log_k 3.18
delta_h 0 kJ
-gamma 0 0
Id: 1609823
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 4Four_picoline = Cd(Four_picoline)4+2
log_k 4
delta_h 0 kJ
-gamma 0 0
Id: 1609824
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + Four_picoline = Cu(Four_picoline)+
log_k 5.65
delta_h 0 kJ
-gamma 0 0
Id: 2309821
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 2Four_picoline = Cu(Four_picoline)2+
log_k 8.2
delta_h 0 kJ
-gamma 0 0
Id: 2309822
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 3Four_picoline = Cu(Four_picoline)3+
log_k 8.8
delta_h 0 kJ
-gamma 0 0
Id: 2309823
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 4Four_picoline = Cu(Four_picoline)4+
log_k 9.2
delta_h 0 kJ
-gamma 0 0
Id: 2309824
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Four_picoline = Cu(Four_picoline)+2
log_k 2.88
delta_h 0 kJ
-gamma 0 0
Id: 2319821

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Four_picoline = Cu(Four_picoline)2+2
log_k 5.16
delta_h 0 kJ
-gamma 0 0
Id: 2319822
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 3Four_picoline = Cu(Four_picoline)3+2
log_k 6.77
delta_h 0 kJ
-gamma 0 0
Id: 2319823
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 4Four_picoline = Cu(Four_picoline)4+2
log_k 8.08
delta_h 0 kJ
-gamma 0 0
Id: 2319824
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 5Four_picoline = Cu(Four_picoline)5+2
log_k 8.3
delta_h 0 kJ
-gamma 0 0
Id: 2319825
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Four_picoline = Ag(Four_picoline)+
log_k 2.03
delta_h -25.5224 kJ
-gamma 0 0
Id: 209821
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Four_picoline = Ag(Four_picoline)2+
log_k 4.39
delta_h -53.5552 kJ
-gamma 0 0
Id: 209822
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Four_picoline = Ni(Four_picoline)+2
log_k 2.11
delta_h 0 kJ

-gamma 0 0
Id: 5409821
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Four_picoline = Ni(Four_picoline)2+2
log_k 3.59
delta_h 0 kJ
-gamma 0 0
Id: 5409822
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 3Four_picoline = Ni(Four_picoline)3+2
log_k 4.34
delta_h 0 kJ
-gamma 0 0
Id: 5409823
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 4Four_picoline = Ni(Four_picoline)4+2
log_k 4.7
delta_h 0 kJ
-gamma 0 0
Id: 5409824
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Four_picoline = Co(Four_picoline)+2
log_k 1.56
delta_h 0 kJ
-gamma 0 0
Id: 2009821
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Co+2 + 2Four_picoline = Co(Four_picoline)2+2
log_k 2.51
delta_h 0 kJ
-gamma 0 0
Id: 2009822
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Co+2 + 3Four_picoline = Co(Four_picoline)3+2
log_k 2.94
delta_h 0 kJ
-gamma 0 0
Id: 2009823
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Co+2 + 4Four_picoline = Co(Four_picoline)4+2

log_k 3.17
delta_h 0 kJ
-gamma 0 0
Id: 2009824
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
H+ + Formate- = H(Formate)
log_k 3.745
delta_h 0.1674 kJ
-gamma 0 0
Id: 3309831
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Formate- = Pb(Formate)+
log_k 2.2
delta_h 0 kJ
-gamma 0 0
Id: 6009831
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + Formate- = Zn(Formate)+
log_k 1.44
delta_h 0 kJ
-gamma 0 0
Id: 9509831
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Formate- = Cd(Formate)+
log_k 1.7
delta_h 0 kJ
-gamma 0 0
Id: 1609831
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Hg(OH)2 + Formate- + 2H+ = Hg(Formate)+ + 2H2O
log_k 9.6
delta_h 0 kJ
-gamma 0 0
Id: 3619831
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Formate- = Cu(Formate)+
log_k 2
delta_h 0 kJ
-gamma 0 0
Id: 2319831
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
Ni+2 + Formate- = Ni(Formate)+
log_k 1.22
delta_h 0 kJ
-gamma 0 0
Id: 5409831
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Co+2 + Formate- = Co(Formate)+
log_k 1.209
delta_h 0 kJ
-gamma 0 0
Id: 2009831
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 30.0
Co+2 + 2Formate- = Co(Formate)2
log_k 1.1365
delta_h 0 kJ
-gamma 0 0
Id: 2009832
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Cr+2 + Formate- = Cr(Formate)+
log_k 1.07
delta_h 0 kJ
-gamma 0 0
Id: 2109831
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Formate- = Mg(Formate)+
log_k 1.43
delta_h 0 kJ
-gamma 0 0
Id: 4609831
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Formate- = Ca(Formate)+
log_k 1.43
delta_h 4.184 kJ
-gamma 0 0
Id: 1509831
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Formate- = Sr(Formate)+
log_k 1.39
delta_h 4 kJ
-gamma 0 0
Id: 8009831

log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + Formate- = Ba(Formate)+
log_k 1.38
delta_h 0 kJ
-gamma 0 0
Id: 1009831
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Isovalerate- = H(Isovalerate)
log_k 4.781
delta_h 4.5606 kJ
-gamma 0 0
Id: 3309841
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Isovalerate- = Zn(Isovalerate)+
log_k 1.39
delta_h 0 kJ
-gamma 0 0
Id: 9509841
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Isovalerate- = Cu(Isovalerate)+
log_k 2.08
delta_h 0 kJ
-gamma 0 0
Id: 2319841
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Isovalerate- = Ca(Isovalerate)+
log_k 0.2
delta_h 0 kJ
-gamma 0 0
Id: 1509841
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
H+ + Valerate- = H(Valerate)
log_k 4.843
delta_h 2.887 kJ
-gamma 0 0
Id: 3309851
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Valerate- = Cu(Valerate)+
log_k 2.12
delta_h 0 kJ

-gamma 0 0
Id: 2319851
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Valerate- = Ca(Valerate)+
log_k 0.3
delta_h 0 kJ
-gamma 0 0
Id: 1509851
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ba+2 + Valerate- = Ba(Valerate)+
log_k -0.2
delta_h 0 kJ
-gamma 0 0
Id: 1009851
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
H+ + Acetate- = H(Acetate)
log_k 4.757
delta_h 0.41 kJ
-gamma 0 0
Id: 3309921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + Acetate- = Sn(Acetate)+ + 2H2O
log_k 10.0213
delta_h 0 kJ
-gamma 0 0
Id: 7909921
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 3.00 25.0
Sn(OH)2 + 2H+ + 2Acetate- = Sn(Acetate)2 + 2H2O
log_k 12.32
delta_h 0 kJ
-gamma 0 0
Id: 7909922
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 3.00 25.0
Sn(OH)2 + 2H+ + 3Acetate- = Sn(Acetate)3- + 2H2O
log_k 13.55
delta_h 0 kJ
-gamma 0 0
Id: 7909923
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 3.00 25.0
Pb+2 + Acetate- = Pb(Acetate)+

log_k 2.68
delta_h -0.4 kJ
-gamma 0 0
Id: 6009921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Pb+2 + 2Acetate- = Pb(Acetate)2
log_k 4.08
delta_h -0.8 kJ
-gamma 0 0
Id: 6009922
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Tl+ + Acetate- = Tl(Acetate)
log_k -0.11
delta_h 0 kJ
-gamma 0 0
Id: 8709921
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Zn+2 + Acetate- = Zn(Acetate)+
log_k 1.58
delta_h 8.3 kJ
-gamma 0 0
Id: 9509921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Zn+2 + 2Acetate- = Zn(Acetate)2
log_k 2.6434
delta_h 22 kJ
-gamma 0 0
Id: 9509922
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Cd+2 + Acetate- = Cd(Acetate)+
log_k 1.93
delta_h 9.6 kJ
-gamma 0 0
Id: 1609921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cd+2 + 2Acetate- = Cd(Acetate)2
log_k 2.86
delta_h 15 kJ
-gamma 0 0
Id: 1609922
log K source: NIST46.4
Delta H source: NIST46.4

#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + Acetate- = Hg(Acetate)+ + 2H2O
log_k 10.494
delta_h 0 kJ
-gamma 0 0
Id: 3619920
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 2Acetate- = Hg(Acetate)2 + 2H2O
log_k 13.83
delta_h 0 kJ
-gamma 0 0
Id: 3619921
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 3.00 25.0
Cu+2 + Acetate- = Cu(Acetate)+
log_k 2.21
delta_h 7.1 kJ
-gamma 0 0
Id: 2319921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+2 + 2Acetate- = Cu(Acetate)2
log_k 3.4
delta_h 12 kJ
-gamma 0 0
Id: 2319922
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+2 + 3Acetate- = Cu(Acetate)3-
log_k 3.9434
delta_h 6.2 kJ
-gamma 0 0
Id: 2319923
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Ag+ + Acetate- = Ag(Acetate)
log_k 0.73
delta_h 3 kJ
-gamma 0 0
Id: 209921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + 2Acetate- = Ag(Acetate)2-
log_k 0.64
delta_h 3 kJ
-gamma 0 0
Id: 209922

log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ni+2 + Acetate- = Ni(Acetate)+
log_k 1.37
delta_h 8.7 kJ
-gamma 0 0
Id: 5409921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ni+2 + 2Acetate- = Ni(Acetate)2
log_k 2.1
delta_h 10 kJ
-gamma 0 0
Id: 5409922
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + Acetate- = Co(Acetate)+
log_k 1.38
delta_h 0 kJ
-gamma 0 0
Id: 2009921
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Co+2 + 2Acetate- = Co(Acetate)2
log_k 0.7565
delta_h 0 kJ
-gamma 0 0
Id: 2009922
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Fe+2 + Acetate- = Fe(Acetate)+
log_k 1.4
delta_h 0 kJ
-gamma 0 0
Id: 2809920
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Fe+3 + Acetate- = Fe(Acetate)+2
log_k 4.0234
delta_h 0 kJ
-gamma 0 0
Id: 2819920
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Fe+3 + 2Acetate- = Fe(Acetate)2+
log_k 7.5723
delta_h 0 kJ

-gamma 0 0
Id: 2819921
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Fe+3 + 3Acetate- = Fe(Acetate)3
log_k 9.5867
delta_h 0 kJ
-gamma 0 0
Id: 2819922
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Mn+2 + Acetate- = Mn(Acetate)+
log_k 1.4
delta_h 0 kJ
-gamma 0 0
Id: 4709920
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Cr+2 + Acetate- = Cr(Acetate)+
log_k 1.8
delta_h 0 kJ
-gamma 0 0
Id: 2109921
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Cr+2 + 2Acetate- = Cr(Acetate)2
log_k 2.92
delta_h 0 kJ
-gamma 0 0
Id: 2109922
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H+ + Acetate- = Cr(Acetate)+2 + 2H2O
log_k 15.0073
delta_h -125.62 kJ
-gamma 0 0
Id: 2119921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Cr(OH)2+ + 2H+ + 2Acetate- = Cr(Acetate)2+ + 2H2O
log_k 17.9963
delta_h -117.62 kJ
-gamma 0 0
Id: 2119922
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Cr(OH)2+ + 2H+ + 3Acetate- = Cr(Acetate)3 + 2H2O

log_k 20.7858
delta_h -96.62 kJ
-gamma 0 0
Id: 2119923
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Be+2 + Acetate- = Be(Acetate)+
log_k 2.0489
delta_h 0 kJ
-gamma 0 0
Id: 1109921
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Be+2 + 2Acetate- = Be(Acetate)2
log_k 3.0034
delta_h 0 kJ
-gamma 0 0
Id: 1109922
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Mg+2 + Acetate- = Mg(Acetate)+
log_k 1.27
delta_h 0 kJ
-gamma 0 0
Id: 4609920
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Ca+2 + Acetate- = Ca(Acetate)+
log_k 1.18
delta_h 4 kJ
-gamma 0 0
Id: 1509920
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sr+2 + Acetate- = Sr(Acetate)+
log_k 1.14
delta_h 0 kJ
-gamma 0 0
Id: 8009921
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Ba+2 + Acetate- = Ba(Acetate)+
log_k 1.07
delta_h 0 kJ
-gamma 0 0
Id: 1009921
log K source: NIST46.4
Delta H source: NIST46.2

#T and ionic strength: 0.00 25.0
Na+ + Acetate- = Na(Acetate)
log_k -0.18
delta_h 12 kJ
-gamma 0 0
Id: 5009920
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
K+ + Acetate- = K(Acetate)
log_k -0.1955
delta_h 4.184 kJ
-gamma 0 0
Id: 4109921
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
H+ + Tartarate-2 = H(Tartarate)-
log_k 4.366
delta_h -0.7531 kJ
-gamma 0 0
Id: 3309931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2H+ + Tartarate-2 = H2(Tartarate)
log_k 7.402
delta_h -3.6819 kJ
-gamma 0 0
Id: 3309932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Sn(OH)2 + 2H+ + Tartarate-2 = Sn(Tartarate) + 2H2O
log_k 13.1518
delta_h 0 kJ
-gamma 0 0
Id: 7909931
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Pb+2 + Tartarate-2 = Pb(Tartarate)
log_k 3.98
delta_h 0 kJ
-gamma 0 0
Id: 6009931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + 2Tartarate-2 = Al(Tartarate)2-
log_k 9.37
delta_h 0 kJ
-gamma 0 0
Id: 309931

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Tartarate-2 = Tl(Tartarate)-
log_k 1.4
delta_h 0 kJ
-gamma 0 0
Id: 8709931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Tartarate-2 + H+ = TlH(Tartarate)
log_k 4.8
delta_h 0 kJ
-gamma 0 0
Id: 8709932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Tartarate-2 = Zn(Tartarate)
log_k 3.43
delta_h 0 kJ
-gamma 0 0
Id: 9509931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Tartarate-2 = Zn(Tartarate)2-2
log_k 5.5
delta_h 0 kJ
-gamma 0 0
Id: 9509932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Tartarate-2 + H+ = ZnH(Tartarate)+
log_k 5.9
delta_h 0 kJ
-gamma 0 0
Id: 9509933
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Tartarate-2 = Cd(Tartarate)
log_k 2.7
delta_h 0 kJ
-gamma 0 0
Id: 1609931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Tartarate-2 = Cd(Tartarate)2-2
log_k 4.1
delta_h 0 kJ

-gamma 0 0
Id: 1609932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Tartarate-2 + 2H+ = Hg(Tartarate) + 2H2O
log_k 14
delta_h 0 kJ
-gamma 0 0
Id: 3619931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Tartarate-2 = Cu(Tartarate)
log_k 3.97
delta_h 0 kJ
-gamma 0 0
Id: 2319931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Tartarate-2 + H+ = CuH(Tartarate)+
log_k 6.7
delta_h 0 kJ
-gamma 0 0
Id: 2319932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Tartarate-2 = Ni(Tartarate)
log_k 3.46
delta_h 0 kJ
-gamma 0 0
Id: 5409931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Tartarate-2 + H+ = NiH(Tartarate)+
log_k 5.89
delta_h 0 kJ
-gamma 0 0
Id: 5409932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Tartarate-2 = Co(Tartarate)
log_k 3.05
delta_h 0 kJ
-gamma 0 0
Id: 2009931
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Co+2 + 2Tartarate-2 = Co(Tartarate)2-2

log_k 4
delta_h 0 kJ
-gamma 0 0
Id: 2009932
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Co+2 + H+ + Tartarate-2 = CoH(Tartarate)+
log_k 5.754
delta_h 0 kJ
-gamma 0 0
Id: 2009933
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 20.0
Fe+2 + Tartarate-2 = Fe(Tartarate)
log_k 3.1
delta_h 0 kJ
-gamma 0 0
Id: 2809931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Tartarate-2 = Fe(Tartarate)+
log_k 7.78
delta_h 0 kJ
-gamma 0 0
Id: 2819931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Tartarate-2 = Mn(Tartarate)
log_k 3.38
delta_h 0 kJ
-gamma 0 0
Id: 4709931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Tartarate-2 + H+ = MnH(Tartarate)+
log_k 6
delta_h 0 kJ
-gamma 0 0
Id: 4709932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Tartarate-2 = Mg(Tartarate)
log_k 2.3
delta_h 0 kJ
-gamma 0 0
Id: 4609931
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
Mg+2 + Tartarate-2 + H+ = MgH(Tartarate)+
log_k 5.75
delta_h 0 kJ
-gamma 0 0
Id: 4609932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Be+2 + Tartarate-2 = Be(Tartarate)
log_k 2.768
delta_h 0 kJ
-gamma 0 0
Id: 1109931
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Be+2 + 2Tartarate-2 = Be(Tartarate)2-2
log_k 4.008
delta_h 0 kJ
-gamma 0 0
Id: 1109932
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Ca+2 + Tartarate-2 = Ca(Tartarate)
log_k 2.8
delta_h -8.368 kJ
-gamma 0 0
Id: 1509931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Tartarate-2 + H+ = CaH(Tartarate)+
log_k 5.86
delta_h -9.1211 kJ
-gamma 0 0
Id: 1509932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Tartarate-2 = Sr(Tartarate)
log_k 2.55
delta_h 0 kJ
-gamma 0 0
Id: 8009931
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 20.0
Sr+2 + H+ + Tartarate-2 = SrH(Tartarate)+
log_k 5.8949
delta_h 0 kJ
-gamma 0 0
Id: 8009932

log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Ba+2 + Tartarate-2 = Ba(Tartarate)
log_k 2.54
delta_h 0 kJ
-gamma 0 0
Id: 1009931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ba+2 + Tartarate-2 + H+ = BaH(Tartarate)+
log_k 5.77
delta_h 0 kJ
-gamma 0 0
Id: 1009932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Na+ + Tartarate-2 = Na(Tartarate)-
log_k 0.9
delta_h -0.8368 kJ
-gamma 0 0
Id: 5009931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Na+ + Tartarate-2 + H+ = NaH(Tartarate)
log_k 4.58
delta_h -2.8451 kJ
-gamma 0 0
Id: 5009932
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
K+ + Tartarate-2 = K(Tartarate)-
log_k 0.8
delta_h 0 kJ
-gamma 0 0
Id: 4109931
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Glycine- = H(Glycine)
log_k 9.778
delta_h -44.3504 kJ
-gamma 0 0
Id: 3309941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2H+ + Glycine- = H2(Glycine)+
log_k 12.128
delta_h -48.4507 kJ

-gamma 0 0
Id: 3309942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Glycine- = Pb(Glycine)+
log_k 5.47
delta_h 0 kJ
-gamma 0 0
Id: 6009941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + 2Glycine- = Pb(Glycine)2
log_k 8.86
delta_h 0 kJ
-gamma 0 0
Id: 6009942
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Tl+ + Glycine- = Tl(Glycine)
log_k 1.72
delta_h 0 kJ
-gamma 0 0
Id: 8709941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Glycine- = Zn(Glycine)+
log_k 5.38
delta_h -11.7152 kJ
-gamma 0 0
Id: 9509941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Glycine- = Zn(Glycine)2
log_k 9.81
delta_h -24.2672 kJ
-gamma 0 0
Id: 9509942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 3Glycine- = Zn(Glycine)3-
log_k 12.3
delta_h -39.748 kJ
-gamma 0 0
Id: 9509943
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Glycine- = Cd(Glycine)+

log_k 4.69
delta_h -8.7864 kJ
-gamma 0 0
Id: 1609941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Glycine- = Cd(Glycine)2
log_k 8.4
delta_h -22.5936 kJ
-gamma 0 0
Id: 1609942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 3Glycine- = Cd(Glycine)3-
log_k 10.7
delta_h -35.9824 kJ
-gamma 0 0
Id: 1609943
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Glycine- + 2H+ = Hg(Glycine)+ + 2H2O
log_k 17
delta_h 0 kJ
-gamma 0 0
Id: 3619941
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Hg(OH)2 + 2Glycine- + 2H+ = Hg(Glycine)2 + 2H2O
log_k 25.8
delta_h 0 kJ
-gamma 0 0
Id: 3619942
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cu+ + 2Glycine- = Cu(Glycine)2-
log_k 10.3
delta_h 0 kJ
-gamma 0 0
Id: 2309941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Glycine- = Cu(Glycine)+
log_k 8.57
delta_h -25.104 kJ
-gamma 0 0
Id: 2319941
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
Cu+2 + 2Glycine- = Cu(Glycine)2
log_k 15.7
delta_h -54.8104 kJ
-gamma 0 0
Id: 2319942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Glycine- = Ag(Glycine)
log_k 3.51
delta_h -19.2464 kJ
-gamma 0 0
Id: 209941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Glycine- = Ag(Glycine)2-
log_k 6.89
delta_h -48.116 kJ
-gamma 0 0
Id: 209942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Glycine- = Ni(Glycine)+
log_k 6.15
delta_h -18.828 kJ
-gamma 0 0
Id: 5409941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Glycine- = Ni(Glycine)2
log_k 11.12
delta_h -38.0744 kJ
-gamma 0 0
Id: 5409942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 3Glycine- = Ni(Glycine)3-
log_k 14.63
delta_h -62.3416 kJ
-gamma 0 0
Id: 5409943
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Co+2 + Glycine- = Co(Glycine)+
log_k 5.07
delta_h -12 kJ
-gamma 0 0
Id: 2009941

log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + 2Glycine- = Co(Glycine)2
log_k 9.07
delta_h -26 kJ
-gamma 0 0
Id: 2009942
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + 3Glycine- = Co(Glycine)3-
log_k 11.6
delta_h -41 kJ
-gamma 0 0
Id: 2009943
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + Glycine- + H2O = CoOH(Glycine) + H+
log_k -5.02
delta_h 0 kJ
-gamma 0 0
Id: 2009944
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Fe+2 + Glycine- = Fe(Glycine)+
log_k 4.31
delta_h -15.0624 kJ
-gamma 0 0
Id: 2809941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + 2Glycine- = Fe(Glycine)2
log_k 8.29
delta_h 0 kJ
-gamma 0 0
Id: 2809942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Glycine- = Fe(Glycine)+2
log_k 9.38
delta_h 0 kJ
-gamma 0 0
Id: 2819941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Glycine- + H+ = FeH(Glycine)+3
log_k 11.55
delta_h 0 kJ

-gamma 0 0
Id: 2819942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Glycine- = Mn(Glycine)+
log_k 3.19
delta_h -1.2552 kJ
-gamma 0 0
Id: 4709941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + 2Glycine- = Mn(Glycine)2
log_k 5.4
delta_h 0 kJ
-gamma 0 0
Id: 4709942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + Glycine- + 2H+ = Cr(Glycine)+2 + 2H2O
log_k 18.7
delta_h 0 kJ
-gamma 0 0
Id: 2119941
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 2Glycine- + 2H+ = Cr(Glycine)2+ + 2H2O
log_k 25.6
delta_h 0 kJ
-gamma 0 0
Id: 2119942
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 3Glycine- + 2H+ = Cr(Glycine)3 + 2H2O
log_k 31.6
delta_h 0 kJ
-gamma 0 0
Id: 2119943
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Mg+2 + Glycine- = Mg(Glycine)+
log_k 2.08
delta_h 4.184 kJ
-gamma 0 0
Id: 4609941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Glycine- = Ca(Glycine)+

log_k 1.39
delta_h -4.184 kJ
-gamma 0 0
Id: 1509941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Glycine- + H+ = CaH(Glycine)+2
log_k 10.1
delta_h -35.9824 kJ
-gamma 0 0
Id: 1509942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Glycine- = Sr(Glycine)+
log_k 0.91
delta_h 0 kJ
-gamma 0 0
Id: 8009941
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Ba+2 + Glycine- = Ba(Glycine)+
log_k 0.77
delta_h 0 kJ
-gamma 0 0
Id: 1009941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Salicylate-2 = H(Salicylate)-
log_k 13.7
delta_h -35.7732 kJ
-gamma 0 0
Id: 3309951
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2H+ + Salicylate-2 = H2(Salicylate)
log_k 16.8
delta_h -38.7857 kJ
-gamma 0 0
Id: 3309952
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Salicylate-2 = Zn(Salicylate)
log_k 7.71
delta_h 0 kJ
-gamma 0 0
Id: 9509951
log K source: SCD2.62
Delta H source: SCD2.62

#T and ionic strength:
Zn+2 + Salicylate-2 + H+ = ZnH(Salicylate)+
log_k 15.5
delta_h 0 kJ
-gamma 0 0
Id: 9509952
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Salicylate-2 = Cd(Salicylate)
log_k 6.2
delta_h 0 kJ
-gamma 0 0
Id: 1609951
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Salicylate-2 + H+ = CdH(Salicylate)+
log_k 16
delta_h 0 kJ
-gamma 0 0
Id: 1609952
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Salicylate-2 = Cu(Salicylate)
log_k 11.3
delta_h -17.9912 kJ
-gamma 0 0
Id: 2319951
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Salicylate-2 = Cu(Salicylate)2-2
log_k 19.3
delta_h 0 kJ
-gamma 0 0
Id: 2319952
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Salicylate-2 + H+ = CuH(Salicylate)+
log_k 14.8
delta_h 0 kJ
-gamma 0 0
Id: 2319953
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Salicylate-2 = Ni(Salicylate)
log_k 8.2
delta_h 0 kJ
-gamma 0 0
Id: 5409951

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Salicylate-2 = Ni(Salicylate)2-2
log_k 12.64
delta_h 0 kJ
-gamma 0 0
Id: 5409952
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Co+2 + Salicylate-2 = Co(Salicylate)
log_k 7.4289
delta_h 0 kJ
-gamma 0 0
Id: 2009951
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Co+2 + 2Salicylate-2 = Co(Salicylate)2-2
log_k 11.8
delta_h 0 kJ
-gamma 0 0
Id: 2009952
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Fe+2 + Salicylate-2 = Fe(Salicylate)
log_k 7.2
delta_h 0 kJ
-gamma 0 0
Id: 2809951
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + 2Salicylate-2 = Fe(Salicylate)2-2
log_k 11.6
delta_h 0 kJ
-gamma 0 0
Id: 2809952
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Salicylate-2 = Fe(Salicylate)+
log_k 17.6
delta_h 0 kJ
-gamma 0 0
Id: 2819951
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + 2Salicylate-2 = Fe(Salicylate)2-
log_k 29.3
delta_h 0 kJ

-gamma 0 0
Id: 2819952
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Salicylate-2 = Mn(Salicylate)
log_k 6.5
delta_h 0 kJ
-gamma 0 0
Id: 4709951
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + 2Salicylate-2 = Mn(Salicylate)2-2
log_k 10.1
delta_h 0 kJ
-gamma 0 0
Id: 4709952
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Be+2 + Salicylate-2 = Be(Salicylate)
log_k 13.3889
delta_h -31.7732 kJ
-gamma 0 0
Id: 1109951
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Be+2 + 2Salicylate-2 = Be(Salicylate)2-2
log_k 23.25
delta_h 0 kJ
-gamma 0 0
Id: 1109952
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Mg+2 + Salicylate-2 = Mg(Salicylate)
log_k 5.76
delta_h 0 kJ
-gamma 0 0
Id: 4609951
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Salicylate-2 + H+ = MgH(Salicylate)+
log_k 15.3
delta_h 0 kJ
-gamma 0 0
Id: 4609952
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ca+2 + Salicylate-2 = Ca(Salicylate)

log_k 4.05
delta_h 0 kJ
-gamma 0 0
Id: 1509951
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Salicylate-2 + H+ = CaH(Salicylate)+
log_k 14.3
delta_h 0 kJ
-gamma 0 0
Id: 1509952
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ba+2 + Salicylate-2 + H+ = BaH(Salicylate)+
log_k 13.9
delta_h 0 kJ
-gamma 0 0
Id: 1009951
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
H+ + Glutamate-2 = H(Glutamate)-
log_k 9.96
delta_h -41.0032 kJ
-gamma 0 0
Id: 3309961
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2H+ + Glutamate-2 = H2(Glutamate)
log_k 14.26
delta_h -43.5136 kJ
-gamma 0 0
Id: 3309962
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
3H+ + Glutamate-2 = H3(Glutamate)+
log_k 16.42
delta_h -46.8608 kJ
-gamma 0 0
Id: 3309963
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Glutamate-2 = Pb(Glutamate)
log_k 6.43
delta_h 0 kJ
-gamma 0 0
Id: 6009961
log K source: SCD2.62
Delta H source: SCD2.62

#T and ionic strength:
Pb+2 + 2Glutamate-2 = Pb(Glutamate)2-2
log_k 8.61
delta_h 0 kJ
-gamma 0 0
Id: 6009962
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Pb+2 + Glutamate-2 + H+ = PbH(Glutamate)+
log_k 14.08
delta_h 0 kJ
-gamma 0 0
Id: 6009963
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Al+3 + Glutamate-2 + H+ = AlH(Glutamate)+2
log_k 13.07
delta_h 0 kJ
-gamma 0 0
Id: 309961
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Glutamate-2 = Zn(Glutamate)
log_k 6.2
delta_h 0 kJ
-gamma 0 0
Id: 9509961
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 2Glutamate-2 = Zn(Glutamate)2-2
log_k 9.13
delta_h 0 kJ
-gamma 0 0
Id: 9509962
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 3Glutamate-2 = Zn(Glutamate)3-4
log_k 9.8
delta_h 0 kJ
-gamma 0 0
Id: 9509963
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + Glutamate-2 = Cd(Glutamate)
log_k 4.7
delta_h 0 kJ
-gamma 0 0
Id: 1609961

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Glutamate-2 = Cd(Glutamate)2-2
log_k 7.59
delta_h 0 kJ
-gamma 0 0
Id: 1609962
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Glutamate-2 + 2H+ = Hg(Glutamate) + 2H2O
log_k 19.8
delta_h 0 kJ
-gamma 0 0
Id: 3619961
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Hg(OH)2 + 2Glutamate-2 + 2H+ = Hg(Glutamate)2-2 + 2H2O
log_k 26.2
delta_h 0 kJ
-gamma 0 0
Id: 3619962
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cu+2 + Glutamate-2 = Cu(Glutamate)
log_k 9.17
delta_h -20.92 kJ
-gamma 0 0
Id: 2319961
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Glutamate-2 = Cu(Glutamate)2-2
log_k 15.78
delta_h -48.116 kJ
-gamma 0 0
Id: 2319962
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Glutamate-2 + H+ = CuH(Glutamate)+
log_k 13.3
delta_h -28.0328 kJ
-gamma 0 0
Id: 2319963
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Glutamate-2 = Ag(Glutamate)-
log_k 4.22
delta_h 0 kJ

-gamma 0 0
Id: 209961
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Glutamate-2 = Ag(Glutamate)2-3
log_k 7.36
delta_h 0 kJ
-gamma 0 0
Id: 209962
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
2Ag+ + Glutamate-2 = Ag2(Glutamate)
log_k 3.4
delta_h 0 kJ
-gamma 0 0
Id: 209963
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Glutamate-2 = Ni(Glutamate)
log_k 6.47
delta_h 0 kJ
-gamma 0 0
Id: 5409961
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Glutamate-2 = Ni(Glutamate)2-2
log_k 10.7
delta_h -30.9616 kJ
-gamma 0 0
Id: 5409962
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Glutamate-2 = Co(Glutamate)
log_k 5.4178
delta_h 0 kJ
-gamma 0 0
Id: 2009961
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Co+2 + 2Glutamate-2 = Co(Glutamate)2-2
log_k 8.7178
delta_h 0 kJ
-gamma 0 0
Id: 2009962
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Mn+2 + Glutamate-2 = Mn(Glutamate)

log_k 4.95
delta_h 0 kJ
-gamma 0 0
Id: 4709961
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Mn+2 + 2Glutamate-2 = Mn(Glutamate)2-2
log_k 8.48
delta_h 0 kJ
-gamma 0 0
Id: 4709962
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + Glutamate-2 + 2H+ = Cr(Glutamate)+ + 2H2O
log_k 22.6
delta_h 0 kJ
-gamma 0 0
Id: 2119961
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 2Glutamate-2 + 2H+ = Cr(Glutamate)2- + 2H2O
log_k 30.7
delta_h 0 kJ
-gamma 0 0
Id: 2119962
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + Glutamate-2 + 3H+ = CrH(Glutamate)+2 + 2H2O
log_k 25.2
delta_h 0 kJ
-gamma 0 0
Id: 2119963
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Mg+2 + Glutamate-2 = Mg(Glutamate)
log_k 2.8
delta_h 0 kJ
-gamma 0 0
Id: 4609961
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Glutamate-2 = Ca(Glutamate)
log_k 2.06
delta_h 0 kJ
-gamma 0 0
Id: 1509961
log K source: NIST46.2
Delta H source: NIST46.2

#T and ionic strength:
Ca+2 + Glutamate-2 + H+ = CaH(Glutamate)+
log_k 11.13
delta_h 0 kJ
-gamma 0 0
Id: 1509962
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Glutamate-2 = Sr(Glutamate)
log_k 2.2278
delta_h 0 kJ
-gamma 0 0
Id: 8009961
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Ba+2 + Glutamate-2 = Ba(Glutamate)
log_k 2.14
delta_h 0 kJ
-gamma 0 0
Id: 1009961
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
H+ + Phthalate-2 = H(Phthalate)-
log_k 5.408
delta_h 2.1757 kJ
-gamma 0 0
Id: 3309971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
2H+ + Phthalate-2 = H2(Phthalate)
log_k 8.358
delta_h 4.8534 kJ
-gamma 0 0
Id: 3309972
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Phthalate-2 = Pb(Phthalate)
log_k 4.26
delta_h 0 kJ
-gamma 0 0
Id: 6009971
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Pb+2 + 2Phthalate-2 = Pb(Phthalate)2-2
log_k 4.83
delta_h 0 kJ
-gamma 0 0
Id: 6009972

log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Phthalate-2 + H+ = PbH(Phthalate)+
log_k 6.98
delta_h 0 kJ
-gamma 0 0
Id: 6009973
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Phthalate-2 = Al(Phthalate)+
log_k 4.56
delta_h 0 kJ
-gamma 0 0
Id: 309971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Al+3 + 2Phthalate-2 = Al(Phthalate)2-
log_k 7.2
delta_h 0 kJ
-gamma 0 0
Id: 309972
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Phthalate-2 = Zn(Phthalate)
log_k 2.91
delta_h 13.3888 kJ
-gamma 0 0
Id: 9509971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Phthalate-2 = Zn(Phthalate)2-2
log_k 4.2
delta_h 0 kJ
-gamma 0 0
Id: 9509972
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Phthalate-2 = Cd(Phthalate)
log_k 3.43
delta_h 0 kJ
-gamma 0 0
Id: 1609971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Phthalate-2 + H+ = CdH(Phthalate)+
log_k 6.3
delta_h 0 kJ

-gamma 0 0
Id: 1609973
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Phthalate-2 = Cd(Phthalate)2-2
log_k 3.7
delta_h 0 kJ
-gamma 0 0
Id: 1609972
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Phthalate-2 = Cu(Phthalate)
log_k 4.02
delta_h 8.368 kJ
-gamma 0 0
Id: 2319971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Phthalate-2 + H+ = CuH(Phthalate)+
log_k 7.1
delta_h 3.8493 kJ
-gamma 0 0
Id: 2319970
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Phthalate-2 = Cu(Phthalate)2-2
log_k 5.3
delta_h 15.8992 kJ
-gamma 0 0
Id: 2319972
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Phthalate-2 = Ni(Phthalate)
log_k 2.95
delta_h 7.5312 kJ
-gamma 0 0
Id: 5409971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Phthalate-2 + H+ = NiH(Phthalate)+
log_k 6.6
delta_h 0 kJ
-gamma 0 0
Id: 5409972
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Phthalate-2 = Co(Phthalate)

log_k 2.83
delta_h 7.9 kJ
-gamma 0 0
Id: 2009971
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + H+ + Phthalate-2 = CoH(Phthalate)+
log_k 7.227
delta_h 0 kJ
-gamma 0 0
Id: 2009972
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Mn+2 + Phthalate-2 = Mn(Phthalate)
log_k 2.74
delta_h 10.0416 kJ
-gamma 0 0
Id: 4709971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + Phthalate-2 + 2H+ = Cr(Phthalate)+ + 2H2O
log_k 16.3
delta_h 0 kJ
-gamma 0 0
Id: 2119971
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 2Phthalate-2 + 2H+ = Cr(Phthalate)2- + 2H2O
log_k 21.2
delta_h 0 kJ
-gamma 0 0
Id: 2119972
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 3Phthalate-2 + 2H+ = Cr(Phthalate)3-3 + 2H2O
log_k 23.3
delta_h 0 kJ
-gamma 0 0
Id: 2119973
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Be+2 + Phthalate-2 = Be(Phthalate)
log_k 4.8278
delta_h 0 kJ
-gamma 0 0
Id: 1109971
log K source: NIST46.4
Delta H source: NIST46.2

#T and ionic strength: 0.10 25.0
Be+2 + 2Phthalate-2 = Be(Phthalate)2-2
log_k 6.5478
delta_h 0 kJ
-gamma 0 0
Id: 1109972
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Mg+2 + Phthalate-2 = Mg(Phthalate)
log_k 2.49
delta_h 0 kJ
-gamma 0 0
Id: 4609971
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ca+2 + Phthalate-2 = Ca(Phthalate)
log_k 2.45
delta_h 0 kJ
-gamma 0 0
Id: 1509970
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Phthalate-2 + H+ = CaH(Phthalate)+
log_k 6.43
delta_h 0 kJ
-gamma 0 0
Id: 1509971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ba+2 + Phthalate-2 = Ba(Phthalate)
log_k 2.33
delta_h 0 kJ
-gamma 0 0
Id: 1009971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Na+ + Phthalate-2 = Na(Phthalate)-
log_k 0.8
delta_h 4.184 kJ
-gamma 0 0
Id: 5009970
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
K+ + Phthalate-2 = K(Phthalate)-
log_k 0.7
delta_h 3.7656 kJ
-gamma 0 0
Id: 4109971

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# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
PHASES
Sulfur
S + H+ + 2e- = HS-
log_k -2.1449
delta_h -16.3 kJ
Semetal(hex
Se + H+ + 2e- = HSe-
log_k -7.7084
delta_h 15.9 kJ
Semetal(am)
Se + H+ + 2e- = HSe-
log_k -7.1099
delta_h 10.8784 kJ
Sbmetal
Sb + 3H2O = Sb(OH)3 + 3H+ + 3e-
log_k -11.6889
delta_h 83.89 kJ
Snmetal(wht)
Sn + 2H2O = Sn(OH)2 + 2H+ + 2e-
log_k -2.3266
delta_h -0 kJ
Pbmetal
Pb = Pb+2 + 2e-
log_k 4.2462
delta_h 0.92 kJ
Tlmetal
Tl = Tl+ + e-
log_k 5.6762
delta_h 5.36 kJ
Znmetal
Zn = Zn+2 + 2e-
log_k 25.7886
delta_h -153.39 kJ
Cdmetal(alpha)
Cd = Cd+2 + 2e-
log_k 13.5147
delta_h -75.33 kJ
Cdmetal(gamma)
Cd = Cd+2 + 2e-
log_k 13.618
delta_h -75.92 kJ
Hgmetal(l)
Hg = 0.5Hg2+2 + e-
log_k -13.4517
delta_h 83.435 kJ
Cumetal
Cu = Cu+ + e-
log_k -8.756
delta_h 71.67 kJ
Agmetal
Ag = Ag+ + e-
```

log_k -13.5065
delta_h 105.79 kJ
Crmetal
Cr = Cr+2 + 2e-
log_k 30.4831
delta_h -172 kJ
Vmetal
V = V+3 + 3e-
log_k 44.0253
delta_h -259 kJ
Stibnite
Sb2S3 + 6H2O = 2Sb(OH)3 + 3H+ + 3HS-
log_k -50.46
delta_h 293.78 kJ
Orpiment
As2S3 + 6H2O = 2H3AsO3 + 3HS- + 3H+
log_k -61.0663
delta_h 350.68 kJ
Realgar
AsS + 3H2O = H3AsO3 + HS- + 2H+ + e-
log_k -19.747
delta_h 127.8 kJ
SnS
SnS + 2H2O = Sn(OH)2 + H+ + HS-
log_k -19.114
delta_h -0 kJ
SnS2
SnS2 + 6H2O = Sn(OH)6-2 + 4H+ + 2HS-
log_k -57.4538
delta_h -0 kJ
Galena
PbS + H+ = Pb+2 + HS-
log_k -13.97
delta_h 80 kJ
Tl2S
Tl2S + H+ = 2Tl+ + HS-
log_k -7.19
delta_h 91.52 kJ
ZnS(am)
ZnS + H+ = Zn+2 + HS-
log_k -9.052
delta_h 15.3553 kJ
Sphalerite
ZnS + H+ = Zn+2 + HS-
log_k -11.45
delta_h 30 kJ
Wurtzite
ZnS + H+ = Zn+2 + HS-
log_k -8.95
delta_h 21.171 kJ
Greenockite
CdS + H+ = Cd+2 + HS-
log_k -14.36
delta_h 55 kJ

Hg2S
Hg2S + H+ = Hg2+2 + HS-
log_k -11.6765
delta_h 69.7473 kJ
Cinnabar
HgS + 2H2O = Hg(OH)2 + H+ + HS-
log_k -45.694
delta_h 253.76 kJ
Metacinnabar
HgS + 2H2O = Hg(OH)2 + H+ + HS-
log_k -45.094
delta_h 253.72 kJ
Chalcocite
Cu2S + H+ = 2Cu+ + HS-
log_k -34.92
delta_h 168 kJ
Djurleite
Cu0.066Cu1.868S + H+ = 0.066Cu+2 + 1.868Cu+ + HS-
log_k -33.92
delta_h 200.334 kJ
Anilite
Cu0.25Cu1.5S + H+ = 0.25Cu+2 + 1.5Cu+ + HS-
log_k -31.878
delta_h 182.15 kJ
BlaubleiII
Cu0.6Cu0.8S + H+ = 0.6Cu+2 + 0.8Cu+ + HS-
log_k -27.279
delta_h -0 kJ
BlaubleiI
Cu0.9Cu0.2S + H+ = 0.9Cu+2 + 0.2Cu+ + HS-
log_k -24.162
delta_h -0 kJ
Covellite
CuS + H+ = Cu+2 + HS-
log_k -22.3
delta_h 97 kJ
Chalcopyrite
CuFeS2 + 2H+ = Cu+2 + Fe+2 + 2HS-
log_k -35.27
delta_h 148.448 kJ
Acanthite
Ag2S + H+ = 2Ag+ + HS-
log_k -36.22
delta_h 227 kJ
NiS(alpha)
NiS + H+ = Ni+2 + HS-
log_k -5.6
delta_h -0 kJ
NiS(beta)
NiS + H+ = Ni+2 + HS-
log_k -11.1
delta_h -0 kJ
NiS(gamma)
NiS + H+ = Ni+2 + HS-

log_k -12.8
delta_h -0 kJ
CoS(alpha)
CoS + H+ = Co+2 + HS-
log_k -7.44
delta_h -0 kJ
CoS(beta)
CoS + H+ = Co+2 + HS-
log_k -11.07
delta_h -0 kJ
FeS(ppt)
FeS + H+ = Fe+2 + HS-
log_k -2.95
delta_h -11 kJ
Greigite
Fe3S4 + 4H+ = 2Fe+3 + Fe+2 + 4HS-
log_k -45.035
delta_h -0 kJ
Mackinawite
FeS + H+ = Fe+2 + HS-
log_k -3.6
delta_h -0 kJ
Pyrite
FeS2 + 2H+ + 2e- = Fe+2 + 2HS-
log_k -18.5082
delta_h 49.844 kJ
MnS(grn)
MnS + H+ = Mn+2 + HS-
log_k 0.17
delta_h -32 kJ
MnS(pnk)
MnS + H+ = Mn+2 + HS-
log_k 3.34
delta_h -0 kJ
MoS2
MoS2 + 4H2O = MoO4-2 + 6H+ + 2HS- + 2e-
log_k -70.2596
delta_h 389.02 kJ
BeS
BeS + H+ = Be+2 + HS-
log_k 19.38
delta_h -0 kJ
BaS
BaS + H+ = Ba+2 + HS-
log_k 16.18
delta_h -0 kJ
Hg2(Cyanide)2
Hg2(Cyanide)2 = Hg2+2 + 2Cyanide-
log_k -39.3
delta_h -0 kJ
CuCyanide
CuCyanide = Cu+ + Cyanide-
log_k -19.5
delta_h -19 kJ

AgCyanide
AgCyanide = Ag+ + Cyanide-
log_k -15.74
delta_h 110.395 kJ
Ag2(Cyanide)2
Ag2(Cyanide)2 = 2Ag+ + 2Cyanide-
log_k -11.3289
delta_h -0 kJ
NaCyanide(cubic)
NaCyanide = Cyanide- + Na+
log_k 1.6012
delta_h 0.969 kJ
KCyanide(cubic)
KCyanide = Cyanide- + K+
log_k 1.4188
delta_h 11.93 kJ
Pb2Fe(Cyanide)6
Pb2Fe(Cyanide)6 = 2Pb+2 + Fe+2 + 6Cyanide-
log_k -53.42
delta_h -0 kJ
Zn2Fe(Cyanide)6
Zn2Fe(Cyanide)6 = 2Zn+2 + Fe+2 + 6Cyanide-
log_k -51.08
delta_h -0 kJ
Cd2Fe(Cyanide)6
Cd2Fe(Cyanide)6 = 2Cd+2 + Fe+2 + 6Cyanide-
log_k -52.78
delta_h -0 kJ
Ag4Fe(Cyanide)6
Ag4Fe(Cyanide)6 = 4Ag+ + Fe+2 + 6Cyanide-
log_k -79.47
delta_h -0 kJ
Ag3Fe(Cyanide)6
Ag3Fe(Cyanide)6 = 3Ag+ + Fe+3 + 6Cyanide-
log_k -72.7867
delta_h -0 kJ
Mn3(Fe(Cyanide)6)2
Mn3(Fe(Cyanide)6)2 = 3Mn+2 + 2Fe+3 + 12Cyanide-
log_k -105.4
delta_h -0 kJ
Sb2Se3
Sb2Se3 + 6H2O = 2Sb(OH)3 + 3HSe- + 3H+
log_k -67.7571
delta_h 343.046 kJ
SnSe
SnSe + 2H2O = Sn(OH)2 + H+ + HSe-
log_k -30.494
delta_h -0 kJ
SnSe2
SnSe2 + 6H2O = Sn(OH)6-2 + 4H+ + 2HSe-
log_k -65.1189
delta_h -0 kJ
Clausthalite
PbSe + H+ = Pb+2 + HSe-

log_k -27.1
delta_h 119.72 kJ
Tl2Se
Tl2Se + H+ = 2Tl+ + HSe-
log_k -18.1
delta_h 85.62 kJ
ZnSe
ZnSe + H+ = Zn+2 + HSe-
log_k -14.4
delta_h 25.51 kJ
CdSe
CdSe + H+ = Cd+2 + HSe-
log_k -20.2
delta_h 75.9814 kJ
HgSe
HgSe + 2H2O = Hg(OH)2 + H+ + HSe-
log_k -55.694
delta_h -0 kJ
Cu2Se(alpha)
Cu2Se + H+ = 2Cu+ + HSe-
log_k -45.8
delta_h 214.263 kJ
Cu3Se2
Cu3Se2 + 2H+ = 2HSe- + 2Cu+ + Cu+2
log_k -63.4911
delta_h 340.327 kJ
CuSe
CuSe + H+ = Cu+2 + HSe-
log_k -33.1
delta_h 121.127 kJ
CuSe2
CuSe2 + 2H+ + 2e- = 2HSe- + Cu+2
log_k -33.3655
delta_h 140.582 kJ
Ag2Se
Ag2Se + H+ = 2Ag+ + HSe-
log_k -48.7
delta_h 265.48 kJ
NiSe
NiSe + H+ = Ni+2 + HSe-
log_k -17.7
delta_h -0 kJ
CoSe
CoSe + H+ = Co+2 + HSe-
log_k -16.2
delta_h -0 kJ
FeSe
FeSe + H+ = Fe+2 + HSe-
log_k -11
delta_h 2.092 kJ
Ferroselite
FeSe2 + 2H+ + 2e- = 2HSe- + Fe+2
log_k -18.5959
delta_h 47.2792 kJ

MnSe
MnSe + H+ = Mn+2 + HSe-
log_k 3.5
delta_h -98.15 kJ
AlSb
AlSb + 3H2O = Sb(OH)3 + 6e- + Al+3 + 3H+
log_k 65.6241
delta_h -0 kJ
ZnSb
ZnSb + 3H2O = Sb(OH)3 + 5e- + Zn+2 + 3H+
log_k 11.0138
delta_h -54.8773 kJ
CdSb
CdSb + 3H2O = Sb(OH)3 + 5e- + 3H+ + Cd+2
log_k -0.3501
delta_h 22.36 kJ
Cu2Sb:3H2O
Cu2Sb:3H2O = Sb(OH)3 + 6e- + 3H+ + Cu+ + Cu+2
log_k -34.8827
delta_h 233.237 kJ
Cu3Sb
Cu3Sb + 3H2O = Sb(OH)3 + 6e- + 3H+ + 3Cu+
log_k -42.5937
delta_h 308.131 kJ
#Ag4Sb
Ag4Sb + 3H2O = Sb(OH)3 + 6e- + 3Ag+ + 3H+
log_k -56.1818
delta_h -0 kJ
Breithauptite
NiSb + 3H2O = Sb(OH)3 + 5e- + 3H+ + Ni+2
log_k -18.5225
delta_h 96.0019 kJ
MnSb
MnSb + 3H2O = Mn+3 + Sb(OH)3 + 6e- + 3H+
log_k -2.9099
delta_h 21.1083 kJ
Mn2Sb
Mn2Sb + 3H2O = 2Mn+2 + Sb(OH)3 + 7e- + 3H+
log_k 61.0796
delta_h -0 kJ
USb2
USb2 + 8H2O = UO2+2 + 2Sb(OH)3 + 12e- + 10H+
log_k 29.5771
delta_h -103.56 kJ
U3Sb4
U3Sb4 + 12H2O = 3U+4 + 4Sb(OH)3 + 24e- + 12H+
log_k 152.383
delta_h -986.04 kJ
Mg2Sb3
Mg2Sb3 + 9H2O = 2Mg+2 + 3Sb(OH)3 + 9H+ + 13e-
log_k 74.6838
delta_h -0 kJ
Ca3Sb2
Ca3Sb2 + 6H2O = 3Ca+2 + 2Sb(OH)3 + 6H+ + 12e-

log_k 142.974
delta_h -732.744 kJ
NaSb
NaSb + 3H2O = Na+ + Sb(OH)3 + 3H+ + 4e-
log_k 23.1658
delta_h -93.45 kJ
Na3Sb
Na3Sb + 3H2O = 3Na+ + Sb(OH)3 + 3H+ + 6e-
log_k 94.4517
delta_h -432.13 kJ
SeO2
SeO2 + H2O = HSeO3- + H+
log_k 0.1246
delta_h 1.4016 kJ
SeO3
SeO3 + H2O = SeO4-2 + 2H+
log_k 21.044
delta_h -146.377 kJ
Sb2O5
Sb2O5 + 7H2O = 2Sb(OH)6- + 2H+
log_k -9.6674
delta_h -0 kJ
SbO2
SbO2 + 4H2O = Sb(OH)6- + e- + 2H+
log_k -27.8241
delta_h -0 kJ
Sb2O4
Sb2O4 + 2H2O + 2H+ + 2e- = 2Sb(OH)3
log_k 3.4021
delta_h -68.04 kJ
Sb4O6(cubic)
Sb4O6 + 6H2O = 4Sb(OH)3
log_k -18.2612
delta_h 61.1801 kJ
Sb4O6(orth)
Sb4O6 + 6H2O = 4Sb(OH)3
log_k -17.9012
delta_h 37.6801 kJ
Sb(OH)3
Sb(OH)3 = Sb(OH)3
log_k -7.1099
delta_h 30.1248 kJ
Senarmontite
Sb2O3 + 3H2O = 2Sb(OH)3
log_k -12.3654
delta_h 30.6478 kJ
Valentinite
Sb2O3 + 3H2O = 2Sb(OH)3
log_k -8.4806
delta_h 19.0163 kJ
Chalcedony
SiO2 + 2H2O = H4SiO4
log_k -3.55
delta_h 19.7 kJ

Cristobalite
SiO2 + 2H2O = H4SiO4
log_k -3.35
delta_h 20.006 kJ
Quartz
SiO2 + 2H2O = H4SiO4
log_k -4
delta_h 22.36 kJ
SiO2(am-gel)
SiO2 + 2H2O = H4SiO4
log_k -2.71
delta_h 14 kJ
SiO2(am-ppt)
SiO2 + 2H2O = H4SiO4
log_k -2.74
delta_h 15.15 kJ
SnO
SnO + H2O = Sn(OH)2
log_k -4.9141
delta_h -0 kJ
SnO2
SnO2 + 4H2O = Sn(OH)6-2 + 2H+
log_k -28.9749
delta_h -0 kJ
Sn(OH)2
Sn(OH)2 = Sn(OH)2
log_k -5.4309
delta_h -0 kJ
Sn(OH)4
Sn(OH)4 + 2H2O = Sn(OH)6-2 + 2H+
log_k -22.2808
delta_h -0 kJ
H2Sn(OH)6
H2Sn(OH)6 = Sn(OH)6-2 + 2H+
log_k -23.5281
delta_h -0 kJ
Massicot
PbO + 2H+ = Pb+2 + H2O
log_k 12.894
delta_h -66.848 kJ
Litharge
PbO + 2H+ = Pb+2 + H2O
log_k 12.694
delta_h -65.501 kJ
PbO:0.3H2O
PbO:0.33H2O + 2H+ = Pb+2 + 1.33H2O
log_k 12.98
delta_h -0 kJ
Plattnerite
PbO2 + 4H+ + 2e- = Pb+2 + 2H2O
log_k 49.6001
delta_h -296.27 kJ
Pb(OH)2
Pb(OH)2 + 2H+ = Pb+2 + 2H2O

log_k 8.15
delta_h -58.5342 kJ
Pb2O(OH)2
Pb2O(OH)2 + 4H+ = 2Pb+2 + 3H2O
log_k 26.188
delta_h -0 kJ
Al(OH)3(am)
Al(OH)3 + 3H+ = Al+3 + 3H2O
log_k 10.8
delta_h -111 kJ
Boehmite
AlOOH + 3H+ = Al+3 + 2H2O
log_k 8.578
delta_h -117.696 kJ
Diaspore
AlOOH + 3H+ = Al+3 + 2H2O
log_k 6.873
delta_h -103.052 kJ
Gibbsite
Al(OH)3 + 3H+ = Al+3 + 3H2O
log_k 8.291
delta_h -95.3952 kJ
Tl2O
Tl2O + 2H+ = 2Tl+ + H2O
log_k 27.0915
delta_h -96.41 kJ
TlOH
TlOH + H+ = Tl+ + H2O
log_k 12.9186
delta_h -41.57 kJ
Avicennite
Tl2O3 + 3H2O = 2Tl(OH)3
log_k -13
delta_h -0 kJ
Tl(OH)3
Tl(OH)3 = Tl(OH)3
log_k -5.441
delta_h -0 kJ
Zn(OH)2(am)
Zn(OH)2 + 2H+ = Zn+2 + 2H2O
log_k 12.474
delta_h -80.62 kJ
Zn(OH)2
Zn(OH)2 + 2H+ = Zn+2 + 2H2O
log_k 12.2
delta_h -0 kJ
Zn(OH)2(beta)
Zn(OH)2 + 2H+ = Zn+2 + 2H2O
log_k 11.754
delta_h -83.14 kJ
Zn(OH)2(gamma)
Zn(OH)2 + 2H+ = Zn+2 + 2H2O
log_k 11.734
delta_h -0 kJ

Zn(OH)2(epsilon)
Zn(OH)2 + 2H+ = Zn+2 + 2H2O
log_k 11.534
delta_h -81.8 kJ
ZnO(active)
ZnO + 2H+ = Zn+2 + H2O
log_k 11.1884
delta_h -88.76 kJ
Zincite
ZnO + 2H+ = Zn+2 + H2O
log_k 11.334
delta_h -89.62 kJ
Cd(OH)2(am)
Cd(OH)2 + 2H+ = Cd+2 + 2H2O
log_k 13.73
delta_h -86.9017 kJ
Cd(OH)2
Cd(OH)2 + 2H+ = Cd+2 + 2H2O
log_k 13.644
delta_h -94.62 kJ
Monteponite
CdO + 2H+ = Cd+2 + H2O
log_k 15.1034
delta_h -103.4 kJ
Hg2(OH)2
Hg2(OH)2 + 2H+ = Hg2+2 + 2H2O
log_k 5.2603
delta_h -0 kJ
Montroydite
HgO + H2O = Hg(OH)2
log_k -3.64
delta_h -38.9 kJ
Hg(OH)2
Hg(OH)2 = Hg(OH)2
log_k -3.4963
delta_h -0 kJ
Cuprite
Cu2O + 2H+ = 2Cu+ + H2O
log_k -1.406
delta_h -124.02 kJ
Cu(OH)2
Cu(OH)2 + 2H+ = Cu+2 + 2H2O
log_k 8.674
delta_h -56.42 kJ
Tenorite
CuO + 2H+ = Cu+2 + H2O
log_k 7.644
delta_h -64.867 kJ
Ag2O
Ag2O + 2H+ = 2Ag+ + H2O
log_k 12.574
delta_h -45.62 kJ
Ni(OH)2
Ni(OH)2 + 2H+ = Ni+2 + 2H2O

log_k 12.794
delta_h -95.96 kJ
Bunsenite
NiO + 2H+ = Ni+2 + H2O
log_k 12.4456
delta_h -100.13 kJ
CoO
CoO + 2H+ = Co+2 + H2O
log_k 13.5864
delta_h -106.295 kJ
Co(OH)2
Co(OH)2 + 2H+ = Co+2 + 2H2O
log_k 13.094
delta_h -0 kJ
Co(OH)3
Co(OH)3 + 3H+ = Co+3 + 3H2O
log_k -2.309
delta_h -92.43 kJ
#Wustite-0.11
WUSTITE-0.11 + 2H+ = 0.947Fe+2 + H2O
log_k 11.6879
delta_h -103.938 kJ
Fe(OH)2
Fe(OH)2 + 2H+ = Fe+2 + 2H2O
log_k 13.564
delta_h -0 kJ
Ferrihydrite
Fe(OH)3 + 3H+ = Fe+3 + 3H2O
log_k 3.191
delta_h -73.374 kJ
Fe3(OH)8
Fe3(OH)8 + 8H+ = 2Fe+3 + Fe+2 + 8H2O
log_k 20.222
delta_h -0 kJ
Goethite
FeOOH + 3H+ = Fe+3 + 2H2O
log_k 0.491
delta_h -60.5843 kJ
Pyrolusite
MnO2 + 4H+ + 2e- = Mn+2 + 2H2O
log_k 41.38
delta_h -272 kJ
Birnessite
MnO2 + 4H+ + e- = Mn+3 + 2H2O
log_k 18.091
delta_h -0 kJ
Nsutite
MnO2 + 4H+ + e- = Mn+3 + 2H2O
log_k 17.504
delta_h -0 kJ
Pyrochroite
Mn(OH)2 + 2H+ = Mn+2 + 2H2O
log_k 15.194
delta_h -97.0099 kJ

Manganite
MnOOH + 3H+ + e- = Mn+2 + 2H2O
log_k 25.34
delta_h -0 kJ
Cr(OH)2
Cr(OH)2 + 2H+ = Cr+2 + 2H2O
log_k 10.8189
delta_h -35.6058 kJ
Cr(OH)3(am)
Cr(OH)3 + H+ = Cr(OH)2+ + H2O
log_k -0.75
delta_h -0 kJ
Cr(OH)3
Cr(OH)3 + H+ = Cr(OH)2+ + H2O
log_k 1.3355
delta_h -29.7692 kJ
CrO3
CrO3 + H2O = CrO4-2 + 2H+
log_k -3.2105
delta_h -5.2091 kJ
MoO3
MoO3 + H2O = MoO4-2 + 2H+
log_k -8
delta_h -0 kJ
VO
VO + 2H+ = V+3 + H2O + e-
log_k 14.7563
delta_h -113.041 kJ
V(OH)3
V(OH)3 + 3H+ = V+3 + 3H2O
log_k 7.591
delta_h -0 kJ
VO(OH)2
VO(OH)2 + 2H+ = VO+2 + 2H2O
log_k 5.1506
delta_h -0 kJ
Uraninite
UO2 + 4H+ = U+4 + 2H2O
log_k -4.6693
delta_h -77.86 kJ
UO2(am)
UO2 + 4H+ = U+4 + 2H2O
log_k 0.934
delta_h -109.746 kJ
UO3
UO3 + 2H+ = UO2+2 + H2O
log_k 7.7
delta_h -81.0299 kJ
Gummite
UO3 + 2H+ = UO2+2 + H2O
log_k 7.6718
delta_h -81.0299 kJ
UO2(OH)2(beta)
UO2(OH)2 + 2H+ = UO2+2 + 2H2O

log_k 5.6116
delta_h -56.7599 kJ
Schoepite
UO2(OH)2:H2O + 2H+ = UO2+2 + 3H2O
log_k 5.994
delta_h -49.79 kJ
Be(OH)2(am)
Be(OH)2 + 2H+ = Be+2 + 2H2O
log_k 7.194
delta_h -0 kJ
Be(OH)2(alpha)
Be(OH)2 + 2H+ = Be+2 + 2H2O
log_k 6.894
delta_h -0 kJ
Be(OH)2(beta)
Be(OH)2 + 2H+ = Be+2 + 2H2O
log_k 6.494
delta_h -0 kJ
Brucite
Mg(OH)2 + 2H+ = Mg+2 + 2H2O
log_k 16.844
delta_h -113.996 kJ
Periclase
MgO + 2H+ = Mg+2 + H2O
log_k 21.5841
delta_h -151.23 kJ
Mg(OH)2(active)
Mg(OH)2 + 2H+ = Mg+2 + 2H2O
log_k 18.794
delta_h -0 kJ
Lime
CaO + 2H+ = Ca+2 + H2O
log_k 32.6993
delta_h -193.91 kJ
Portlandite
Ca(OH)2 + 2H+ = Ca+2 + 2H2O
log_k 22.804
delta_h -128.62 kJ
Ba(OH)2:8H2O
Ba(OH)2:8H2O + 2H+ = Ba+2 + 10H2O
log_k 24.394
delta_h -54.32 kJ
Cu(SbO3)2
Cu(SbO3)2 + 6H+ + 4e- = 2Sb(OH)3 + Cu+2
log_k 45.2105
delta_h -0 kJ
Arsenolite
As4O6 + 6H2O = 4H3AsO3
log_k -2.76
delta_h 59.9567 kJ
Claudetite
As4O6 + 6H2O = 4H3AsO3
log_k -3.065
delta_h 55.6054 kJ

As2O5
As2O5 + 3H2O = 2H3AsO4
log_k 6.7061
delta_h -22.64 kJ
Pb2O3
Pb2O3 + 6H+ + 2e- = 2Pb+2 + 3H2O
log_k 61.04
delta_h -0 kJ
Minium
Pb3O4 + 8H+ + 2e- = 3Pb+2 + 4H2O
log_k 73.5219
delta_h -421.874 kJ
Al2O3
Al2O3 + 6H+ = 2Al+3 + 3H2O
log_k 19.6524
delta_h -258.59 kJ
Co3O4
Co3O4 + 8H+ = Co+2 + 2Co+3 + 4H2O
log_k -10.4956
delta_h -107.5 kJ
CoFe2O4
CoFe2O4 + 8H+ = Co+2 + 2Fe+3 + 4H2O
log_k -3.5281
delta_h -158.82 kJ
Magnetite
Fe3O4 + 8H+ = 2Fe+3 + Fe+2 + 4H2O
log_k 3.4028
delta_h -208.526 kJ
Hercynite
FeAl2O4 + 8H+ = Fe+2 + 2Al+3 + 4H2O
log_k 22.893
delta_h -313.92 kJ
Hematite
Fe2O3 + 6H+ = 2Fe+3 + 3H2O
log_k -1.418
delta_h -128.987 kJ
Maghemite
Fe2O3 + 6H+ = 2Fe+3 + 3H2O
log_k 6.386
delta_h -0 kJ
Lepidocrocite
FeOOH + 3H+ = Fe+3 + 2H2O
log_k 1.371
delta_h -0 kJ
Hausmannite
Mn3O4 + 8H+ + 2e- = 3Mn+2 + 4H2O
log_k 61.03
delta_h -421 kJ
Bixbyite
Mn2O3 + 6H+ = 2Mn+3 + 3H2O
log_k -0.6445
delta_h -124.49 kJ
Cr2O3
Cr2O3 + H2O + 2H+ = 2Cr(OH)2+

log_k -2.3576
delta_h -50.731 kJ
#V2O3
V2O3 + 3H+ = V+3 + 1.5H2O
log_k 4.9
delta_h -82.5085 kJ
V3O5
V3O5 + 4H+ = 3VO+2 + 2H2O + 2e-
log_k 1.8361
delta_h -98.46 kJ
#V2O4
V2O4 + 2H+ = VO+2 + H2O
log_k 4.27
delta_h -58.8689 kJ
V4O7
V4O7 + 6H+ = 4VO+2 + 3H2O + 2e-
log_k 7.1865
delta_h -163.89 kJ
V6O13
V6O13 + 2H+ = 6VO2+ + H2O + 4e-
log_k -60.86
delta_h 271.5 kJ
V2O5
V2O5 + 2H+ = 2VO2+ + H2O
log_k -1.36
delta_h 34 kJ
U4O9
U4O9 + 18H+ + 2e- = 4U+4 + 9H2O
log_k -3.0198
delta_h -426.87 kJ
U3O8
U3O8 + 16H+ + 4e- = 3U+4 + 8H2O
log_k 21.0834
delta_h -485.44 kJ
Spinel
MgAl2O4 + 8H+ = Mg+2 + 2Al+3 + 4H2O
log_k 36.8476
delta_h -388.012 kJ
Magnesioferrite
Fe2MgO4 + 8H+ = Mg+2 + 2Fe+3 + 4H2O
log_k 16.8597
delta_h -278.92 kJ
Natron
Na2CO3:10H2O = 2Na+ + CO3-2 + 10H2O
log_k -1.311
delta_h 65.8771 kJ
Cuprousferrite
CuFeO2 + 4H+ = Cu+ + Fe+3 + 2H2O
log_k -8.9171
delta_h -15.89 kJ
Cupricferrite
CuFe2O4 + 8H+ = Cu+2 + 2Fe+3 + 4H2O
log_k 5.9882
delta_h -210.21 kJ

FeCr2O4
FeCr2O4 + 4H+ = 2Cr(OH)2+ + Fe+2
log_k 7.2003
delta_h -140.4 kJ
MgCr2O4
MgCr2O4 + 4H+ = 2Cr(OH)2+ + Mg+2
log_k 16.2007
delta_h -179.4 kJ
SbF3
SbF3 + 3H2O = Sb(OH)3 + 3H+ + 3F-
log_k -10.2251
delta_h -6.7279 kJ
PbF2
PbF2 = Pb+2 + 2F-
log_k -7.44
delta_h 20 kJ
ZnF2
ZnF2 = Zn+2 + 2F-
log_k -0.5343
delta_h -59.69 kJ
CdF2
CdF2 = Cd+2 + 2F-
log_k -1.2124
delta_h -46.22 kJ
Hg2F2
Hg2F2 = Hg2+2 + 2F-
log_k -10.3623
delta_h -18.486 kJ
CuF
CuF = Cu+ + F-
log_k -4.9056
delta_h 16.648 kJ
CuF2
CuF2 = Cu+2 + 2F-
log_k 1.115
delta_h -66.901 kJ
CuF2:2H2O
CuF2:2H2O = Cu+2 + 2F- + 2H2O
log_k -4.55
delta_h -15.2716 kJ
AgF:4H2O
AgF:4H2O = Ag+ + F- + 4H2O
log_k 1.0491
delta_h 15.4202 kJ
CoF2
CoF2 = Co+2 + 2F-
log_k -1.5969
delta_h -57.368 kJ
CoF3
CoF3 = Co+3 + 3F-
log_k -1.4581
delta_h -123.692 kJ
CrF3
CrF3 + 2H2O = Cr(OH)2+ + 3F- + 2H+

log_k -11.3367
delta_h -23.3901 kJ
VF4
VF4 + H2O = VO+2 + 4F- + 2H+
log_k 14.93
delta_h -199.117 kJ
UF4
UF4 = U+4 + 4F-
log_k -29.5371
delta_h -79.0776 kJ
UF4:2.5H2O
UF4:2.5H2O = U+4 + 4F- + 2.5H2O
log_k -32.7179
delta_h 24.325 kJ
MgF2
MgF2 = Mg+2 + 2F-
log_k -8.13
delta_h -8 kJ
Fluorite
CaF2 = Ca+2 + 2F-
log_k -10.5
delta_h 8 kJ
SrF2
SrF2 = Sr+2 + 2F-
log_k -8.58
delta_h 4 kJ
BaF2
BaF2 = Ba+2 + 2F-
log_k -5.82
delta_h 4 kJ
Cryolite
Na3AlF6 = 3Na+ + Al+3 + 6F-
log_k -33.84
delta_h 38 kJ
SbCl3
SbCl3 + 3H2O = Sb(OH)3 + 3Cl- + 3H+
log_k 0.5719
delta_h -35.18 kJ
SnCl2
SnCl2 + 2H2O = Sn(OH)2 + 2H+ + 2Cl-
log_k -9.2752
delta_h -0 kJ
Cotunnite
PbCl2 = Pb+2 + 2Cl-
log_k -4.78
delta_h 26.166 kJ
Matlockite
PbClF = Pb+2 + Cl- + F-
log_k -8.9733
delta_h 33.19 kJ
Phosgenite
PbCl2:PbCO3 = 2Pb+2 + 2Cl- + CO3-2
log_k -19.81
delta_h -0 kJ

Laurionite
PbOHCl + H+ = Pb+2 + Cl- + H2O
log_k 0.623
delta_h -0 kJ
Pb2(OH)3Cl
Pb2(OH)3Cl + 3H+ = 2Pb+2 + 3H2O + Cl-
log_k 8.793
delta_h -0 kJ
TlCl
TlCl = Tl+ + Cl-
log_k -3.74
delta_h 41 kJ
ZnCl2
ZnCl2 = Zn+2 + 2Cl-
log_k 7.05
delta_h -72.5 kJ
Zn2(OH)3Cl
Zn2(OH)3Cl + 3H+ = 2Zn+2 + 3H2O + Cl-
log_k 15.191
delta_h -0 kJ
Zn5(OH)8Cl2
Zn5(OH)8Cl2 + 8H+ = 5Zn+2 + 8H2O + 2Cl-
log_k 38.5
delta_h -0 kJ
CdCl2
CdCl2 = Cd+2 + 2Cl-
log_k -0.6588
delta_h -18.58 kJ
CdCl2:1H2O
CdCl2:1H2O = Cd+2 + 2Cl- + H2O
log_k -1.6932
delta_h -7.47 kJ
CdCl2:2.5H2O
CdCl2:2.5H2O = Cd+2 + 2Cl- + 2.5H2O
log_k -1.913
delta_h 7.2849 kJ
CdOHCl
CdOHCl + H+ = Cd+2 + H2O + Cl-
log_k 3.5373
delta_h -30.93 kJ
Calomel
Hg2Cl2 = Hg2+2 + 2Cl-
log_k -17.91
delta_h 92 kJ
HgCl2
HgCl2 + 2H2O = Hg(OH)2 + 2Cl- + 2H+
log_k -21.2621
delta_h 107.82 kJ
Nantokite
CuCl = Cu+ + Cl-
log_k -6.73
delta_h 42.662 kJ
Melanothallite
CuCl2 = Cu+2 + 2Cl-

log_k 6.2572
delta_h -63.407 kJ
Atacamite
Cu2(OH)3Cl + 3H+ = 2Cu+2 + 3H2O + Cl-
log_k 7.391
delta_h -93.43 kJ
Cerargyrite
AgCl = Ag+ + Cl-
log_k -9.75
delta_h 65.2 kJ
CoCl2
CoCl2 = Co+2 + 2Cl-
log_k 8.2672
delta_h -79.815 kJ
CoCl2:6H2O
CoCl2:6H2O = Co+2 + 2Cl- + 6H2O
log_k 2.5365
delta_h 8.0598 kJ
(Co(NH3)6)Cl3
(Co(NH3)6)Cl3 + 6H+ = Co+3 + 6NH4+ + 3Cl-
log_k 20.0317
delta_h -33.1 kJ
(Co(NH3)5OH2)Cl3
(Co(NH3)5OH2)Cl3 + 5H+ = Co+3 + 5NH4+ + 3Cl- + H2O
log_k 11.7351
delta_h -25.37 kJ
(Co(NH3)5Cl)Cl2
(Co(NH3)5Cl)Cl2 + 5H+ = Co+3 + 5NH4+ + 3Cl-
log_k 4.5102
delta_h -10.74 kJ
Fe(OH)2.7Cl.3
Fe(OH)2.7Cl.3 + 2.7H+ = Fe+3 + 2.7H2O + 0.3Cl-
log_k -3.04
delta_h -0 kJ
MnCl2:4H2O
MnCl2:4H2O = Mn+2 + 2Cl- + 4H2O
log_k 2.7151
delta_h -10.83 kJ
CrCl2
CrCl2 = Cr+2 + 2Cl-
log_k 14.0917
delta_h -110.76 kJ
CrCl3
CrCl3 + 2H2O = Cr(OH)2+ + 3Cl- + 2H+
log_k 15.1145
delta_h -121.08 kJ
VCl2
VCl2 = V+3 + 2Cl- + e-
log_k 18.8744
delta_h -141.16 kJ
VCl3
VCl3 = V+3 + 3Cl-
log_k 23.4326
delta_h -179.54 kJ

VOCl
VOCl + 2H+ = V+3 + Cl- + H2O
log_k 11.1524
delta_h -104.91 kJ
VOCl2
VOCl2 = VO+2 + 2Cl-
log_k 12.7603
delta_h -117.76 kJ
VO2Cl
VO2Cl = VO2+ + Cl-
log_k 2.8413
delta_h -40.28 kJ
Halite
NaCl = Na+ + Cl-
log_k 1.6025
delta_h 3.7 kJ
SbBr3
SbBr3 + 3H2O = Sb(OH)3 + 3Br- + 3H+
log_k 0.9689
delta_h -20.94 kJ
SnBr2
SnBr2 + 2H2O = Sn(OH)2 + 2H+ + 2Br-
log_k -9.5443
delta_h -0 kJ
SnBr4
SnBr4 + 6H2O = Sn(OH)6-2 + 6H+ + 4Br-
log_k -28.8468
delta_h -0 kJ
PbBr2
PbBr2 = Pb+2 + 2Br-
log_k -5.3
delta_h 35.499 kJ
PbBrF
PbBrF = Pb+2 + Br- + F-
log_k -8.49
delta_h -0 kJ
TlBr
TlBr = Tl+ + Br-
log_k -5.44
delta_h 54 kJ
ZnBr2:2H2O
ZnBr2:2H2O = Zn+2 + 2Br- + 2H2O
log_k 5.2005
delta_h -30.67 kJ
CdBr2:4H2O
CdBr2:4H2O = Cd+2 + 2Br- + 4H2O
log_k -2.425
delta_h 30.5001 kJ
Hg2Br2
Hg2Br2 = Hg2+2 + 2Br-
log_k -22.25
delta_h 133 kJ
HgBr2
HgBr2 + 2H2O = Hg(OH)2 + 2Br- + 2H+

log_k -25.2734
delta_h 138.492 kJ
CuBr
CuBr = Cu+ + Br-
log_k -8.3
delta_h 54.86 kJ
Cu2(OH)3Br
Cu2(OH)3Br + 3H+ = 2Cu+2 + 3H2O + Br-
log_k 7.9085
delta_h -93.43 kJ
Bromyrite
AgBr = Ag+ + Br-
log_k -12.3
delta_h 84.5 kJ
(Co(NH3)6)Br3
(Co(NH3)6)Br3 + 6H+ = Co+3 + 6NH4+ + 3Br-
log_k 18.3142
delta_h -21.1899 kJ
(Co(NH3)5Cl)Br2
(Co(NH3)5Cl)Br2 + 5H+ = Co+3 + 5NH4+ + Cl- + 2Br-
log_k 5.0295
delta_h -6.4 kJ
CrBr3
CrBr3 + 2H2O = Cr(OH)2+ + 3Br- + 2H+
log_k 19.9086
delta_h -141.323 kJ
AsI3
AsI3 + 3H2O = H3AsO3 + 3I- + 3H+
log_k 4.2307
delta_h 3.15 kJ
SbI3
SbI3 + 3H2O = Sb(OH)3 + 3H+ + 3I-
log_k -0.538
delta_h 13.5896 kJ
PbI2
PbI2 = Pb+2 + 2I-
log_k -8.1
delta_h 62 kJ
TlI
TlI = Tl+ + I-
log_k -7.23
delta_h 75 kJ
ZnI2
ZnI2 = Zn+2 + 2I-
log_k 7.3055
delta_h -58.92 kJ
CdI2
CdI2 = Cd+2 + 2I-
log_k -3.5389
delta_h 13.82 kJ
Hg2I2
Hg2I2 = Hg2+2 + 2I-
log_k -28.34
delta_h 163 kJ

Coccinite
HgI2 + 2H2O = Hg(OH)2 + 2H+ + 2I-
log_k -34.9525
delta_h 210.72 kJ
HgI2:2NH3
HgI2:2NH3 + 2H2O = Hg(OH)2 + 2I- + 2NH4+
log_k -16.2293
delta_h 132.18 kJ
HgI2:6NH3
HgI2:6NH3 + 2H2O + 4H+ = Hg(OH)2 + 2I- + 6NH4+
log_k 33.7335
delta_h -90.3599 kJ
CuI
CuI = Cu+ + I-
log_k -12
delta_h 82.69 kJ
Iodyrite
AgI = Ag+ + I-
log_k -16.08
delta_h 110 kJ
(Co(NH3)6)I3
(Co(NH3)6)I3 + 6H+ = Co+3 + 6NH4+ + 3I-
log_k 16.5831
delta_h -9.6999 kJ
(Co(NH3)5Cl)I2
(Co(NH3)5Cl)I2 + 5H+ = Co+3 + 5NH4+ + Cl- + 2I-
log_k 5.5981
delta_h 0.66 kJ
CrI3
CrI3 + 2H2O = Cr(OH)2+ + 3I- + 2H+
log_k 20.4767
delta_h -134.419 kJ
Cerussite
PbCO3 = Pb+2 + CO3-2
log_k -13.13
delta_h 24.79 kJ
Pb2OCO3
Pb2OCO3 + 2H+ = 2Pb+2 + H2O + CO3-2
log_k -0.5578
delta_h -40.8199 kJ
Pb3O2CO3
Pb3O2CO3 + 4H+ = 3Pb+2 + CO3-2 + 2H2O
log_k 11.02
delta_h -110.583 kJ
Hydrocerussite
Pb3(OH)2(CO3)2 + 2H+ = 3Pb+2 + 2H2O + 2CO3-2
log_k -18.7705
delta_h -0 kJ
Pb10(OH)6O(CO3)6
Pb10(OH)6O(CO3)6 + 8H+ = 10Pb+2 + 6CO3-2 + 7H2O
log_k -8.76
delta_h -0 kJ
Tl2CO3
Tl2CO3 = 2Tl+ + CO3-2

log_k -3.8367
delta_h 35.49 kJ
Smithsonite
ZnCO3 = Zn+2 + CO3-2
log_k -10
delta_h -15.84 kJ
ZnCO3:1H2O
ZnCO3:1H2O = Zn+2 + CO3-2 + H2O
log_k -10.26
delta_h -0 kJ
Otavite
CdCO3 = Cd+2 + CO3-2
log_k -12
delta_h -0.55 kJ
Hg2CO3
Hg2CO3 = Hg2+2 + CO3-2
log_k -16.05
delta_h 45.14 kJ
Hg3O2CO3
Hg3O2CO3 + 4H2O = 3Hg(OH)2 + 2H+ + CO3-2
log_k -29.682
delta_h -0 kJ
CuCO3
CuCO3 = Cu+2 + CO3-2
log_k -11.5
delta_h -0 kJ
Malachite
Cu2(OH)2CO3 + 2H+ = 2Cu+2 + 2H2O + CO3-2
log_k -5.306
delta_h 76.38 kJ
Azurite
Cu3(OH)2(CO3)2 + 2H+ = 3Cu+2 + 2H2O + 2CO3-2
log_k -16.906
delta_h -95.22 kJ
Ag2CO3
Ag2CO3 = 2Ag+ + CO3-2
log_k -11.09
delta_h 42.15 kJ
NiCO3
NiCO3 = Ni+2 + CO3-2
log_k -6.87
delta_h -41.589 kJ
CoCO3
CoCO3 = Co+2 + CO3-2
log_k -9.98
delta_h -12.7612 kJ
Siderite
FeCO3 = Fe+2 + CO3-2
log_k -10.24
delta_h -16 kJ
Rhodochrosite
MnCO3 = Mn+2 + CO3-2
log_k -10.58
delta_h -1.88 kJ

Rutherfordine
UO2CO3 = UO2+2 + CO3-2
log_k -14.5
delta_h -3.03 kJ
Artinite
MgCO3:Mg(OH)2:3H2O + 2H+ = 2Mg+2 + CO3-2 + 5H2O
log_k 9.6
delta_h -120.257 kJ
Hydromagnesite
Mg5(CO3)4(OH)2:4H2O + 2H+ = 5Mg+2 + 4CO3-2 + 6H2O
log_k -8.766
delta_h -218.447 kJ
Magnesite
MgCO3 = Mg+2 + CO3-2
log_k -7.46
delta_h 20 kJ
Nesquehonite
MgCO3:3H2O = Mg+2 + CO3-2 + 3H2O
log_k -4.67
delta_h -24.2212 kJ
Aragonite
CaCO3 = Ca+2 + CO3-2
log_k -8.3
delta_h -12 kJ
Calcite
CaCO3 = Ca+2 + CO3-2
log_k -8.48
delta_h -8 kJ
Dolomite(ordered)
CaMg(CO3)2 = Ca+2 + Mg+2 + 2CO3-2
log_k -17.09
delta_h -39.5 kJ
Dolomite(disordered)
CaMg(CO3)2 = Ca+2 + Mg+2 + 2CO3-2
log_k -16.54
delta_h -46.4 kJ
Huntite
CaMg3(CO3)4 = 3Mg+2 + Ca+2 + 4CO3-2
log_k -29.968
delta_h -107.78 kJ
Strontianite
SrCO3 = Sr+2 + CO3-2
log_k -9.27
delta_h -0 kJ
Witherite
BaCO3 = Ba+2 + CO3-2
log_k -8.57
delta_h 4 kJ
Thermonatrite
Na2CO3:H2O = 2Na+ + CO3-2 + H2O
log_k 0.637
delta_h -10.4799 kJ
TlNO3
TlNO3 = Tl+ + NO3-

log_k -1.6127
delta_h 42.44 kJ
Zn(NO3)2:6H2O
Zn(NO3)2:6H2O = Zn+2 + 2NO3- + 6H2O
log_k 3.3153
delta_h 24.5698 kJ
Cu2(OH)3NO3
Cu2(OH)3NO3 + 3H+ = 2Cu+2 + 3H2O + NO3-
log_k 9.251
delta_h -72.5924 kJ
(Co(NH3)6)(NO3)3
(Co(NH3)6)(NO3)3 + 6H+ = Co+3 + 6NH4+ + 3NO3-
log_k 17.9343
delta_h 1.59 kJ
(Co(NH3)5Cl)(NO3)2
(Co(NH3)5Cl)(NO3)2 + 5H+ = Co+3 + 5NH4+ + Cl- + 2NO3-
log_k 6.2887
delta_h 6.4199 kJ
UO2(NO3)2
UO2(NO3)2 = UO2+2 + 2NO3-
log_k 12.1476
delta_h -83.3999 kJ
UO2(NO3)2:2H2O
UO2(NO3)2:2H2O = UO2+2 + 2NO3- + 2H2O
log_k 4.851
delta_h -25.355 kJ
UO2(NO3)2:3H2O
UO2(NO3)2:3H2O = UO2+2 + 2NO3- + 3H2O
log_k 3.39
delta_h -9.1599 kJ
UO2(NO3)2:6H2O
UO2(NO3)2:6H2O = UO2+2 + 2NO3- + 6H2O
log_k 2.0464
delta_h 20.8201 kJ
Pb(BO2)2
Pb(BO2)2 + 2H2O + 2H+ = Pb+2 + 2H3BO3
log_k 6.5192
delta_h -15.6119 kJ
Zn(BO2)2
Zn(BO2)2 + 2H2O + 2H+ = Zn+2 + 2H3BO3
log_k 8.29
delta_h -0 kJ
Cd(BO2)2
Cd(BO2)2 + 2H2O + 2H+ = Cd+2 + 2H3BO3
log_k 9.84
delta_h -0 kJ
Co(BO2)2
Co(BO2)2 + 2H2O + 2H+ = Co+2 + 2H3BO3
log_k 27.0703
delta_h -0 kJ
SnSO4
SnSO4 + 2H2O = Sn(OH)2 + 2H+ + SO4-2
log_k -56.9747
delta_h -0 kJ

Sn(SO4)2
Sn(SO4)2 + 6H2O = Sn(OH)6-2 + 6H+ + 2SO4-2
log_k -15.2123
delta_h -0 kJ
Larnakite
PbO:PbSO4 + 2H+ = 2Pb+2 + SO4-2 + H2O
log_k -0.4344
delta_h -21.83 kJ
Pb3O2SO4
Pb3O2SO4 + 4H+ = 3Pb+2 + SO4-2 + 2H2O
log_k 10.6864
delta_h -79.14 kJ
Pb4O3SO4
Pb4O3SO4 + 6H+ = 4Pb+2 + SO4-2 + 3H2O
log_k 21.8772
delta_h -136.45 kJ
Anglesite
PbSO4 = Pb+2 + SO4-2
log_k -7.79
delta_h 12 kJ
Pb4(OH)6SO4
Pb4(OH)6SO4 + 6H+ = 4Pb+2 + SO4-2 + 6H2O
log_k 21.1
delta_h -0 kJ
AlOHSO4
AlOHSO4 + H+ = Al+3 + SO4-2 + H2O
log_k -3.23
delta_h -0 kJ
Al4(OH)10SO4
Al4(OH)10SO4 + 10H+ = 4Al+3 + SO4-2 + 10H2O
log_k 22.7
delta_h -0 kJ
Tl2SO4
Tl2SO4 = 2Tl+ + SO4-2
log_k -3.7868
delta_h 33.1799 kJ
Zn2(OH)2SO4
Zn2(OH)2SO4 + 2H+ = 2Zn+2 + 2H2O + SO4-2
log_k 7.5
delta_h -0 kJ
Zn4(OH)6SO4
Zn4(OH)6SO4 + 6H+ = 4Zn+2 + 6H2O + SO4-2
log_k 28.4
delta_h -0 kJ
Zn3O(SO4)2
Zn3O(SO4)2 + 2H+ = 3Zn+2 + 2SO4-2 + H2O
log_k 18.9135
delta_h -258.08 kJ
Zincosite
ZnSO4 = Zn+2 + SO4-2
log_k 3.9297
delta_h -82.586 kJ
ZnSO4:1H2O
ZnSO4:1H2O = Zn+2 + SO4-2 + H2O

log_k -0.638
delta_h -44.0699 kJ
Bianchite
ZnSO4:6H2O = Zn+2 + SO4-2 + 6H2O
log_k -1.765
delta_h -0.6694 kJ
Goslarite
ZnSO4:7H2O = Zn+2 + SO4-2 + 7H2O
log_k -2.0112
delta_h 14.21 kJ
Cd3(OH)4SO4
Cd3(OH)4SO4 + 4H+ = 3Cd+2 + 4H2O + SO4-2
log_k 22.56
delta_h -0 kJ
Cd3(OH)2(SO4)2
Cd3(OH)2(SO4)2 + 2H+ = 3Cd+2 + 2H2O + 2SO4-2
log_k 6.71
delta_h -0 kJ
Cd4(OH)6SO4
Cd4(OH)6SO4 + 6H+ = 4Cd+2 + 6H2O + SO4-2
log_k 28.4
delta_h -0 kJ
CdSO4
CdSO4 = Cd+2 + SO4-2
log_k -0.1722
delta_h -51.98 kJ
CdSO4:1H2O
CdSO4:1H2O = Cd+2 + SO4-2 + H2O
log_k -1.7261
delta_h -31.5399 kJ
CdSO4:2.67H2O
CdSO4:2.67H2O = Cd+2 + SO4-2 + 2.67H2O
log_k -1.873
delta_h -17.9912 kJ
Hg2SO4
Hg2SO4 = Hg2+2 + SO4-2
log_k -6.13
delta_h 5.4 kJ
HgSO4
HgSO4 + 2H2O = Hg(OH)2 + SO4-2 + 2H+
log_k -9.4189
delta_h 14.6858 kJ
Cu2SO4
Cu2SO4 = 2Cu+ + SO4-2
log_k -1.95
delta_h -19.079 kJ
Antlerite
Cu3(OH)4SO4 + 4H+ = 3Cu+2 + 4H2O + SO4-2
log_k 8.788
delta_h -0 kJ
Brochantite
Cu4(OH)6SO4 + 6H+ = 4Cu+2 + 6H2O + SO4-2
log_k 15.222
delta_h -202.86 kJ

Langite
Cu4(OH)6SO4:H2O + 6H+ = 4Cu+2 + 7H2O + SO4-2
log_k 17.4886
delta_h -165.55 kJ
CuOCuSO4
CuOCuSO4 + 2H+ = 2Cu+2 + H2O + SO4-2
log_k 10.3032
delta_h -137.777 kJ
CuSO4
CuSO4 = Cu+2 + SO4-2
log_k 2.9395
delta_h -73.04 kJ
Chalcanthite
CuSO4:5H2O = Cu+2 + SO4-2 + 5H2O
log_k -2.64
delta_h 6.025 kJ
Ag2SO4
Ag2SO4 = 2Ag+ + SO4-2
log_k -4.82
delta_h 17 kJ
Ni4(OH)6SO4
Ni4(OH)6SO4 + 6H+ = 4Ni+2 + SO4-2 + 6H2O
log_k 32
delta_h -0 kJ
Retgersite
NiSO4:6H2O = Ni+2 + SO4-2 + 6H2O
log_k -2.04
delta_h 4.6024 kJ
Morenosite
NiSO4:7H2O = Ni+2 + SO4-2 + 7H2O
log_k -2.1449
delta_h 12.1802 kJ
CoSO4
CoSO4 = Co+2 + SO4-2
log_k 2.8024
delta_h -79.277 kJ
CoSO4:6H2O
CoSO4:6H2O = Co+2 + SO4-2 + 6H2O
log_k -2.4726
delta_h 1.0801 kJ
Melanterite
FeSO4:7H2O = Fe+2 + SO4-2 + 7H2O
log_k -2.209
delta_h 20.5 kJ
Fe2(SO4)3
Fe2(SO4)3 = 2Fe+3 + 3SO4-2
log_k -3.7343
delta_h -242.028 kJ
H-Jarosite
(H3O)Fe3(SO4)2(OH)6 + 5H+ = 3Fe+3 + 2SO4-2 + 7H2O
log_k -12.1
delta_h -230.748 kJ
Na-Jarosite
NaFe3(SO4)2(OH)6 + 6H+ = Na+ + 3Fe+3 + 2SO4-2 + 6H2O

log_k -11.2
delta_h -151.377 kJ
K-Jarosite
KFe3(SO4)2(OH)6 + 6H+ = K+ + 3Fe+3 + 2SO4-2 + 6H2O
log_k -14.8
delta_h -130.875 kJ
MnSO4
MnSO4 = Mn+2 + SO4-2
log_k 2.5831
delta_h -64.8401 kJ
Mn2(SO4)3
Mn2(SO4)3 = 2Mn+3 + 3SO4-2
log_k -5.711
delta_h -163.427 kJ
VOSO4
VOSO4 = VO+2 + SO4-2
log_k 3.6097
delta_h -86.7401 kJ
Epsomite
MgSO4:7H2O = Mg+2 + SO4-2 + 7H2O
log_k -2.1265
delta_h 11.5601 kJ
Anhydrite
CaSO4 = Ca+2 + SO4-2
log_k -4.36
delta_h -7.2 kJ
Gypsum
CaSO4:2H2O = Ca+2 + SO4-2 + 2H2O
log_k -4.61
delta_h 1 kJ
Celestite
SrSO4 = Sr+2 + SO4-2
log_k -6.62
delta_h 2 kJ
Barite
BaSO4 = Ba+2 + SO4-2
log_k -9.98
delta_h 23 kJ
Mirabilite
Na2SO4:10H2O = 2Na+ + SO4-2 + 10H2O
log_k -1.114
delta_h 79.4416 kJ
Thenardite
Na2SO4 = 2Na+ + SO4-2
log_k 0.3217
delta_h -9.121 kJ
K-Alum
KAl(SO4)2:12H2O = K+ + Al+3 + 2SO4-2 + 12H2O
log_k -5.17
delta_h 30.2085 kJ
Alunite
KAl3(SO4)2(OH)6 + 6H+ = K+ + 3Al+3 + 2SO4-2 + 6H2O
log_k -1.4
delta_h -210 kJ

(NH4)2CrO4
(NH4)2CrO4 = CrO4-2 + 2NH4+
log_k 0.4046
delta_h 9.163 kJ
PbCrO4
PbCrO4 = Pb+2 + CrO4-2
log_k -12.6
delta_h 44.18 kJ
Tl2CrO4
Tl2CrO4 = 2Tl+ + CrO4-2
log_k -12.01
delta_h 74.27 kJ
Hg2CrO4
Hg2CrO4 = Hg2+2 + CrO4-2
log_k -8.7
delta_h -0 kJ
CuCrO4
CuCrO4 = Cu+2 + CrO4-2
log_k -5.44
delta_h -0 kJ
Ag2CrO4
Ag2CrO4 = 2Ag+ + CrO4-2
log_k -11.59
delta_h 62 kJ
MgCrO4
MgCrO4 = CrO4-2 + Mg+2
log_k 5.3801
delta_h -88.9518 kJ
CaCrO4
CaCrO4 = Ca+2 + CrO4-2
log_k -2.2657
delta_h -26.945 kJ
SrCrO4
SrCrO4 = Sr+2 + CrO4-2
log_k -4.65
delta_h -10.1253 kJ
BaCrO4
BaCrO4 = Ba+2 + CrO4-2
log_k -9.67
delta_h 33 kJ
Li2CrO4
Li2CrO4 = CrO4-2 + 2Li+
log_k 4.8568
delta_h -45.2792 kJ
Na2CrO4
Na2CrO4 = CrO4-2 + 2Na+
log_k 2.9302
delta_h -19.6301 kJ
Na2Cr2O7
Na2Cr2O7 + H2O = 2CrO4-2 + 2Na+ + 2H+
log_k -9.8953
delta_h 22.1961 kJ
K2CrO4
K2CrO4 = CrO4-2 + 2K+

log_k -0.5134
delta_h 18.2699 kJ
K2Cr2O7
K2Cr2O7 + H2O = 2CrO4-2 + 2K+ + 2H+
log_k -17.2424
delta_h 80.7499 kJ
Hg2SeO3
Hg2SeO3 + H+ = Hg2+2 + HSeO3-
log_k -4.657
delta_h -0 kJ
HgSeO3
HgSeO3 + 2H2O = Hg(OH)2 + H+ + HSeO3-
log_k -12.43
delta_h -0 kJ
Ag2SeO3
Ag2SeO3 + H+ = 2Ag+ + HSeO3-
log_k -7.15
delta_h 39.68 kJ
CuSeO3:2H2O
CuSeO3:2H2O + H+ = Cu+2 + HSeO3- + 2H2O
log_k 0.5116
delta_h -36.861 kJ
NiSeO3:2H2O
NiSeO3:2H2O + H+ = HSeO3- + Ni+2 + 2H2O
log_k 2.8147
delta_h -31.0034 kJ
CoSeO3
CoSeO3 + H+ = Co+2 + HSeO3-
log_k 1.32
delta_h -0 kJ
Fe2(SeO3)3:2H2O
Fe2(SeO3)3:2H2O + 3H+ = 3HSeO3- + 2Fe+3 + 2H2O
log_k -20.6262
delta_h -0 kJ
Fe2(OH)4SeO3
Fe2(OH)4SeO3 + 5H+ = HSeO3- + 2Fe+3 + 4H2O
log_k 1.5539
delta_h -0 kJ
MnSeO3
MnSeO3 + H+ = Mn+2 + HSeO3-
log_k 1.13
delta_h -0 kJ
MnSeO3:2H2O
MnSeO3:2H2O + H+ = HSeO3- + Mn+2 + 2H2O
log_k 0.9822
delta_h 8.4935 kJ
MgSeO3:6H2O
MgSeO3:6H2O + H+ = Mg+2 + HSeO3- + 6H2O
log_k 3.0554
delta_h 5.23 kJ
CaSeO3:2H2O
CaSeO3:2H2O + H+ = HSeO3- + Ca+2 + 2H2O
log_k 2.8139
delta_h -19.4556 kJ

SrSeO3
SrSeO3 + H+ = Sr+2 + HSeO3-
log_k 2.3
delta_h -0 kJ
BaSeO3
BaSeO3 + H+ = Ba+2 + HSeO3-
log_k 1.83
delta_h 11.98 kJ
Na2SeO3:5H2O
Na2SeO3:5H2O + H+ = 2Na+ + HSeO3- + 5H2O
log_k 10.3
delta_h -0 kJ
PbSeO4
PbSeO4 = Pb+2 + SeO4-2
log_k -6.84
delta_h 15 kJ
Tl2SeO4
Tl2SeO4 = 2Tl+ + SeO4-2
log_k -4.1
delta_h 43 kJ
ZnSeO4:6H2O
ZnSeO4:6H2O = Zn+2 + SeO4-2 + 6H2O
log_k -1.52
delta_h -0 kJ
CdSeO4:2H2O
CdSeO4:2H2O = Cd+2 + SeO4-2 + 2H2O
log_k -1.85
delta_h -0 kJ
Ag2SeO4
Ag2SeO4 = 2Ag+ + SeO4-2
log_k -8.91
delta_h -43.5 kJ
CuSeO4:5H2O
CuSeO4:5H2O = Cu+2 + SeO4-2 + 5H2O
log_k -2.44
delta_h -0 kJ
NiSeO4:6H2O
NiSeO4:6H2O = Ni+2 + SeO4-2 + 6H2O
log_k -1.52
delta_h -0 kJ
CoSeO4:6H2O
CoSeO4:6H2O = Co+2 + SeO4-2 + 6H2O
log_k -1.53
delta_h -0 kJ
MnSeO4:5H2O
MnSeO4:5H2O = Mn+2 + SeO4-2 + 5H2O
log_k -2.05
delta_h -0 kJ
UO2SeO4:4H2O
UO2SeO4:4H2O = UO2+2 + SeO4-2 + 4H2O
log_k -2.25
delta_h -0 kJ
MgSeO4:6H2O
MgSeO4:6H2O = Mg+2 + SeO4-2 + 6H2O

log_k -1.2
delta_h -0 kJ
CaSeO4:2H2O
CaSeO4:2H2O = Ca+2 + SeO4-2 + 2H2O
log_k -3.02
delta_h -8.3 kJ
SrSeO4
SrSeO4 = Sr+2 + SeO4-2
log_k -4.4
delta_h 0.4 kJ
BaSeO4
BaSeO4 = Ba+2 + SeO4-2
log_k -7.46
delta_h 22 kJ
BeSeO4:4H2O
BeSeO4:4H2O = Be+2 + SeO4-2 + 4H2O
log_k -2.94
delta_h -0 kJ
Na2SeO4
Na2SeO4 = 2Na+ + SeO4-2
log_k 1.28
delta_h -0 kJ
K2SeO4
K2SeO4 = 2K+ + SeO4-2
log_k -0.73
delta_h -0 kJ
(NH4)2SeO4
(NH4)2SeO4 = 2NH4+ + SeO4-2
log_k 0.45
delta_h -0 kJ
H2MoO4
H2MoO4 = MoO4-2 + 2H+
log_k -12.8765
delta_h 49 kJ
PbMoO4
PbMoO4 = Pb+2 + MoO4-2
log_k -15.62
delta_h 53.93 kJ
Al2(MoO4)3
Al2(MoO4)3 = 3MoO4-2 + 2Al+3
log_k 2.3675
delta_h -260.8 kJ
Tl2MoO4
Tl2MoO4 = MoO4-2 + 2Tl+
log_k -7.9887
delta_h -0 kJ
ZnMoO4
ZnMoO4 = MoO4-2 + Zn+2
log_k -10.1254
delta_h -10.6901 kJ
CdMoO4
CdMoO4 = MoO4-2 + Cd+2
log_k -14.1497
delta_h 19.48 kJ

CuMoO4
CuMoO4 = MoO4-2 + Cu+2
log_k -13.0762
delta_h 12.2 kJ
Ag2MoO4
Ag2MoO4 = 2Ag+ + MoO4-2
log_k -11.55
delta_h 52.7 kJ
NiMoO4
NiMoO4 = MoO4-2 + Ni+2
log_k -11.1421
delta_h 1.3 kJ
CoMoO4
CoMoO4 = MoO4-2 + Co+2
log_k -7.7609
delta_h -23.3999 kJ
FeMoO4
FeMoO4 = MoO4-2 + Fe+2
log_k -10.091
delta_h -11.1 kJ
BeMoO4
BeMoO4 = MoO4-2 + Be+2
log_k -1.7817
delta_h -56.4 kJ
MgMoO4
MgMoO4 = Mg+2 + MoO4-2
log_k -1.85
delta_h -0 kJ
CaMoO4
CaMoO4 = Ca+2 + MoO4-2
log_k -7.95
delta_h -2 kJ
BaMoO4
BaMoO4 = MoO4-2 + Ba+2
log_k -6.9603
delta_h 10.96 kJ
Li2MoO4
Li2MoO4 = MoO4-2 + 2Li+
log_k 2.4416
delta_h -33.9399 kJ
Na2MoO4
Na2MoO4 = MoO4-2 + 2Na+
log_k 1.4901
delta_h -9.98 kJ
Na2MoO4:2H2O
Na2MoO4:2H2O = MoO4-2 + 2Na+ + 2H2O
log_k 1.224
delta_h -0 kJ
Na2Mo2O7
Na2Mo2O7 + H2O = 2MoO4-2 + 2Na+ + 2H+
log_k -16.5966
delta_h 56.2502 kJ
K2MoO4
K2MoO4 = MoO4-2 + 2K+

log_k 3.2619
delta_h -3.38 kJ
PbHPO4
PbHPO4 = Pb+2 + H+ + PO4-3
log_k -23.805
delta_h -0 kJ
Pb3(PO4)2
Pb3(PO4)2 = 3Pb+2 + 2PO4-3
log_k -43.53
delta_h -0 kJ
Pyromorphite
Pb5(PO4)3Cl = 5Pb+2 + 3PO4-3 + Cl-
log_k -84.43
delta_h -0 kJ
Hydroxylpyromorphite
Pb5(PO4)3OH + H+ = 5Pb+2 + 3PO4-3 + H2O
log_k -62.79
delta_h -0 kJ
Plumbgummite
PbAl3(PO4)2(OH)5:H2O + 5H+ = Pb+2 + 3Al+3 + 2PO4-3 + 6H2O
log_k -32.79
delta_h -0 kJ
Hinsdalite
PbAl3PO4SO4(OH)6 + 6H+ = Pb+2 + 3Al+3 + PO4-3 + SO4-2 + 6H2O
log_k -2.5
delta_h -0 kJ
Tsumebite
Pb2CuPO4(OH)3:3H2O + 3H+ = 2Pb+2 + Cu+2 + PO4-3 + 6H2O
log_k -9.79
delta_h -0 kJ
Zn3(PO4)2:4H2O
Zn3(PO4)2:4H2O = 3Zn+2 + 2PO4-3 + 4H2O
log_k -35.42
delta_h -0 kJ
Cd3(PO4)2
Cd3(PO4)2 = 3Cd+2 + 2PO4-3
log_k -32.6
delta_h -0 kJ
Hg2HPO4
Hg2HPO4 = Hg2+2 + H+ + PO4-3
log_k -24.775
delta_h -0 kJ
Cu3(PO4)2
Cu3(PO4)2 = 3Cu+2 + 2PO4-3
log_k -36.85
delta_h -0 kJ
Cu3(PO4)2:3H2O
Cu3(PO4)2:3H2O = 3Cu+2 + 2PO4-3 + 3H2O
log_k -35.12
delta_h -0 kJ
Ag3PO4
Ag3PO4 = 3Ag+ + PO4-3
log_k -17.59
delta_h -0 kJ

Ni3(PO4)2
Ni3(PO4)2 = 3Ni+2 + 2PO4-3
log_k -31.3
delta_h -0 kJ
CoHPO4
CoHPO4 = Co+2 + PO4-3 + H+
log_k -19.0607
delta_h -0 kJ
Co3(PO4)2
Co3(PO4)2 = 3Co+2 + 2PO4-3
log_k -34.6877
delta_h -0 kJ
Vivianite
Fe3(PO4)2:8H2O = 3Fe+2 + 2PO4-3 + 8H2O
log_k -36
delta_h -0 kJ
Strengite
FePO4:2H2O = Fe+3 + PO4-3 + 2H2O
log_k -26.4
delta_h -9.3601 kJ
Mn3(PO4)2
Mn3(PO4)2 = 3Mn+2 + 2PO4-3
log_k -23.827
delta_h 8.8701 kJ
MnHPO4
MnHPO4 = Mn+2 + PO4-3 + H+
log_k -25.4
delta_h -0 kJ
(VO)3(PO4)2
(VO)3(PO4)2 = 3VO+2 + 2PO4-3
log_k -25.1
delta_h -0 kJ
Mg3(PO4)2
Mg3(PO4)2 = 3Mg+2 + 2PO4-3
log_k -23.28
delta_h -0 kJ
MgHPO4:3H2O
MgHPO4:3H2O = Mg+2 + H+ + PO4-3 + 3H2O
log_k -18.175
delta_h -0 kJ
FCO3Apatite
Ca9.316Na0.36Mg0.144(PO4)4.8(CO3)1.2F2.48 = 9.316Ca+2 + 0.36Na+ + 0.144Mg+2 +
4.8PO4-3 + 1.2CO3-2 + 2.48F-
log_k -114.4
delta_h 164.808 kJ
Hydroxylapatite
Ca5(PO4)3OH + H+ = 5Ca+2 + 3PO4-3 + H2O
log_k -44.333
delta_h -0 kJ
CaHPO4:2H2O
CaHPO4:2H2O = Ca+2 + H+ + PO4-3 + 2H2O
log_k -18.995
delta_h 23 kJ
CaHPO4

CaHPO4 = Ca+2 + H+ + PO4-3
log_k -19.275
delta_h 31 kJ
Ca3(PO4)2(beta)
Ca3(PO4)2 = 3Ca+2 + 2PO4-3
log_k -28.92
delta_h 54 kJ
Ca4H(PO4)3:3H2O
Ca4H(PO4)3:3H2O = 4Ca+2 + H+ + 3PO4-3 + 3H2O
log_k -47.08
delta_h -0 kJ
SrHPO4
SrHPO4 = Sr+2 + H+ + PO4-3
log_k -19.295
delta_h -0 kJ
BaHPO4
BaHPO4 = Ba+2 + H+ + PO4-3
log_k -19.775
delta_h -0 kJ
U(HPO4)2:4H2O
U(HPO4)2:4H2O = U+4 + 2PO4-3 + 2H+ + 4H2O
log_k -51.584
delta_h 16.0666 kJ
(UO2)3(PO4)2
(UO2)3(PO4)2 = 3UO2+2 + 2PO4-3
log_k -49.4
delta_h 397.062 kJ
UO2HPO4
UO2HPO4 = UO2+2 + H+ + PO4-3
log_k -24.225
delta_h -0 kJ
Uramphite
(NH4)2(UO2)2(PO4)2 = 2UO2+2 + 2NH4+ + 2PO4-3
log_k -51.749
delta_h 40.5848 kJ
Przhevalskite
Pb(UO2)2(PO4)2 = 2UO2+2 + Pb+2 + 2PO4-3
log_k -44.365
delta_h -46.024 kJ
Torbernite
Cu(UO2)2(PO4)2 = 2UO2+2 + Cu+2 + 2PO4-3
log_k -45.279
delta_h -66.5256 kJ
Bassetite
Fe(UO2)2(PO4)2 = 2UO2+2 + Fe+2 + 2PO4-3
log_k -44.485
delta_h -83.2616 kJ
Saleeite
Mg(UO2)2(PO4)2 = 2UO2+2 + Mg+2 + 2PO4-3
log_k -43.646
delta_h -84.4331 kJ
Ningyoite
CaU(PO4)2:2H2O = U+4 + Ca+2 + 2PO4-3 + 2H2O
log_k -53.906

delta_h -9.4977 kJ
H-Autunite
H2(UO2)2(PO4)2 = 2UO2+2 + 2H+ + 2PO4-3
log_k -47.931
delta_h -15.0624 kJ
Autunite
Ca(UO2)2(PO4)2 = 2UO2+2 + Ca+2 + 2PO4-3
log_k -43.927
delta_h -59.9986 kJ
Sr-Autunite
Sr(UO2)2(PO4)2 = 2UO2+2 + Sr+2 + 2PO4-3
log_k -44.457
delta_h -54.6012 kJ
Na-Autunite
Na2(UO2)2(PO4)2 = 2UO2+2 + 2Na+ + 2PO4-3
log_k -47.409
delta_h -1.9246 kJ
K-Autunite
K2(UO2)2(PO4)2 = 2UO2+2 + 2K+ + 2PO4-3
log_k -48.244
delta_h 24.5182 kJ
Uranocircite
Ba(UO2)2(PO4)2 = 2UO2+2 + Ba+2 + 2PO4-3
log_k -44.631
delta_h -42.2584 kJ
Pb3(AsO4)2
Pb3(AsO4)2 + 6H+ = 3Pb+2 + 2H3AsO4
log_k 5.8
delta_h -0 kJ
AlAsO4:2H2O
AlAsO4:2H2O + 3H+ = Al+3 + H3AsO4 + 2H2O
log_k 4.8
delta_h -0 kJ
Zn3(AsO4)2:2.5H2O
Zn3(AsO4)2:2.5H2O + 6H+ = 3Zn+2 + 2H3AsO4 + 2.5H2O
log_k 13.65
delta_h -0 kJ
Cu3(AsO4)2:2H2O
Cu3(AsO4)2:2H2O + 6H+ = 3Cu+2 + 2H3AsO4 + 2H2O
log_k 6.1
delta_h -0 kJ
Ag3AsO3
Ag3AsO3 + 3H+ = 3Ag+ + H3AsO3
log_k 2.1573
delta_h -0 kJ
Ag3AsO4
Ag3AsO4 + 3H+ = 3Ag+ + H3AsO4
log_k -2.7867
delta_h -0 kJ
Ni3(AsO4)2:8H2O
Ni3(AsO4)2:8H2O + 6H+ = 3Ni+2 + 2H3AsO4 + 8H2O
log_k 15.7
delta_h -0 kJ
Co3(AsO4)2

Co3(AsO4)2 + 6H+ = 3Co+2 + 2H3AsO4
log_k 13.0341
delta_h -0 kJ
FeAsO4:2H2O
FeAsO4:2H2O + 3H+ = Fe+3 + H3AsO4 + 2H2O
log_k 0.4
delta_h -0 kJ
Mn3(AsO4)2:8H2O
Mn3(AsO4)2:8H2O + 6H+ = 3Mn+2 + 2H3AsO4 + 8H2O
log_k 12.5
delta_h -0 kJ
Ca3(AsO4)2:4H2O
Ca3(AsO4)2:4H2O + 6H+ = 3Ca+2 + 2H3AsO4 + 4H2O
log_k 22.3
delta_h -0 kJ
Ba3(AsO4)2
Ba3(AsO4)2 + 6H+ = 3Ba+2 + 2H3AsO4
log_k -8.91
delta_h 11.0458 kJ
#NH4VO3
NH4VO3 + 2H+ = 2VO2+ + H2O
log_k 3.8
delta_h 30 kJ
Pb3(VO4)2
Pb3(VO4)2 + 8H+ = 3Pb+2 + 2VO2+ + 4H2O
log_k 6.14
delta_h -72.6342 kJ
Pb2V2O7
Pb2V2O7 + 6H+ = 2Pb+2 + 2VO2+ + 3H2O
log_k -1.9
delta_h -26.945 kJ
AgVO3
AgVO3 + 2H+ = Ag+ + VO2+ + H2O
log_k 0.77
delta_h -0 kJ
Ag2HVO4
Ag2HVO4 + 3H+ = 2Ag+ + VO2+ + 2H2O
log_k 1.48
delta_h -0 kJ
Ag3H2VO5
Ag3H2VO5 + 4H+ = 3Ag+ + VO2+ + 3H2O
log_k 5.18
delta_h -0 kJ
Fe(VO3)2
Fe(VO3)2 + 4H+ = Fe+2 + 2VO2+ + 2H2O
log_k -3.72
delta_h -61.6722 kJ
Mn(VO3)2
Mn(VO3)2 + 4H+ = Mn+2 + 2VO2+ + 2H2O
log_k 4.9
delta_h -92.4664 kJ
Mg(VO3)2
Mg(VO3)2 + 4H+ = Mg+2 + 2VO2+ + 2H2O
log_k 11.28

delta_h -136.649 kJ
Mg2V2O7
Mg2V2O7 + 6H+ = 2Mg+2 + 2VO2+ + 3H2O
log_k 26.36
delta_h -255.224 kJ
Carnotite
KUO2VO4 + 4H+ = K+ + UO2+2 + VO2+ + 2H2O
log_k 0.23
delta_h -36.4008 kJ
Tyuyamunite
Ca(UO2)2(VO4)2 + 8H+ = Ca+2 + 2UO2+2 + 2VO2+ + 4H2O
log_k 4.08
delta_h -153.134 kJ
Ca(VO3)2
Ca(VO3)2 + 4H+ = Ca+2 + 2VO2+ + 2H2O
log_k 5.66
delta_h -84.7678 kJ
Ca3(VO4)2
Ca3(VO4)2 + 8H+ = 3Ca+2 + 2VO2+ + 4H2O
log_k 38.96
delta_h -293.466 kJ
Ca2V2O7
Ca2V2O7 + 6H+ = 2Ca+2 + 2VO2+ + 3H2O
log_k 17.5
delta_h -159.494 kJ
Ca3(VO4)2:4H2O
Ca3(VO4)2:4H2O + 8H+ = 3Ca+2 + 2VO2+ + 8H2O
log_k 39.86
delta_h -0 kJ
Ca2V2O7:2H2O
Ca2V2O7:2H2O + 6H+ = 2Ca+2 + 2VO2+ + 5H2O
log_k 21.552
delta_h -0 kJ
Ba3(VO4)2:4H2O
Ba3(VO4)2:4H2O + 8H+ = 3Ba+2 + 2VO2+ + 8H2O
log_k 32.94
delta_h -0 kJ
Ba2V2O7:2H2O
Ba2V2O7:2H2O + 6H+ = 2Ba+2 + 2VO2+ + 5H2O
log_k 15.872
delta_h -0 kJ
NaVO3
NaVO3 + 2H+ = Na+ + VO2+ + H2O
log_k 3.8582
delta_h -30.1799 kJ
Na3VO4
Na3VO4 + 4H+ = 3Na+ + VO2+ + 2H2O
log_k 36.6812
delta_h -184.61 kJ
Na4V2O7
Na4V2O7 + 6H+ = 4Na+ + 2VO2+ + 3H2O
log_k 37.4
delta_h -201.083 kJ
Halloysite

Al2Si2O5(OH)4 + 6H+ = 2Al+3 + 2H4SiO4 + H2O
log_k 9.5749
delta_h -181.43 kJ
Kaolinite
Al2Si2O5(OH)4 + 6H+ = 2Al+3 + 2H4SiO4 + H2O
log_k 7.435
delta_h -148 kJ
Greenalite
Fe3Si2O5(OH)4 + 6H+ = 3Fe+2 + 2H4SiO4 + H2O
log_k 20.81
delta_h -0 kJ
Chrysotile
Mg3Si2O5(OH)4 + 6H+ = 3Mg+2 + 2H4SiO4 + H2O
log_k 32.2
delta_h -196 kJ
Sepiolite
Mg2Si3O7.5OH:3H2O + 4H+ + 0.5H2O = 2Mg+2 + 3H4SiO4
log_k 15.76
delta_h -114.089 kJ
Sepiolite(A)
Mg2Si3O7.5OH:3H2O + 0.5H2O + 4H+ = 2Mg+2 + 3H4SiO4
log_k 18.78
delta_h -0 kJ
PHASES
O2(g)
O2 + 4H+ + 4e- = 2H2O
log_k 83.0894
delta_h -571.66 kJ
CH4(g)
CH4 + 3H2O = CO3-2 + 8e- + 10H+
log_k -41.0452
delta_h 257.133 kJ
CO2(g)
CO2 + H2O = 2H+ + CO3-2
log_k -18.147
delta_h 4.06 kJ
H2S(g)
H2S = H+ + HS-
log_k -8.01
delta_h -0 kJ
H2Se(g)
H2Se = HSe- + H+
log_k -4.96
delta_h -15.3 kJ
Hg(g)
Hg = 0.5Hg2+2 + e-
log_k -7.8733
delta_h 22.055 kJ
Hg2(g)
Hg2 = Hg2+2 + 2e-
log_k -14.9554
delta_h 58.07 kJ
Hg(CH3)2(g)
Hg(CH3)2 + 8H2O = Hg(OH)2 + 2CO3-2 + 16e- + 20H+

log_k -73.7066
delta_h 481.99 kJ
HgF(g)
HgF = 0.5Hg2+2 + F-
log_k 32.6756
delta_h -254.844 kJ
HgF2(g)
HgF2 + 2H2O = Hg(OH)2 + 2F- + 2H+
log_k 12.5652
delta_h -165.186 kJ
HgCl(g)
HgCl = 0.5Hg2+2 + Cl-
log_k 19.4966
delta_h -162.095 kJ
HgBr(g)
HgBr = 0.5Hg2+2 + Br-
log_k 16.7566
delta_h -142.157 kJ
HgBr2(g)
HgBr2 + 2H2O = Hg(OH)2 + 2Br- + 2H+
log_k -18.3881
delta_h 54.494 kJ
HgI(g)
HgI = 0.5Hg2+2 + I-
log_k 11.3322
delta_h -106.815 kJ
HgI2(g)
HgI2 + 2H2O = Hg(OH)2 + 2I- + 2H+
log_k -27.2259
delta_h 114.429 kJ
SURFACE_MASTER_SPECIES
Hfo_s Hfo_sOH
Hfo_w Hfo_wOH
Hao_ Hao_OH #hydrous aluminum oxides - gibbsite
SURFACE_SPECIES
Hfo_wOH = Hfo_wOH
log_k 0.0
Hfo_sOH = Hfo_sOH
log_k 0.0
Hao_OH = Hao_OH
log_k 0.0

Hfo_sOH + H+ = Hfo_sOH2+
log_k 7.29
delta_h 0 kJ
Id: 8113302
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH = Hfo_sO- + H+
log_k -8.93
delta_h 0 kJ
Id: 8113301
log K source:

Delta H source:
#T and ionic strength:
Hfo_wOH + H+ = Hfo_wOH2+
log_k 7.29
delta_h 0 kJ
Id: 8123302
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH = Hfo_wO- + H+
log_k -8.93
delta_h 0 kJ
Id: 8123301
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Ba+2 = Hfo_sOHBa+2
log_k 5.46
delta_h 0 kJ
Id: 8111000
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Ba+2 = Hfo_wOBa+ + H+
log_k -7.2
delta_h 0 kJ
Id: 8121000
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Ca+2 = Hfo_sOHCa+2
log_k 4.97
delta_h 0 kJ
Id: 8111500
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Ca+2 = Hfo_wOCa+ + H+
log_k -5.85
delta_h 0 kJ
Id: 8121500
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Mg+2 = Hfo_wOMg+ + H+
log_k -4.6
delta_h 0 kJ
Id: 8124600
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Ag+ = Hfo_sOAg + H+
log_k -1.72
delta_h 0 kJ

Id: 8110200
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Ag+ = Hfo_wOAg + H+
log_k -5.3
delta_h 0 kJ
Id: 8120200
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Ni+2 = Hfo_sONi+ + H+
log_k 0.37
delta_h 0 kJ
Id: 8115400
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Ni+2 = Hfo_wONi+ + H+
log_k -2.5
delta_h 0 kJ
Id: 8125400
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Cd+2 = Hfo_sOCd+ + H+
log_k 0.47
delta_h 0 kJ
Id: 8111600
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Cd+2 = Hfo_wOCd+ + H+
log_k -2.9
delta_h 0 kJ
Id: 8121600
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Co+2 = Hfo_sOCo+ + H+
log_k -0.46
delta_h 0 kJ
Id: 8112000
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Co+2 = Hfo_wOCo+ + H+
log_k -3.01
delta_h 0 kJ
Id: 8122000
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Zn+2 = Hfo_sOZn+ + H+

log_k 0.99
delta_h 0 kJ
Id: 8119500
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Zn+2 = Hfo_wOZn+ + H+
log_k -1.99
delta_h 0 kJ
Id: 8129500
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Cu+2 = Hfo_sOCu+ + H+
log_k 2.89
delta_h 0 kJ
Id: 8112310
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Cu+2 = Hfo_wOCu+ + H+
log_k 0.6
delta_h 0 kJ
Id: 8123100
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Pb+2 = Hfo_sOPb+ + H+
log_k 4.65
delta_h 0 kJ
Id: 8116000
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Pb+2 = Hfo_wOPb+ + H+
log_k 0.3
delta_h 0 kJ
Id: 8126000
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Be+2 = Hfo_sOBe+ + H+
log_k 5.7
delta_h 0 kJ
Id: 8111100
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Be+2 = Hfo_wOBe+ + H+
log_k 3.3
delta_h 0 kJ
Id: 8121100
log K source:
Delta H source:

#T and ionic strength:
Hfo_sOH + Hg(OH)2 + H+ = Hfo_sOHg+ + 2H2O
log_k 13.95
delta_h 0 kJ
Id: 8113610
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Hg(OH)2 + H+ = Hfo_wOHg+ + 2H2O
log_k 12.64
delta_h 0 kJ
Id: 8123610
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Sn(OH)2 + H+ = Hfo_sOSn+ + 2H2O
log_k 15.1
delta_h 0 kJ
Id: 8117900
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Sn(OH)2 + H+ = Hfo_wOSn+ + 2H2O
log_k 13
delta_h 0 kJ
Id: 8127900
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Cr(OH)2+ = Hfo_sOCrOH+ + H2O
log_k 11.63
delta_h 0 kJ
Id: 8112110
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + H3AsO3 = Hfo_sH2AsO3 + H2O
log_k 5.41
delta_h 0 kJ
Id: 8110600
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + H3AsO3 = Hfo_wH2AsO3 + H2O
log_k 5.41
delta_h 0 kJ
Id: 8120600
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + H3BO3 = Hfo_sH2BO3 + H2O
log_k 0.62
delta_h 0 kJ
Id: 8110900

log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + H3BO3 = Hfo_wH2BO3 + H2O
log_k 0.62
delta_h 0 kJ
Id: 8120900
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + PO4-3 + 3H+ = Hfo_sH2PO4 + H2O
log_k 31.29
delta_h 0 kJ
Id: 8115800
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + PO4-3 + 3H+ = Hfo_wH2PO4 + H2O
log_k 31.29
delta_h 0 kJ
Id: 8125800
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + PO4-3 + 2H+ = Hfo_sHPO4- + H2O
log_k 25.39
delta_h 0 kJ
Id: 8115801
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + PO4-3 + 2H+ = Hfo_wHPO4- + H2O
log_k 25.39
delta_h 0 kJ
Id: 8125801
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + PO4-3 + H+ = Hfo_sPO4-2 + H2O
log_k 17.72
delta_h 0 kJ
Id: 8115802
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + PO4-3 + H+ = Hfo_wPO4-2 + H2O
log_k 17.72
delta_h 0 kJ
Id: 8125802
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + H3AsO4 = Hfo_sH2AsO4 + H2O
log_k 8.61

delta_h 0 kJ
Id: 8110610
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + H3AsO4 = Hfo_wH2AsO4 + H2O
log_k 8.61
delta_h 0 kJ
Id: 8120610
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + H3AsO4 = Hfo_sHAsO4- + H2O + H+
log_k 2.81
delta_h 0 kJ
Id: 8110611
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + H3AsO4 = Hfo_wHAsO4- + H2O + H+
log_k 2.81
delta_h 0 kJ
Id: 8120611
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + H3AsO4 = Hfo_sOHAsO4-3 + 3H+
log_k -10.12
delta_h 0 kJ
Id: 8110613
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + H3AsO4 = Hfo_wOHAsO4-3 + 3H+
log_k -10.12
delta_h 0 kJ
Id: 8120613
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + VO2+ + 2H2O = Hfo_sOHVO4-3 + 4H+
log_k -16.63
delta_h 0 kJ
Id: 8119031
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + VO2+ + 2H2O = Hfo_wOHVO4-3 + 4H+
log_k -16.63
delta_h 0 kJ
Id: 8129031
log K source:
Delta H source:
#T and ionic strength:

Hfo_sOH + SO4-2 + H+ = Hfo_sSO4- + H2O
log_k 7.78
delta_h 0 kJ
Id: 8117320
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + SO4-2 + H+ = Hfo_wSO4- + H2O
log_k 7.78
delta_h 0 kJ
Id: 8127320
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + SO4-2 = Hfo_sOHSO4-2
log_k 0.79
delta_h 0 kJ
Id: 8117321
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + SO4-2 = Hfo_wOHSO4-2
log_k 0.79
delta_h 0 kJ
Id: 8127321
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + HSeO3- = Hfo_sSeO3- + H2O
log_k 4.29
delta_h 0 kJ
Id: 8117610
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + HSeO3- = Hfo_wSeO3- + H2O
log_k 4.29
delta_h 0 kJ
Id: 8127610
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + HSeO3- = Hfo_sOHSeO3-2 + H+
log_k -3.23
delta_h 0 kJ
Id: 8117611
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + HSeO3- = Hfo_wOHSeO3-2 + H+
log_k -3.23
delta_h 0 kJ
Id: 8127611
log K source:

Delta H source:
#T and ionic strength:
Hfo_sOH + SeO4-2 + H+ = Hfo_sSeO4- + H2O
log_k 7.73
delta_h 0 kJ
Id: 8117620
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + SeO4-2 + H+ = Hfo_wSeO4- + H2O
log_k 7.73
delta_h 0 kJ
Id: 8127620
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + SeO4-2 = Hfo_sOHSeO4-2
log_k 0.8
delta_h 0 kJ
Id: 8117621
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + SeO4-2 = Hfo_wOHSeO4-2
log_k 0.8
delta_h 0 kJ
Id: 8127621
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + CrO4-2 + H+ = Hfo_sCrO4- + H2O
log_k 10.85
delta_h 0 kJ
Id: 8112120
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + CrO4-2 + H+ = Hfo_wCrO4- + H2O
log_k 10.85
delta_h 0 kJ
Id: 8122120
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + CrO4-2 = Hfo_sOHCrO4-2
log_k 3.9
delta_h 0 kJ
Id: 8112121
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + CrO4-2 = Hfo_wOHCrO4-2
log_k 3.9
delta_h 0 kJ

Id: 8122121
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + MoO4-2 + H+ = Hfo_sMoO4- + H2O
log_k 9.5
delta_h 0 kJ
Id: 8114800
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + MoO4-2 + H+ = Hfo_wMoO4- + H2O
log_k 9.5
delta_h 0 kJ
Id: 8124800
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + MoO4-2 = Hfo_sOHMoO4-2
log_k 2.4
delta_h 0 kJ
Id: 8114801
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + MoO4-2 = Hfo_wOHMoO4-2
log_k 2.4
delta_h 0 kJ
Id: 8124801
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Sb(OH)6- + H+ = Hfo_sSbO(OH)4 + 2H2O
log_k 8.4
delta_h 0 kJ
Id: 8117410
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Sb(OH)6- + H+ = Hfo_wSbO(OH)4 + 2H2O
log_k 8.4
delta_h 0 kJ
Id: 8127410
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Sb(OH)6- = Hfo_sOHSbO(OH)4- + H2O
log_k 1.3
delta_h 0 kJ
Id: 8117411
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Sb(OH)6- = Hfo_wOHSbO(OH)4- + H2O

log_k 1.3
delta_h 0 kJ
Id: 8127411
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Cyanide- + H+ = Hfo_sCyanide + H2O
log_k 13
delta_h 0 kJ
Id: 8111430
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Cyanide- + H+ = Hfo_wCyanide + H2O
log_k 13
delta_h 0 kJ
Id: 8121430
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Cyanide- = Hfo_sOHCyanide-
log_k 5.7
delta_h 0 kJ
Id: 8111431
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Cyanide- = Hfo_wOHCyanide-
log_k 5.7
delta_h 0 kJ
Id: 8121431
log K source:
Delta H source:
#T and ionic strength:
#Additions from GWB Minteq
Hfo_wOH + H4SiO4 = Hfo_wOSi(OH)3 + H2O
log_k 4.28
delta_h 0 kJ
Hfo_wOH + H4SiO4 = Hfo_wOSiO(OH)2- + H+ + H2O
log_k -3.22
delta_h 0 kJ
Hfo_sOH + H4SiO4 = Hfo_sOSi(OH)3 + H2O
log_k 4.28
delta_h 0
Hfo_sOH + H4SiO4 = Hfo_sOSiO(OH)2- + H+ + H2O
log_k -3.22
delta_h 0
Hfo_wOH + CO3-2 + H+ = Hfo_wCO3- + H2O
log_k 12.56
delta_h 0
Hfo_wOH + CO3-2 + 2H+= Hfo_wHCO3 + H2O
log_k 20.62
delta_h 0
Hfo_sOH + CO3-2 + H+ = Hfo_sCO3- + H2O

log_k 12.56
delta_h 0
Hfo_sOH + CO3-2 + 2H+= Hfo_sHCO3 + H2O
log_k 20.62
delta_h 0

#Karamalidis and Dzombak sorption to gibbsite (hao) as compiled in Cravotta 2021 (https://doi.org/10.1016/j.apgeochem.2020.104845) Table S4 unless otherwise noted
Hao_OH + Cu+2 = Hao_OCu+ + H+
log_k 0.25
Hao_OH + Pb+2 = Hao_OPb+ + H+
log_k 0.37
Hao_OH + Co+2 = Hao_OCo+ + H+
log_k -2.52
Hao_OH + Cd+2 = Hao_OCd+ + H+
log_k -2.73
Hao_OH + Mn+2 = Hao_OMn+ + H+
log_k -5.49
Hao_OH + Fe+2 = Hao_OFe+ + H+
log_k -3.77
Hao_OH + Ca+2 = Hao_OCa+ + H+
log_k -10.49
Hao_OH + Mg+2 = Hao_OMg+ + H+
log_k -5.93
Hao_OH + Ba+2 = Hao_OBa+ + H+
log_k -8.5
Hao_OH + Sr+2 = Hao_OSr+ + H+
log_k -8.26
Hao_OH + Zn+2 = Hao_OZn+ + H+
log_k -0.96
Hao_OH + PO4-3 + 3 H+ = Hao_H2PO4 + H2O
log_k 26.89
Hao_OH + PO4-3 + 2H+ = Hao_HPO4- + H2O
log_k 19.37
Hao_OH + PO4-3 + H+ = Hao_PO4-2 + H2O
log_k 13.57
#Hao_OH + SO4-2 + H+ = Hao_SO4- + H2O
log_k -0.45
#Hao_OH + SO4-2 = Hao_OHSO4-2
log_k 1.19
Hao_OH + F- + H+ = Hao_F + H2O
log_k 8.78
Hao_OH + F- = Hao_OHF-
log_k 2.88
Hao_OH + 2 F- + H+ = Hao_F2- + H2O
log_k 11.94
Hao_OH + H4SiO4 = Hao_OH4SiO4- + H+
log_k -4.16

#Modified value from Goldberg and Glaubig (1985)
Hao_OH + H3BO3 = Hao_H2BO3 + H2O
Log_k 4.83
Hao_OH + H3BO3 = Hao_H3BO4- + H+
Log_k -7.40

#Modified value from Kitadai et al. (2018)

```
Hao_OH + SO4-2 + H+ = Hao_SO4- + H2O
log_k 2.4
#Modified value from Kitadai et al. (2018)
Hao_OH + SO4-2 = Hao_OHSO4-2
log_k 7.5

END
```

ATTACHMENT C
Details of Geochemical Model Parameterization

Attachment C. Details of Geochemical Model Parameterization

Introduction

This appendix to the Groundwater Polishing Report for the Hennepin Power Plant West Ash Pond System (WAPS) provides detailed information regarding geochemical model parameterization. The information provided includes sources of thermodynamic data, sources of data used in model parameterization, summarized values, and calculation methods. All solid-phase data is fully documented in the Nature and Extent Report.[1] All aqueous data have been posted to the facility's operating record in accordance with Title 35 of the Illinois Administrative Code § 845.800(d)(15).

Solid Phase Inputs

The solid phase inputs to the model included iron (hydr)oxides and aluminum (hydr)oxides. These phases tend to have relatively rapid precipitation kinetics and form an outer layer on the surfaces of aquifer solids, creating surface area for sorption and attenuation of boron. Sequential extraction procedure (SEP) methods are described in the Geochemical Conceptual Site Model (GCSM)[2] and employ chemical extractants to dissolve metals from specific solid-associated phases. SEP methods use progressively stronger reagents to solubilize metals from increasingly recalcitrant phases. Although these procedures do not identify the discrete solid phases in a soil/aquifer matrix, they provide a means to evaluate the characterize the metal binding mechanisms and relative stability of metals in each phase, and to estimate the available mass of the respective attenuating phase(s) (i.e., aluminum and iron [hydr]oxide). While SEP analyses were completed on WAPS aquifer solids samples in March 2021 and were presented in the GCSM, the SEP methodology used to analyze these samples did not include extraction stages associated with non-crystalline or sulfide materials, both of which are important to solid-phase iron distribution. Therefore, this SEP data was not included in model set up.

SEP data from the October 2024 sampling event included two samples collected adjacent to monitoring location 21R from within the uppermost aquifer unit (UAU) at depths associated with the screened interval of 21R. The SEP analyses used for WAPS samples included a more reactive non-crystalline metal oxide fraction and a less reactive metal hydroxide fraction, as well as a sulfide fraction. Input concentrations for iron and aluminum (hydr)oxides were derived using SEP data from

[1] The Nature and Extent Report was previously submitted to IEPA on May 8, 2024, and provided with relevant updates as Appendix D of the CAAA to which this report is attached.
[2] Ibid.; the GCSM is an appendix of the Nature and Extent Report.

aquifer solids samples collected in October 2024 and discussed in the Addendum to the Nature and Extent Report.[3]

Sorption of inorganic constituents to iron (hydr)oxides in the MINTEQ v4 database[4] is represented by the hydrous ferric oxide (HFO) thermodynamic data set presented in Dzombak and Morel (1990). Sorption of inorganic constituents to aluminum (hydr)oxides is represented by the hydrous aluminum oxide (HAO) thermodynamic data presented in Karamalidis and Dzombak (2010), Goldberg and Glaubig (1985) (boron), and Kitadai et al. (2018) (sulfate). These sorption data are based on gibbsite, a nearly ubiquitous crystalline aluminum hydroxide mineral (Karamalidis and Dzombak 2010).

In thermodynamic modeling, the amount of sorbing phase present is typically the dominant control on the concentration of constituents sorbed. Therefore, different amounts of metal oxides were used to test the sensitivity of the model to the amount of sorbing phase present. The amount of metal oxides used were derived from the 25th percentile, mean, and 75th percentile of the SEP results for the relevant iron and aluminum phases.

The quantities of HFO and HAO in the model are represented by ferrihydrite ($Fe(OH)_3$) and gibbsite ($Al(OH)_3$), respectively. Ferrihydrite is the most similar naturally occurring iron oxide to HFO (Dzombak and Morel, 1990), and sorption data for HAO was determined using gibbsite (Karamalidis and Dzombak 2010). Metal concentrations are presented in milligrams per kilogram of dry weight (mg/kg dw), whereas ferrihydrite and gibbsite inputs to the model represent moles of solid phase associated with one liter (L) of aqueous phase. The concentrations of iron and aluminum were converted to moles of ferrihydrite and gibbsite (respectively) according to the following:

The mass in kilograms (kg) of solid in the model (i.e., per 1 L of water) was calculated by:

$$Solid\ Mass\ In\ Model\ (kg) = \frac{(1-\phi)}{\phi} \times \frac{1000\ cm^3\ water}{L\ water} \times 1\ L\ water\ \times \rho\ \times \frac{1\ kg\ solid}{1000\ g\ solid}$$

Where:

ϕ = porosity (water volume in cubic centimeters [cm^3] / total volume in cm^3)

ρ = density of the solid (grams [g]/cm^3)

Porosity and density represent the median of measurements each hydrostratigraphic unit as reported in the Hydrogeologic Characterization Report[5].

Moles of ferrihydrite and gibbsite were determined using metals concentrations as described above, the molar mass of iron or aluminum, and the mass of solid phase in the model:

[3] The Nature and Extent Report Addendum is provided in Appendix D of the CAAA to which this report is attached.

[4] The default MINTEQ v4 database for PHREEQC does not include sorption data for carbonate and silicate to HFO. Thermodynamic constants for sorption of carbonate and silicate to HFO were added from the MINTEQ database associated with the Geochemist's Workbench software program.

[5] The Hydrogeologic Characterization Report was previously submitted to IEPA as part of the Closure Permit Application and is provided as Appendix B.2 to the Construction Permit Application.

$$Moles\ of\ Metal\ Oxide = \frac{mg\ Fe\ or\ Al}{kg\ solid} \times \frac{g}{1000\ mg} \times \frac{moles\ Fe\ or\ Al}{g\ Fe\ or\ Al} \times kg\ Solid\ Mass\ in\ Model$$

The moles of ferrihydrite and gibbsite are represented by moles of Fe or Al (respectively) in a 1:1 ratio mased on the mineral formula. Ferrihydrite and gibbsite were allowed to precipitate or dissolve in the reaction phase of the model to evaluate the impact of source control on sorbing phase availability.

Calcite and dolomite were included as mineral phases in the model because carbonate mineral formation and dissolution are often major controls on groundwater pH. Calcite and dolomite are common carbonate minerals and were detected at levels of greater than 1% by weight in X-ray diffraction (XRD) analysis and are therefore considered to be present in excess within the aquifer. Therefore, the mass fractions reported in the XRD results presented in the GCSM are used as model inputs. Both calcite and dolomite were allowed to precipitate in the reaction phase of the model.

Barite and gypsum are common sulfate minerals that have the potential to form under ambient environmental conditions. Neither mineral was detected in XRD results at well locations containing exceedances of groundwater protection standards (GWPS). Therefore, barite and gypsum did not have initial concentrations in the model but were allowed to precipitate or dissolve in the reaction phase of the model.

Aqueous Inputs

In addition to the constituent of concern boron, the following parameters are included in the model and are anticipated to capture the expected attenuation and mobilization mechanisms for reasons detailed below:

- Temperature, pH and pe: pH and pe (a measure of redox potential) are major controls on chemical attenuation and mobility.
- Chloride, potassium, and sodium: Major ions in groundwater typically required for the model to reach charge balance.
- Carbonate ion, calcium, and magnesium: Major ions in groundwater that may also form common minerals, including carbonates. Carbonate mineral formation and dissolution is often a major control on groundwater pH. Bicarbonate and carbonate ions, a major component of groundwater alkalinity, may also compete with sulfate/boron for sorbing sites.
- Silicon and phosphate: Silicate and phosphate are oxyanions that compete with sulfate/boron for sorbing sites.
- Aluminum, iron, and manganese: As discussed above, iron and aluminum form reactive metal (hydr)oxide minerals which have high capacities for sorbing other ions on their surfaces. Although sorption to manganese oxides was not considered in this model, manganese behaves similarly to iron and is included for completeness.

- Remaining constituents regulated under 35 I.A.C. § 845.600[6]: Although these parameters are not subject to corrective action at the WAPS, they are included in the model for completeness.

Values for pe and carbonate ion concentrations were derived from values previously reported in the analytical data according to the following methods.

pe is a non-dimension scale of redox potential and is calculated from oxidation reduction potential (ORP). First, the field-measured ORP was converted to Eh (i.e., the redox potential normalized to the standard hydrogen electrode). The following equation provided in the Horiba water quality meter instruction manual[7] was used:

$$Eh = ORP + 206 - 0.7*(T - 25)$$

Where both Eh and ORP are in volts (V) and T is temperature in degrees Celsius. Eh is then converted to pe:

$$pe = (Eh * F) / (2.303 * R * T)$$

Where:

F = Faraday constant (96,500 Joules (J) / V-equivalent)

R = Molar gas constant (8.31 J / Kelvin (K)-mole)

T = temperature in Kelvin

Data reported for groundwater at the site include carbonate and bicarbonate alkalinity in units of mg of calcium carbonate per liter (mg $CaCO_3$/L). For use in modeling, it is convenient to convert these values to a single carbonate (CO_3^{2-}) ion concentration. Because carbonate and bicarbonate alkalinity are reported in the same units (i.e., standardized to mg $CaCO_3$) and represent different protonation states of the same inorganic carbon oxyanion, they were summed to represent total alkalinity due to carbonate. This summed alkalinity was converted to concentration of carbonate ion according to the following equation:

$$\frac{mg\ CO_3^{2-}}{L} = \frac{mg\ CaCO_3}{L} \times \frac{mole\ CaCO_3}{100.1\ mg\ CaCO_3} \times \frac{1\ mole\ CO_3^{2-}}{1\ mole\ CaCO_3} \times \frac{60\ mg\ CO_3^{2-}}{mole\ CO_3^{2-}}$$

The full suite of geochemical parameters for the modeling effort were measured in Quarter 2 and Quarter 3, 2023, for all compliance monitoring wells with exceedances of GWPS. The medians of these results were used in the model to represent average groundwater interacting with the solid phase.

As discussed in detail in the Groundwater Polishing Evaluation Report primary document, groundwater flow conditions at and near the WAPS are variable and warrant consideration of

[6] Mercury, thallium, total dissolved solids, and radium were not included in the model. Mercury reactions within the environment are highly complex and would require a separate modeling effort. Thallium forms a non-reactive monovalent cation and is rarely detected in the groundwater and is therefore not expected to contribute to model outcomes. Total dissolved solids are not a chemical parameter, but rather the result of other chemical abundances taken together. Radium is not included in most thermodynamic databases.

[7] https://static.horiba.com/fileadmin/Horiba/Products/Process_and_Environmental/Water_Pollution/Instruction_Manuals/U-50/U-50_Manual.pdf

appropriate background groundwater sources for individual compliance wells. Background groundwater was represented in modeling efforts for compliance wells 21R and 51 using the average composition of background well 34 from 2024 Q1 and Q2 sampling events (referred to as HEN – West). Background groundwater was represented in modeling efforts for compliance wells 22, 23, and 35 using the average composition of background well 32 from 2024 Q1 and Q2 sampling events (referred to as HEN – East). Additionally, the average composition of eight surface water samples collected from three sampling locations in the Illinois River immediately north of the WAPS was used in a separate model scenario to evaluate the Illinois River as a background water source for well 22 during flooding events (referred to as HEN – River).

The model was run without charge balancing and with charge balancing on chloride. The results during the reaction modeling did not substantially differ with and without charge balancing on chloride. The results presented in the Groundwater Polishing Evaluation Report therefore represent the model results using charge balancing on chloride.

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ATTACHMENT D
Complete Geochemical Modeling Output

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	pH	pe	charge	pct_err	S(6)	B	Li	As	C(4)	Cl	F	Ca	Mg
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	25p	7.44	0.980	1.00e-16	4.53e-13	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00619	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Initial Soln	TRUE	25p	7.30	1.42	1.69e-12	7.46e-09	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00680	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	25p	7.44	0.980	1.02e-16	4.61e-13	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00619	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Speciation Model	TRUE	25p	7.30	1.42	1.69e-12	7.46e-09	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00680	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	First Reaction	TRUE	25p	7.29	-3.11e-01	-7.49e-05	-2.94e-01	0.000485	8.90e-05	1.17e-06	7.10e-07	0.00492	0.00776	8.15e-06	0.00256	0.00283
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	25p	7.25	-2.12e-01	-1.43e-05	-5.46e-02	0.000476	7.37e-05	1.17e-06	7.67e-07	0.00539	0.00776	8.16e-06	0.00266	0.00293
HEN_845_804W	51	C - UA	First Reaction	TRUE	25p	7.25	-2.34e-01	-3.55e-05	-1.36e-01	0.000492	7.40e-05	1.17e-06	6.57e-07	0.00530	0.00776	8.15e-06	0.00264	0.00292
HEN_845_804W	51	C - UA	Second Reaction	TRUE	25p	7.23	-1.78e-01	-5.91e-06	-2.23e-02	0.000479	6.29e-05	1.17e-06	7.03e-07	0.00558	0.00776	8.16e-06	0.00269	0.00297
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	75p	7.44	0.980	1.00e-16	4.53e-13	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00619	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Initial Soln	TRUE	75p	7.30	1.42	1.69e-12	7.46e-09	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00680	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	75p	7.44	0.980	1.01e-16	4.57e-13	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00619	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Speciation Model	TRUE	75p	7.30	1.42	1.69e-12	7.46e-09	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00680	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	First Reaction	TRUE	75p	7.31	-3.17e-01	-9.53e-05	-3.78e-01	0.000487	8.92e-05	1.17e-06	6.62e-07	0.00477	0.00776	8.15e-06	0.00253	0.00280
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	75p	7.26	-2.23e-01	-1.98e-05	-7.65e-02	0.000475	7.50e-05	1.17e-06	7.33e-07	0.00524	0.00776	8.16e-06	0.00263	0.00290
HEN_845_804W	51	C - UA	First Reaction	TRUE	75p	7.26	-2.24e-01	-4.34e-05	-1.67e-01	0.000496	7.36e-05	1.17e-06	6.14e-07	0.00521	0.00776	8.15e-06	0.00263	0.00290
HEN_845_804W	51	C - UA	Second Reaction	TRUE	75p	7.24	-1.73e-01	-9.03e-06	-3.43e-02	0.000479	6.34e-05	1.17e-06	6.66e-07	0.00549	0.00776	8.16e-06	0.00267	0.00296
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	median	7.44	0.980	1.00e-16	4.53e-13	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00619	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Initial Soln	TRUE	median	7.30	1.42	1.69e-12	7.46e-09	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00680	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	median	7.44	0.980	1.02e-16	4.61e-13	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00619	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Speciation Model	TRUE	median	7.30	1.42	1.69e-12	7.46e-09	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00680	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	First Reaction	TRUE	median	7.30	-3.14e-01	-8.46e-05	-3.34e-01	0.000486	8.90e-05	1.17e-06	6.85e-07	0.00485	0.00776	8.15e-06	0.00255	0.00282
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	median	7.25	-2.17e-01	-1.70e-05	-6.54e-02	0.000476	7.42e-05	1.17e-06	7.51e-07	0.00532	0.00776	8.16e-06	0.00264	0.00292
HEN_845_804W	51	C - UA	First Reaction	TRUE	median	7.26	-2.28e-01	-3.93e-05	-1.51e-01	0.000494	7.37e-05	1.17e-06	6.35e-07	0.00526	0.00776	8.15e-06	0.00263	0.00291
HEN_845_804W	51	C - UA	Second Reaction	TRUE	median	7.23	-1.75e-01	-7.45e-06	-2.82e-02	0.000479	6.30e-05	1.17e-06	6.84e-07	0.00553	0.00776	8.16e-06	0.00268	0.00296
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	25p	7.44	0.980	0.00340	18.2	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00279	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Initial Soln	FALSE	25p	7.30	1.42	0.00393	21.1	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00286	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	25p	7.44	0.980	0.00340	18.2	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00279	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Speciation Model	FALSE	25p	7.30	1.42	0.00393	21.1	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00286	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	First Reaction	FALSE	25p	7.29	-3.13e-01	-7.30e-05	-2.87e-01	0.000485	8.75e-05	1.17e-06	7.30e-07	0.00492	0.00776	8.15e-06	0.00256	0.00283
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	25p	7.25	-2.14e-01	-1.42e-05	-5.44e-02	0.000476	7.25e-05	1.17e-06	7.91e-07	0.00539	0.00776	8.16e-06	0.00265	0.00293
HEN_845_804W	51	C - UA	First Reaction	FALSE	25p	7.25	-2.36e-01	-3.80e-05	-1.46e-01	0.000492	7.25e-05	1.17e-06	6.79e-07	0.00530	0.00776	8.15e-06	0.00264	0.00292
HEN_845_804W	51	C - UA	Second Reaction	FALSE	25p	7.23	-1.80e-01	-5.91e-06	-2.24e-02	0.000480	6.17e-05	1.17e-06	7.28e-07	0.00558	0.00776	8.16e-06	0.00269	0.00297
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	75p	7.44	0.980	0.00340	18.2	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00279	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Initial Soln	FALSE	75p	7.30	1.42	0.00393	21.1	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00286	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	75p	7.44	0.980	0.00340	18.2	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00279	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Speciation Model	FALSE	75p	7.30	1.42	0.00393	21.1	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00286	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	First Reaction	FALSE	75p	7.31	-3.19e-01	-9.39e-05	-3.73e-01	0.000487	8.76e-05	1.17e-06	6.80e-07	0.00476	0.00776	8.15e-06	0.00253	0.00280
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	75p	7.26	-2.24e-01	-1.97e-05	-7.62e-02	0.000476	7.38e-05	1.17e-06	7.54e-07	0.00523	0.00776	8.16e-06	0.00263	0.00290
HEN_845_804W	51	C - UA	First Reaction	FALSE	75p	7.26	-2.26e-01	-4.81e-05	-1.85e-01	0.000496	7.20e-05	1.17e-06	6.35e-07	0.00521	0.00776	8.15e-06	0.00262	0.00290
HEN_845_804W	51	C - UA	Second Reaction	FALSE	75p	7.24	-1.75e-01	-9.09e-06	-3.45e-02	0.000479	6.22e-05	1.17e-06	6.89e-07	0.00549	0.00776	8.16e-06	0.00267	0.00296
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	median	7.44	0.980	0.00340	18.2	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00279	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Initial Soln	FALSE	median	7.30	1.42	0.00393	21.1	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00286	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	median	7.44	0.980	0.00340	18.2	0.000964	0.000186	3.08e-06	3.37e-07	0.00379	0.00279	9.22e-06	0.00301	0.00166
HEN_845_804W	51	C - UA	Speciation Model	FALSE	median	7.30	1.42	0.00393	21.1	0.000974	0.000136	6.95e-06	2.48e-07	0.00348	0.00286	8.95e-06	0.00296	0.00159
HEN_845_804W	21R	C - UA	First Reaction	FALSE	median	7.30	-3.16e-01	-8.29e-05	-3.28e-01	0.000486	8.74e-05	1.17e-06	7.04e-07	0.00484	0.00776	8.15e-06	0.00255	0.00282
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	median	7.25	-2.18e-01	-1.70e-05	-6.51e-02	0.000476	7.30e-05	1.17e-06	7.73e-07	0.00531	0.00776	8.16e-06	0.00264	0.00292
HEN_845_804W	51	C - UA	First Reaction	FALSE	median	7.26	-2.31e-01	-4.28e-05	-1.65e-01	0.000494	7.21e-05	1.17e-06	6.56e-07	0.00525	0.00776	8.15e-06	0.00263	0.00291
HEN_845_804W	51	C - UA	Second Reaction	FALSE	median	7.23	-1.77e-01	-7.48e-06	-2.84e-02	0.000480	6.18e-05	1.17e-06	7.08e-07	0.00553	0.00776	8.16e-06	0.00268	0.00296
HEN_845_804E	22	C - UA	Initial Soln	TRUE	25p	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Initial Soln	TRUE	25p	7.41	1.54	-1.47e-18	-6.33e-15	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00288	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Initial Soln	TRUE	25p	6.96	6.08	-7.91e-18	-2.58e-14	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.00187	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	Speciation Model	TRUE	25p	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Speciation Model	TRUE	25p	7.41	1.54	-3.27e-17	-1.41e-13	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00288	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Speciation Model	TRUE	25p	6.96	6.08	-1.14e-17	-3.71e-14	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.00187	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	First Reaction	TRUE	25p	7.52	3.11	-7.88e-05	-3.93e-01	0.000633	0.000137	5.55e-07	2.25e-08	0.00335	0.00603	8.42e-06	0.00204	0.00227
HEN_845_804E	22	C - UA	Second Reaction	TRUE	25p	7.50	3.20	-1.56e-05	-7.72e-02	0.000644	0.000107	5.55e-07	1.78e-08	0.00341	0.00603	8.42e-06	0.00207	0.00230
HEN_845_804E	23	C - UA	First Reaction	TRUE	25p	7.51	0.924	5.58e-05	0.274	0.000703	0.000239	5.55e-07	5.55e-08	0.00333	0.00603	8.42e-06	0.00210	0.00233
HEN_845_804E	23	C - UA	Second Reaction	TRUE	25p	7.49	1.11	-1.29e-06	-6.34e-03	0.000633	0.000158	5.55e-07	5.75e-08	0.00347	0.00603	8.42e-06	0.00208	0.00232
HEN_845_804E	35	C - UA	First Reaction	TRUE	25p	7.31	4.32	0.000160	0.686	0.000884	0.000299	5.55e-07	3.42e-08	0.00482	0.00603	8.42e-06	0.00251	0.00278
HEN_845_804E	35	C - UA	Second Reaction	TRUE	25p	7.37	4.21	1.08e-05	0.0495	0.000633	0.000181	5.55e-07	2.83e-08	0.00442	0.00603	8.42e-06	0.00228	0.00253
HEN_845_804E	22	C - UA	Initial Soln	TRUE	75p	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Initial Soln	TRUE	75p	7.41	1.54	-1.47e-18	-6.33e-15	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00288	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Initial Soln	TRUE	75p	6.96	6.08	-7.91e-18	-2.58e-14	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.00187	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	Speciation Model	TRUE	75p	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Speciation Model	TRUE	75p	7.41	1.54	-3.27e-17	-1.41e-13	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00288	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Speciation Model	TRUE	75p	6.96	6.08	-1.14e-17	-3.71e-14	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.00187	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	First Reaction	TRUE	75p	7.52	3.09	-1.03e-04	-5.13e-01	0.000633	0.000140	5.55e-07	2.41e-08	0.00333	0.00603	8.42e-06	0.00203	0.00226
HEN_845_804E	22	C - UA	Second Reaction	TRUE	75p	7.51	3.18	-1.88e-05	-9.30e-02	0.000643	0.000111	5.55e-07	1.99e-08	0.00338	0.00603	8.42e-06	0.00207	0.00229
HEN_845_804E	23	C - UA	First Reaction	TRUE	75p	7.52	0.897	9.09e-05	0.446	0.000730	0.000250	5.55e-07	5.47e-08	0.00328	0.00603	8.42e-06	0.00211	0.00235
HEN_845_804E	23	C - UA	Second Reaction	TRUE	75p	7.50	1.07	1.30e-07	0.000643	0.000632	0.000166	5.55e-07	5.70e-08	0.00342	0.00603	8.42e-06	0.00207	0.00230
HEN_845_804E	35	C - UA	First Reaction	TRUE	75p	7.29	4.36	0.000238	0.999	0.000983	0.000314	5.55e-07	3.61e-08	0.00494	0.00603	8.42e-06	0.00260	0.00287
HEN_845_804E	35	C - UA	Second Reaction	TRUE	75p	7.35	4.27	1.91e-05	0.0865	0.000637	0.000187	5.55e-07	3.03e-08	0.00459	0.00603	8.42e-06	0.00231	0.00257
HEN_845_804E	22	C - UA	Initial Soln	TRUE	median	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Initial Soln	TRUE	median	7.41	1.54	-1.47e-18	-6.33e-15	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00288	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Initial Soln	TRUE	median	6.96	6.08	-7.91e-18	-2.58e-14	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.00187	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	Speciation Model	TRUE	median	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Speciation Model	TRUE	median	7.41	1.54	-3.27e-17	-1.41e-13	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00288	9.75e-06	0.00268	0.00320

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
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program_id	Location	Location Description	Model	Charge Balance	Solids Summary	pH	pe	charge	pct_err	S(6)	B	Li	As	C(4)	Cl	F	Ca	Mg
HEN_845_804E	35	C - UA	Speciation Model	TRUE	median	6.96	6.08	-1.14e-17	-3.71e-14	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.00187	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	First Reaction	TRUE	median	7.52	3.10	-9.00e-05	-4.49e-01	0.000633	0.000138	5.55e-07	2.33e-08	0.00334	0.00603	8.42e-06	0.00204	0.00226
HEN_845_804E	22	C - UA	Second Reaction	TRUE	median	7.51	3.19	-1.72e-05	-8.50e-02	0.000644	0.000109	5.55e-07	1.89e-08	0.00339	0.00603	8.42e-06	0.00207	0.00230
HEN_845_804E	23	C - UA	First Reaction	TRUE	median	7.51	0.911	7.24e-05	0.356	0.000716	0.000244	5.55e-07	5.51e-08	0.00331	0.00603	8.42e-06	0.00211	0.00234
HEN_845_804E	23	C - UA	Second Reaction	TRUE	median	7.50	1.09	-7.78e-07	-3.84e-03	0.000632	0.000162	5.55e-07	5.73e-08	0.00345	0.00603	8.42e-06	0.00208	0.00231
HEN_845_804E	35	C - UA	First Reaction	TRUE	median	7.30	4.34	0.000197	0.836	0.000930	0.000306	5.55e-07	3.52e-08	0.00488	0.00603	8.42e-06	0.00255	0.00282
HEN_845_804E	35	C - UA	Second Reaction	TRUE	median	7.36	4.24	1.45e-05	0.0658	0.000634	0.000183	5.55e-07	2.93e-08	0.00451	0.00603	8.42e-06	0.00229	0.00255
HEN_845_804E	22	C - UA	Initial Soln	FALSE	25p	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Initial Soln	FALSE	25p	7.41	1.54	0.00136	6.21	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00152	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Initial Soln	FALSE	25p	6.96	6.08	0.000895	3.01	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.000974	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	Speciation Model	FALSE	25p	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Speciation Model	FALSE	25p	7.41	1.54	0.00136	6.21	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00152	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Speciation Model	FALSE	25p	6.96	6.08	0.000895	3.01	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.000974	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	First Reaction	FALSE	25p	7.52	3.11	-8.22e-05	-4.09e-01	0.000634	0.000137	5.55e-07	2.21e-08	0.00336	0.00603	8.42e-06	0.00204	0.00227
HEN_845_804E	22	C - UA	Second Reaction	FALSE	25p	7.50	3.20	-1.56e-05	-7.73e-02	0.000644	0.000108	5.55e-07	1.75e-08	0.00341	0.00603	8.42e-06	0.00207	0.00230
HEN_845_804E	23	C - UA	First Reaction	FALSE	25p	7.51	0.919	5.35e-05	0.263	0.000703	0.000239	5.55e-07	5.63e-08	0.00333	0.00603	8.42e-06	0.00210	0.00233
HEN_845_804E	23	C - UA	Second Reaction	FALSE	25p	7.50	1.10	-1.32e-06	-6.51e-03	0.000633	0.000158	5.55e-07	5.84e-08	0.00347	0.00603	8.42e-06	0.00208	0.00232
HEN_845_804E	35	C - UA	First Reaction	FALSE	25p	7.31	4.32	0.000158	0.676	0.000884	0.000299	5.55e-07	3.44e-08	0.00482	0.00603	8.42e-06	0.00251	0.00278
HEN_845_804E	35	C - UA	Second Reaction	FALSE	25p	7.37	4.21	1.08e-05	0.0493	0.000633	0.000181	5.55e-07	2.85e-08	0.00442	0.00603	8.42e-06	0.00228	0.00253
HEN_845_804E	22	C - UA	Initial Soln	FALSE	75p	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Initial Soln	FALSE	75p	7.41	1.54	0.00136	6.21	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00152	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Initial Soln	FALSE	75p	6.96	6.08	0.000895	3.01	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.000974	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	Speciation Model	FALSE	75p	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Speciation Model	FALSE	75p	7.41	1.54	0.00136	6.21	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00152	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Speciation Model	FALSE	75p	6.96	6.08	0.000895	3.01	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.000974	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	First Reaction	FALSE	75p	7.52	3.09	-1.06e-04	-5.31e-01	0.000634	0.000140	5.55e-07	2.37e-08	0.00334	0.00603	8.42e-06	0.00203	0.00226
HEN_845_804E	22	C - UA	Second Reaction	FALSE	75p	7.51	3.18	-1.88e-05	-9.31e-02	0.000643	0.000111	5.55e-07	1.96e-08	0.00338	0.00603	8.42e-06	0.00207	0.00230
HEN_845_804E	23	C - UA	First Reaction	FALSE	75p	7.52	0.892	8.70e-05	0.427	0.000730	0.000250	5.55e-07	5.55e-08	0.00328	0.00603	8.42e-06	0.00211	0.00234
HEN_845_804E	23	C - UA	Second Reaction	FALSE	75p	7.50	1.07	4.39e-08	0.000217	0.000632	0.000166	5.55e-07	5.78e-08	0.00342	0.00603	8.42e-06	0.00207	0.00230
HEN_845_804E	35	C - UA	First Reaction	FALSE	75p	7.29	4.36	0.000235	0.984	0.000983	0.000315	5.55e-07	3.64e-08	0.00494	0.00603	8.42e-06	0.00260	0.00287
HEN_845_804E	35	C - UA	Second Reaction	FALSE	75p	7.35	4.26	1.91e-05	0.0861	0.000637	0.000187	5.55e-07	3.05e-08	0.00459	0.00603	8.42e-06	0.00231	0.00257
HEN_845_804E	22	C - UA	Initial Soln	FALSE	median	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Initial Soln	FALSE	median	7.41	1.54	0.00136	6.21	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00152	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Initial Soln	FALSE	median	6.96	6.08	0.000895	3.01	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.000974	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	Speciation Model	FALSE	median	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804E	23	C - UA	Speciation Model	FALSE	median	7.41	1.54	0.00136	6.21	0.00474	0.000782	5.23e-07	3.50e-08	0.00159	0.00152	9.75e-06	0.00268	0.00320
HEN_845_804E	35	C - UA	Speciation Model	FALSE	median	6.96	6.08	0.000895	3.01	0.00813	0.00114	3.97e-06	2.98e-08	0.00229	0.000974	8.17e-06	0.00763	0.00152
HEN_845_804E	22	C - UA	First Reaction	FALSE	median	7.52	3.10	-9.35e-05	-4.66e-01	0.000634	0.000139	5.55e-07	2.30e-08	0.00335	0.00603	8.42e-06	0.00204	0.00226
HEN_845_804E	22	C - UA	Second Reaction	FALSE	median	7.51	3.19	-1.72e-05	-8.51e-02	0.000643	0.000109	5.55e-07	1.86e-08	0.00339	0.00603	8.42e-06	0.00207	0.00230
HEN_845_804E	23	C - UA	First Reaction	FALSE	median	7.51	0.906	6.94e-05	0.341	0.000715	0.000243	5.55e-07	5.59e-08	0.00331	0.00603	8.42e-06	0.00210	0.00234
HEN_845_804E	23	C - UA	Second Reaction	FALSE	median	7.50	1.09	-8.35e-07	-4.12e-03	0.000633	0.000161	5.55e-07	5.81e-08	0.00345	0.00603	8.42e-06	0.00208	0.00231
HEN_845_804E	35	C - UA	First Reaction	FALSE	median	7.30	4.34	0.000194	0.824	0.000930	0.000306	5.55e-07	3.54e-08	0.00488	0.00603	8.42e-06	0.00255	0.00282
HEN_845_804E	35	C - UA	Second Reaction	FALSE	median	7.36	4.24	1.44e-05	0.0656	0.000634	0.000183	5.55e-07	2.94e-08	0.00451	0.00603	8.42e-06	0.00229	0.00255
HEN_845_804R	22	C - UA	Initial Soln	TRUE	25p	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	Speciation Model	TRUE	25p	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	First Reaction	TRUE	25p	7.67	2.97	-1.64e-06	-9.02e-03	0.000482	0.000126	2.83e-06	3.51e-08	0.00425	0.00426	2.16e-05	0.00109	0.00129
HEN_845_804R	22	C - UA	Second Reaction	TRUE	25p	7.69	3.01	-5.76e-06	-3.19e-02	0.000482	0.000104	2.83e-06	2.87e-08	0.00417	0.00426	2.16e-05	0.00108	0.00127
HEN_845_804R	22	C - UA	Initial Soln	TRUE	75p	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	Speciation Model	TRUE	75p	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	First Reaction	TRUE	75p	7.67	2.98	2.19e-06	0.0120	0.000483	0.000128	2.83e-06	3.72e-08	0.00427	0.00426	2.16e-05	0.00110	0.00130
HEN_845_804R	22	C - UA	Second Reaction	TRUE	75p	7.68	3.01	-5.32e-06	-2.95e-02	0.000481	0.000106	2.83e-06	3.16e-08	0.00420	0.00426	2.16e-05	0.00108	0.00127
HEN_845_804R	22	C - UA	Initial Soln	TRUE	median	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	Speciation Model	TRUE	median	7.62	4.82	3.46e-18	3.10e-14	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00117	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	First Reaction	TRUE	median	7.67	2.98	2.05e-07	0.00113	0.000482	0.000127	2.83e-06	3.62e-08	0.00426	0.00426	2.16e-05	0.00110	0.00129
HEN_845_804R	22	C - UA	Second Reaction	TRUE	median	7.69	3.01	-5.60e-06	-3.10e-02	0.000482	0.000104	2.83e-06	3.02e-08	0.00418	0.00426	2.16e-05	0.00108	0.00127
HEN_845_804R	22	C - UA	Initial Soln	FALSE	25p	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	Speciation Model	FALSE	25p	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	First Reaction	FALSE	25p	7.67	2.97	-4.96e-06	-2.73e-02	0.000482	0.000127	2.83e-06	3.45e-08	0.00426	0.00426	2.16e-05	0.00109	0.00129
HEN_845_804R	22	C - UA	Second Reaction	FALSE	25p	7.69	3.01	-5.78e-06	-3.21e-02	0.000482	0.000104	2.83e-06	2.82e-08	0.00417	0.00426	2.16e-05	0.00108	0.00127
HEN_845_804R	22	C - UA	Initial Soln	FALSE	75p	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	Speciation Model	FALSE	75p	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	First Reaction	FALSE	75p	7.67	2.98	-1.49e-06	-8.17e-03	0.000483	0.000128	2.83e-06	3.66e-08	0.00428	0.00426	2.16e-05	0.00110	0.00130
HEN_845_804R	22	C - UA	Second Reaction	FALSE	75p	7.68	3.01	-5.35e-06	-2.96e-02	0.000481	0.000106	2.83e-06	3.11e-08	0.00420	0.00426	2.16e-05	0.00108	0.00128
HEN_845_804R	22	C - UA	Initial Soln	FALSE	median	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	Speciation Model	FALSE	median	7.62	4.82	-1.46e-03	-1.15e+01	0.00127	0.000165	7.14e-06	2.98e-08	0.00242	0.00262	9.22e-06	0.00137	0.000805
HEN_845_804R	22	C - UA	First Reaction	FALSE	median	7.67	2.98	-3.27e-06	-1.80e-02	0.000483	0.000127	2.83e-06	3.56e-08	0.00427	0.00426	2.16e-05	0.00110	0.00129
HEN_845_804R	22	C - UA	Second Reaction	FALSE	median	7.69	3.01	-5.63e-06	-3.12e-02	0.000482	0.000105	2.83e-06	2.97e-08	0.00419	0.00426	2.16e-05	0.00108	0.00127

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	Na	K	Ba	Si	P	Mn	Fe	Al	Sb	Be	Cd	Cr	Co
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	25p	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Initial Soln	TRUE	25p	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	25p	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Speciation Model	TRUE	25p	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	First Reaction	TRUE	25p	0.00212	1.11e-05	5.58e-07	0.000207	6.39e-06	1.97e-05	6.88e-05	4.46e-08	3.49e-09	3.22e-08	1.44e-09	5.30e-08	2.02e-08
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	25p	0.00212	1.11e-05	5.81e-07	0.000233	6.45e-06	2.19e-05	7.60e-05	4.29e-08	3.49e-09	3.69e-08	1.50e-09	5.98e-08	2.11e-08
HEN_845_804W	51	C - UA	First Reaction	TRUE	25p	0.00212	1.11e-05	5.59e-07	0.000187	9.86e-07	1.97e-05	7.52e-05	4.32e-08	3.49e-09	2.99e-08	1.30e-09	3.31e-08	1.19e-08
HEN_845_804W	51	C - UA	Second Reaction	TRUE	25p	0.00212	1.11e-05	5.80e-07	0.000203	1.03e-06	2.18e-05	7.90e-05	4.24e-08	3.49e-09	3.23e-08	1.31e-09	3.55e-08	1.20e-08
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	75p	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Initial Soln	TRUE	75p	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	75p	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Speciation Model	TRUE	75p	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	First Reaction	TRUE	75p	0.00212	1.11e-05	5.52e-07	0.000200	6.40e-06	1.93e-05	6.24e-05	4.52e-08	3.49e-09	3.07e-08	1.39e-09	5.09e-08	1.93e-08
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	75p	0.00212	1.11e-05	5.78e-07	0.000227	6.50e-06	2.18e-05	7.02e-05	4.34e-08	3.49e-09	3.52e-08	1.48e-09	5.76e-08	2.05e-08
HEN_845_804W	51	C - UA	First Reaction	TRUE	75p	0.00212	1.11e-05	5.53e-07	0.000182	9.80e-07	1.94e-05	6.93e-05	4.35e-08	3.49e-09	2.90e-08	1.25e-09	3.22e-08	1.14e-08
HEN_845_804W	51	C - UA	Second Reaction	TRUE	75p	0.00212	1.11e-05	5.79e-07	0.000199	1.02e-06	2.17e-05	7.38e-05	4.26e-08	3.49e-09	3.14e-08	1.29e-09	3.46e-08	1.17e-08
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	median	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Initial Soln	TRUE	median	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	median	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Speciation Model	TRUE	median	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	First Reaction	TRUE	median	0.00212	1.11e-05	5.55e-07	0.000203	6.40e-06	1.95e-05	6.54e-05	4.49e-08	3.49e-09	3.15e-08	1.42e-09	5.19e-08	1.97e-08
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	median	0.00212	1.11e-05	5.79e-07	0.000230	6.48e-06	2.19e-05	7.31e-05	4.31e-08	3.49e-09	3.61e-08	1.49e-09	5.87e-08	2.08e-08
HEN_845_804W	51	C - UA	First Reaction	TRUE	median	0.00212	1.11e-05	5.56e-07	0.000185	9.83e-07	1.96e-05	7.21e-05	4.33e-08	3.49e-09	2.95e-08	1.27e-09	3.26e-08	1.16e-08
HEN_845_804W	51	C - UA	Second Reaction	TRUE	median	0.00212	1.11e-05	5.80e-07	0.000201	1.02e-06	2.18e-05	7.64e-05	4.25e-08	3.49e-09	3.19e-08	1.30e-09	3.51e-08	1.18e-08
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	25p	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Initial Soln	FALSE	25p	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	25p	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Speciation Model	FALSE	25p	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	First Reaction	FALSE	25p	0.00212	1.11e-05	5.59e-07	0.000206	6.38e-06	1.96e-05	6.89e-05	4.46e-08	3.49e-09	3.21e-08	1.67e-09	5.29e-08	2.05e-08
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	25p	0.00212	1.11e-05	5.80e-07	0.000232	6.45e-06	2.19e-05	7.62e-05	4.29e-08	3.49e-09	3.68e-08	1.74e-09	5.97e-08	2.14e-08
HEN_845_804W	51	C - UA	First Reaction	FALSE	25p	0.00212	1.11e-05	5.60e-07	0.000186	9.87e-07	1.97e-05	7.53e-05	4.32e-08	3.49e-09	2.98e-08	1.53e-09	3.31e-08	1.21e-08
HEN_845_804W	51	C - UA	Second Reaction	FALSE	25p	0.00212	1.11e-05	5.80e-07	0.000202	1.03e-06	2.18e-05	7.92e-05	4.24e-08	3.49e-09	3.22e-08	1.55e-09	3.55e-08	1.22e-08
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	75p	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Initial Soln	FALSE	75p	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	75p	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Speciation Model	FALSE	75p	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	First Reaction	FALSE	75p	0.00212	1.11e-05	5.53e-07	0.000198	6.40e-06	1.93e-05	6.24e-05	4.53e-08	3.49e-09	3.06e-08	1.61e-09	5.08e-08	1.95e-08
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	75p	0.00212	1.11e-05	5.77e-07	0.000226	6.50e-06	2.18e-05	7.03e-05	4.34e-08	3.49e-09	3.51e-08	1.72e-09	5.75e-08	2.07e-08
HEN_845_804W	51	C - UA	First Reaction	FALSE	75p	0.00212	1.11e-05	5.53e-07	0.000181	9.80e-07	1.94e-05	6.93e-05	4.35e-08	3.49e-09	2.89e-08	1.48e-09	3.22e-08	1.15e-08
HEN_845_804W	51	C - UA	Second Reaction	FALSE	75p	0.00212	1.11e-05	5.78e-07	0.000198	1.02e-06	2.17e-05	7.40e-05	4.26e-08	3.49e-09	3.13e-08	1.52e-09	3.47e-08	1.18e-08
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	median	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Initial Soln	FALSE	median	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	median	0.00205	7.43e-05	2.17e-06	0.000151	7.01e-06	2.01e-06	9.89e-05	3.50e-07	3.49e-09	2.03e-08	1.49e-09	3.85e-08	2.29e-08
HEN_845_804W	51	C - UA	Speciation Model	FALSE	median	0.00241	0.000157	7.61e-07	0.000135	7.43e-07	2.91e-06	0.000113	3.50e-07	3.49e-09	2.03e-08	1.49e-09	2.41e-08	1.41e-08
HEN_845_804W	21R	C - UA	First Reaction	FALSE	median	0.00212	1.11e-05	5.56e-07	0.000202	6.39e-06	1.95e-05	6.55e-05	4.49e-08	3.49e-09	3.13e-08	1.64e-09	5.18e-08	1.99e-08
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	median	0.00212	1.11e-05	5.79e-07	0.000229	6.48e-06	2.19e-05	7.32e-05	4.31e-08	3.49e-09	3.59e-08	1.73e-09	5.87e-08	2.11e-08
HEN_845_804W	51	C - UA	First Reaction	FALSE	median	0.00212	1.11e-05	5.57e-07	0.000184	9.84e-07	1.96e-05	7.21e-05	4.34e-08	3.49e-09	2.94e-08	1.50e-09	3.26e-08	1.18e-08
HEN_845_804W	51	C - UA	Second Reaction	FALSE	median	0.00212	1.11e-05	5.79e-07	0.000200	1.02e-06	2.18e-05	7.65e-05	4.25e-08	3.49e-09	3.18e-08	1.53e-09	3.51e-08	1.20e-08
HEN_845_804E	22	C - UA	Initial Soln	TRUE	25p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Initial Soln	TRUE	25p	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Initial Soln	TRUE	25p	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	Speciation Model	TRUE	25p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Speciation Model	TRUE	25p	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Speciation Model	TRUE	25p	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	First Reaction	TRUE	25p	0.00170	5.53e-05	2.93e-07	0.000346	9.49e-08	1.30e-06	1.07e-08	5.72e-08	3.49e-09	3.01e-08	5.87e-08	3.00e-08	5.71e-08
HEN_845_804E	22	C - UA	Second Reaction	TRUE	25p	0.00170	5.53e-05	2.91e-07	0.000303	9.45e-08	1.25e-06	1.02e-08	5.64e-08	3.49e-09	2.91e-08	5.10e-08	2.82e-08	4.97e-08
HEN_845_804E	23	C - UA	First Reaction	TRUE	25p	0.00170	5.53e-05	2.91e-07	0.000122	5.73e-07	2.68e-06	8.68e-07	5.68e-08	3.49e-09	3.37e-08	7.03e-10	1.77e-08	3.13e-09
HEN_845_804E	23	C - UA	Second Reaction	TRUE	25p	0.00170	5.53e-05	2.91e-07	0.000126	5.76e-07	1.48e-06	6.31e-07	5.57e-08	3.49e-09	3.44e-08	5.56e-10	1.76e-08	2.50e-09
HEN_845_804E	35	C - UA	First Reaction	TRUE	25p	0.00170	5.53e-05	2.90e-07	7.29e-05	9.77e-07	1.37e-06	9.77e-09	4.54e-08	3.49e-09	1.44e-08	3.55e-10	1.03e-08	4.56e-09
HEN_845_804E	35	C - UA	Second Reaction	TRUE	25p	0.00170	5.53e-05	2.91e-07	6.27e-05	9.36e-07	1.19e-06	8.46e-09	4.81e-08	3.49e-09	1.26e-08	2.40e-10	8.64e-09	2.95e-09
HEN_845_804E	22	C - UA	Initial Soln	TRUE	75p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Initial Soln	TRUE	75p	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Initial Soln	TRUE	75p	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	Speciation Model	TRUE	75p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Speciation Model	TRUE	75p	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Speciation Model	TRUE	75p	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	First Reaction	TRUE	75p	0.00170	5.53e-05	2.93e-07	0.000360	9.49e-08	1.31e-06	1.07e-08	5.75e-08	3.49e-09	3.04e-08	5.91e-08	3.03e-08	5.74e-08
HEN_845_804E	22	C - UA	Second Reaction	TRUE	75p	0.00170	5.53e-05	2.91e-07	0.000323	9.37e-08	1.25e-06	1.02e-08	5.67e-08	3.49e-09	2.96e-08	5.19e-08	2.87e-08	5.04e-08
HEN_845_804E	23	C - UA	First Reaction	TRUE	75p	0.00170	5.53e-05	2.91e-07	0.000121	5.72e-07	2.79e-06	8.94e-07	5.72e-08	3.49e-09	3.34e-08	7.26e-10	1.78e-08	3.21e-09
HEN_845_804E	23	C - UA	Second Reaction	TRUE	75p	0.00170	5.53e-05	2.91e-07	0.000125	5.76e-07	1.51e-06	6.51e-07	5.62e-08	3.49e-09	3.40e-08	5.77e-10	1.75e-08	2.56e-09
HEN_845_804E	35	C - UA	First Reaction	TRUE	75p	0.00170	5.53e-05	2.70e-07	7.64e-05	9.89e-07	1.39e-06	1.02e-08	4.47e-08	3.49e-09	1.50e-08	3.79e-10	1.08e-08	4.89e-09
HEN_845_804E	35	C - UA	Second Reaction	TRUE	75p	0.00170	5.53e-05	3.11e-07	6.60e-05	9.49e-07	1.19e-06	8.81e-09	4.71e-08	3.49e-09	1.31e-08	2.54e-10	9.07e-09	3.14e-09
HEN_845_804E	22	C - UA	Initial Soln	TRUE	median	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Initial Soln	TRUE	median	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Initial Soln	TRUE	median	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	Speciation Model	TRUE	median	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Speciation Model	TRUE	median	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	Na	K	Ba	Si	P	Mn	Fe	Al	Sb	Be	Cd	Cr	Co
HEN_845_804E	35	C - UA	Speciation Model	TRUE	median	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	First Reaction	TRUE	median	0.00170	5.53e-05	2.93e-07	0.000353	9.48e-08	1.31e-06	1.07e-08	5.74e-08	3.49e-09	3.02e-08	5.89e-08	3.01e-08	5.72e-08
HEN_845_804E	22	C - UA	Second Reaction	TRUE	median	0.00170	5.53e-05	2.91e-07	0.000313	9.40e-08	1.25e-06	1.02e-08	5.66e-08	3.49e-09	2.94e-08	5.14e-08	2.85e-08	5.00e-08
HEN_845_804E	23	C - UA	First Reaction	TRUE	median	0.00170	5.53e-05	2.91e-07	0.000121	5.73e-07	2.72e-06	8.79e-07	5.70e-08	3.49e-09	3.35e-08	7.13e-10	1.77e-08	3.17e-09
HEN_845_804E	23	C - UA	Second Reaction	TRUE	median	0.00170	5.53e-05	2.91e-07	0.000125	5.76e-07	1.50e-06	6.39e-07	5.59e-08	3.49e-09	3.42e-08	5.66e-10	1.76e-08	2.53e-09
HEN_845_804E	35	C - UA	First Reaction	TRUE	median	0.00170	5.53e-05	2.82e-07	7.47e-05	9.83e-07	1.38e-06	9.98e-09	4.50e-08	3.49e-09	1.47e-08	3.66e-10	1.05e-08	4.71e-09
HEN_845_804E	35	C - UA	Second Reaction	TRUE	median	0.00170	5.53e-05	2.98e-07	6.43e-05	9.42e-07	1.19e-06	8.63e-09	4.76e-08	3.49e-09	1.28e-08	2.46e-10	8.85e-09	3.04e-09
HEN_845_804E	22	C - UA	Initial Soln	FALSE	25p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Initial Soln	FALSE	25p	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Initial Soln	FALSE	25p	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	Speciation Model	FALSE	25p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Speciation Model	FALSE	25p	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Speciation Model	FALSE	25p	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	First Reaction	FALSE	25p	0.00170	5.53e-05	2.93e-07	0.000347	9.45e-08	1.30e-06	1.07e-08	5.72e-08	3.49e-09	3.01e-08	5.41e-08	3.00e-08	5.63e-08
HEN_845_804E	22	C - UA	Second Reaction	FALSE	25p	0.00170	5.53e-05	2.91e-07	0.000303	9.42e-08	1.25e-06	1.01e-08	5.64e-08	3.49e-09	2.91e-08	4.69e-08	2.82e-08	4.89e-08
HEN_845_804E	23	C - UA	First Reaction	FALSE	25p	0.00170	5.53e-05	2.91e-07	0.000122	5.75e-07	2.70e-06	8.76e-07	5.69e-08	3.49e-09	3.36e-08	7.45e-10	1.77e-08	3.16e-09
HEN_845_804E	23	C - UA	Second Reaction	FALSE	25p	0.00170	5.53e-05	2.91e-07	0.000126	5.78e-07	1.49e-06	6.37e-07	5.57e-08	3.49e-09	3.43e-08	5.90e-10	1.76e-08	2.53e-09
HEN_845_804E	35	C - UA	First Reaction	FALSE	25p	0.00170	5.53e-05	2.90e-07	7.29e-05	9.78e-07	1.37e-06	9.77e-09	4.54e-08	3.49e-09	1.44e-08	3.68e-10	1.03e-08	4.60e-09
HEN_845_804E	35	C - UA	Second Reaction	FALSE	25p	0.00170	5.53e-05	2.91e-07	6.27e-05	9.37e-07	1.19e-06	8.46e-09	4.81e-08	3.49e-09	1.26e-08	2.48e-10	8.66e-09	2.98e-09
HEN_845_804E	22	C - UA	Initial Soln	FALSE	75p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Initial Soln	FALSE	75p	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Initial Soln	FALSE	75p	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	Speciation Model	FALSE	75p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Speciation Model	FALSE	75p	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Speciation Model	FALSE	75p	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	First Reaction	FALSE	75p	0.00170	5.53e-05	2.93e-07	0.000361	9.46e-08	1.30e-06	1.07e-08	5.75e-08	3.49e-09	3.04e-08	5.45e-08	3.02e-08	5.66e-08
HEN_845_804E	22	C - UA	Second Reaction	FALSE	75p	0.00170	5.53e-05	2.91e-07	0.000324	9.34e-08	1.25e-06	1.02e-08	5.67e-08	3.49e-09	2.96e-08	4.78e-08	2.87e-08	4.97e-08
HEN_845_804E	23	C - UA	First Reaction	FALSE	75p	0.00170	5.53e-05	2.91e-07	0.000120	5.74e-07	2.81e-06	9.02e-07	5.73e-08	3.49e-09	3.33e-08	7.70e-10	1.78e-08	3.25e-09
HEN_845_804E	23	C - UA	Second Reaction	FALSE	75p	0.00170	5.53e-05	2.91e-07	0.000125	5.78e-07	1.52e-06	6.57e-07	5.62e-08	3.49e-09	3.39e-08	6.11e-10	1.75e-08	2.59e-09
HEN_845_804E	35	C - UA	First Reaction	FALSE	75p	0.00170	5.53e-05	2.69e-07	7.64e-05	9.91e-07	1.39e-06	1.02e-08	4.47e-08	3.49e-09	1.50e-08	3.93e-10	1.08e-08	4.93e-09
HEN_845_804E	35	C - UA	Second Reaction	FALSE	75p	0.00170	5.53e-05	3.11e-07	6.60e-05	9.51e-07	1.19e-06	8.81e-09	4.71e-08	3.49e-09	1.31e-08	2.63e-10	9.09e-09	3.17e-09
HEN_845_804E	22	C - UA	Initial Soln	FALSE	median	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Initial Soln	FALSE	median	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Initial Soln	FALSE	median	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	Speciation Model	FALSE	median	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804E	23	C - UA	Speciation Model	FALSE	median	0.00196	7.76e-05	3.28e-07	9.98e-05	3.23e-07	2.06e-05	2.58e-06	3.50e-07	3.49e-09	3.14e-08	1.49e-09	1.88e-08	7.39e-09
HEN_845_804E	35	C - UA	Speciation Model	FALSE	median	0.00132	0.000359	3.10e-07	8.32e-05	4.20e-07	9.71e-06	3.00e-07	3.50e-07	3.50e-09	2.03e-08	1.49e-09	1.88e-08	2.21e-08
HEN_845_804E	22	C - UA	First Reaction	FALSE	median	0.00170	5.53e-05	2.93e-07	0.000354	9.45e-08	1.30e-06	1.07e-08	5.73e-08	3.49e-09	3.03e-08	5.42e-08	3.01e-08	5.64e-08
HEN_845_804E	22	C - UA	Second Reaction	FALSE	median	0.00170	5.53e-05	2.91e-07	0.000314	9.37e-08	1.25e-06	1.01e-08	5.65e-08	3.49e-09	2.94e-08	4.73e-08	2.85e-08	4.92e-08
HEN_845_804E	23	C - UA	First Reaction	FALSE	median	0.00170	5.53e-05	2.91e-07	0.000121	5.75e-07	2.74e-06	8.87e-07	5.71e-08	3.49e-09	3.34e-08	7.56e-10	1.77e-08	3.20e-09
HEN_845_804E	23	C - UA	Second Reaction	FALSE	median	0.00170	5.53e-05	2.91e-07	0.000125	5.78e-07	1.50e-06	6.45e-07	5.59e-08	3.49e-09	3.41e-08	6.00e-10	1.76e-08	2.56e-09
HEN_845_804E	35	C - UA	First Reaction	FALSE	median	0.00170	5.53e-05	2.82e-07	7.46e-05	9.84e-07	1.38e-06	9.98e-09	4.51e-08	3.49e-09	1.47e-08	3.79e-10	1.06e-08	4.75e-09
HEN_845_804E	35	C - UA	Second Reaction	FALSE	median	0.00170	5.53e-05	2.98e-07	6.43e-05	9.43e-07	1.19e-06	8.63e-09	4.76e-08	3.49e-09	1.28e-08	2.55e-10	8.87e-09	3.06e-09
HEN_845_804R	22	C - UA	Initial Soln	TRUE	25p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	Speciation Model	TRUE	25p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	First Reaction	TRUE	25p	0.00444	9.66e-05	3.90e-07	0.000337	1.20e-07	5.48e-07	7.54e-09	6.79e-08	1.64e-09	2.41e-08	3.31e-08	2.34e-08	3.48e-08
HEN_845_804R	22	C - UA	Second Reaction	TRUE	25p	0.00444	9.66e-05	3.87e-07	0.000292	1.09e-07	4.34e-07	6.92e-09	6.92e-08	1.64e-09	2.26e-08	2.82e-08	2.16e-08	2.96e-08
HEN_845_804R	22	C - UA	Initial Soln	TRUE	75p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	Speciation Model	TRUE	75p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	First Reaction	TRUE	75p	0.00444	9.66e-05	3.90e-07	0.000352	1.24e-07	5.58e-07	7.64e-09	6.75e-08	1.64e-09	2.45e-08	3.36e-08	2.38e-08	3.54e-08
HEN_845_804R	22	C - UA	Second Reaction	TRUE	75p	0.00444	9.66e-05	3.88e-07	0.000312	1.14e-07	4.39e-07	7.02e-09	6.88e-08	1.64e-09	2.32e-08	2.89e-08	2.21e-08	3.03e-08
HEN_845_804R	22	C - UA	Initial Soln	TRUE	median	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	Speciation Model	TRUE	median	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	First Reaction	TRUE	median	0.00444	9.66e-05	3.90e-07	0.000345	1.22e-07	5.52e-07	7.59e-09	6.77e-08	1.64e-09	2.43e-08	3.33e-08	2.36e-08	3.51e-08
HEN_845_804R	22	C - UA	Second Reaction	TRUE	median	0.00444	9.66e-05	3.88e-07	0.000302	1.12e-07	4.36e-07	6.97e-09	6.90e-08	1.64e-09	2.29e-08	2.85e-08	2.18e-08	2.99e-08
HEN_845_804R	22	C - UA	Initial Soln	FALSE	25p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	Speciation Model	FALSE	25p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	First Reaction	FALSE	25p	0.00444	9.66e-05	3.89e-07	0.000338	1.20e-07	5.44e-07	7.55e-09	6.79e-08	1.64e-09	2.41e-08	3.05e-08	2.34e-08	3.43e-08
HEN_845_804R	22	C - UA	Second Reaction	FALSE	25p	0.00444	9.66e-05	3.88e-07	0.000293	1.08e-07	4.33e-07	6.92e-09	6.91e-08	1.64e-09	2.27e-08	2.60e-08	2.16e-08	2.92e-08
HEN_845_804R	22	C - UA	Initial Soln	FALSE	75p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	Speciation Model	FALSE	75p	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	First Reaction	FALSE	75p	0.00444	9.66e-05	3.89e-07	0.000353	1.23e-07	5.54e-07	7.64e-09	6.75e-08	1.64e-09	2.46e-08	3.10e-08	2.38e-08	3.49e-08
HEN_845_804R	22	C - UA	Second Reaction	FALSE	75p	0.00444	9.66e-05	3.89e-07	0.000312	1.14e-07	4.38e-07	7.02e-09	6.88e-08	1.64e-09	2.32e-08	2.66e-08	2.20e-08	2.98e-08
HEN_845_804R	22	C - UA	Initial Soln	FALSE	median	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	Speciation Model	FALSE	median	0.00148	0.000178	2.60e-07	0.000318	8.08e-08	6.37e-07	3.00e-07	3.49e-07	5.96e-09	2.03e-08	2.35e-08	1.88e-08	2.68e-08
HEN_845_804R	22	C - UA	First Reaction	FALSE	median	0.00444	9.66e-05	3.89e-07	0.000346	1.21e-07	5.48e-07	7.59e-09	6.77e-08	1.64e-09	2.43e-08	3.07e-08	2.36e-08	3.46e-08
HEN_845_804R	22	C - UA	Second Reaction	FALSE	median	0.00444	9.66e-05	3.88e-07	0.000303	1.11e-07	4.35e-07	6.97e-09	6.90e-08	1.64e-09	2.29e-08	2.62e-08	2.18e-08	2.94e-08

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	Pb	Mo	Se	Hfo_s	Hfo_w	Hao_	m_Hfo_wOH	m_Hfo_wOH2+	m_Hfo_wOHSO4-2	m_Hfo_wSO4-	m_Hfo_wOSi(OH)3	m_Hfo_wOSiO(OH)2-	m_Hfo_wHCO3
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	25p	1.16e-08	9.23e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	TRUE	25p	7.73e-09	8.14e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	25p	1.16e-08	9.23e-08	5.01e-09	0.000360	0.0144	0.00195	0.000778	0.000459	3.06e-06	9.05e-07	0.00224	0.00235	0.00135
HEN_845_804W	51	C - UA	Speciation Model	TRUE	25p	7.73e-09	8.14e-08	5.01e-09	0.000360	0.0144	0.00195	0.000910	0.000570	5.98e-06	1.88e-06	0.00235	0.00231	0.00193
HEN_845_804W	21R	C - UA	First Reaction	TRUE	25p	1.05e-08	2.94e-08	1.37e-07	0.000361	0.0144	0.00195	0.000600	0.000397	1.80e-06	5.97e-07	0.00237	0.00221	0.00174
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	25p	1.10e-08	1.91e-08	8.63e-09	0.000361	0.0144	0.00195	0.000545	0.000385	1.72e-06	6.09e-07	0.00243	0.00213	0.00190
HEN_845_804W	51	C - UA	First Reaction	TRUE	25p	8.42e-09	3.86e-08	1.98e-07	0.000361	0.0144	0.00195	0.000672	0.000437	2.49e-06	8.12e-07	0.00240	0.00227	0.00226
HEN_845_804W	51	C - UA	Second Reaction	TRUE	25p	8.56e-09	2.26e-08	1.63e-08	0.000361	0.0144	0.00195	0.000632	0.000429	2.33e-06	7.94e-07	0.00245	0.00222	0.00235
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	75p	1.16e-08	9.23e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	TRUE	75p	7.73e-09	8.14e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	75p	1.16e-08	9.23e-08	5.01e-09	0.000500	0.0200	0.00211	0.00108	0.000637	4.25e-06	1.26e-06	0.00312	0.00326	0.00187
HEN_845_804W	51	C - UA	Speciation Model	TRUE	75p	7.73e-09	8.14e-08	5.01e-09	0.000500	0.0200	0.00211	0.00126	0.000792	8.31e-06	2.61e-06	0.00326	0.00321	0.00268
HEN_845_804W	21R	C - UA	First Reaction	TRUE	75p	1.03e-08	3.32e-08	1.85e-07	0.000501	0.0200	0.00211	0.000859	0.000558	2.51e-06	8.17e-07	0.00327	0.00311	0.00234
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	75p	1.10e-08	2.10e-08	1.29e-08	0.000501	0.0200	0.00211	0.000778	0.000541	2.37e-06	8.27e-07	0.00337	0.00299	0.00256
HEN_845_804W	51	C - UA	First Reaction	TRUE	75p	8.26e-09	4.43e-08	2.60e-07	0.000501	0.0200	0.00211	0.000952	0.000614	3.48e-06	1.13e-06	0.00332	0.00317	0.00310
HEN_845_804W	51	C - UA	Second Reaction	TRUE	75p	8.53e-09	2.63e-08	3.06e-08	0.000501	0.0200	0.00211	0.000894	0.000602	3.24e-06	1.09e-06	0.00339	0.00310	0.00322
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	median	1.16e-08	9.23e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	TRUE	median	7.73e-09	8.14e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	median	1.16e-08	9.23e-08	5.01e-09	0.000425	0.0170	0.00201	0.000918	0.000541	3.62e-06	1.07e-06	0.00265	0.00277	0.00159
HEN_845_804W	51	C - UA	Speciation Model	TRUE	median	7.73e-09	8.14e-08	5.01e-09	0.000425	0.0170	0.00201	0.00107	0.000673	7.06e-06	2.22e-06	0.00277	0.00273	0.00228
HEN_845_804W	21R	C - UA	First Reaction	TRUE	median	1.04e-08	3.13e-08	1.59e-07	0.000426	0.0170	0.00201	0.000719	0.000471	2.13e-06	6.99e-07	0.00279	0.00263	0.00202
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	median	1.10e-08	2.00e-08	1.04e-08	0.000426	0.0170	0.00201	0.000652	0.000457	2.02e-06	7.11e-07	0.00287	0.00252	0.00221
HEN_845_804W	51	C - UA	First Reaction	TRUE	median	8.34e-09	4.14e-08	2.27e-07	0.000426	0.0170	0.00201	0.000801	0.000519	2.95e-06	9.58e-07	0.00283	0.00269	0.00265
HEN_845_804W	51	C - UA	Second Reaction	TRUE	median	8.55e-09	2.43e-08	2.23e-08	0.000426	0.0170	0.00201	0.000752	0.000509	2.75e-06	9.34e-07	0.00289	0.00263	0.00276
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	25p	1.16e-08	9.23e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	FALSE	25p	7.73e-09	8.14e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	25p	1.16e-08	9.23e-08	5.01e-09	0.000360	0.0144	0.00195	0.000775	0.000457	3.08e-06	9.12e-07	0.00223	0.00233	0.00135
HEN_845_804W	51	C - UA	Speciation Model	FALSE	25p	7.73e-09	8.14e-08	5.01e-09	0.000360	0.0144	0.00195	0.000906	0.000569	6.01e-06	1.89e-06	0.00234	0.00229	0.00193
HEN_845_804W	21R	C - UA	First Reaction	FALSE	25p	1.04e-08	2.98e-08	1.38e-07	0.000361	0.0144	0.00195	0.000601	0.000398	1.79e-06	5.95e-07	0.00236	0.00220	0.00174
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	25p	1.09e-08	1.92e-08	8.56e-09	0.000361	0.0144	0.00195	0.000546	0.000386	1.71e-06	6.08e-07	0.00242	0.00211	0.00190
HEN_845_804W	51	C - UA	First Reaction	FALSE	25p	8.36e-09	3.92e-08	1.99e-07	0.000361	0.0144	0.00195	0.000673	0.000439	2.47e-06	8.07e-07	0.00239	0.00226	0.00226
HEN_845_804W	51	C - UA	Second Reaction	FALSE	25p	8.51e-09	2.28e-08	1.61e-08	0.000361	0.0144	0.00195	0.000632	0.000431	2.31e-06	7.90e-07	0.00244	0.00221	0.00235
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	75p	1.16e-08	9.23e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	FALSE	75p	7.73e-09	8.14e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	75p	1.16e-08	9.23e-08	5.01e-09	0.000500	0.0200	0.00211	0.00108	0.000635	4.28e-06	1.27e-06	0.00310	0.00324	0.00187
HEN_845_804W	51	C - UA	Speciation Model	FALSE	75p	7.73e-09	8.14e-08	5.01e-09	0.000500	0.0200	0.00211	0.00126	0.000790	8.35e-06	2.63e-06	0.00324	0.00319	0.00268
HEN_845_804W	21R	C - UA	First Reaction	FALSE	75p	1.02e-08	3.36e-08	1.86e-07	0.000501	0.0200	0.00211	0.000861	0.000561	2.49e-06	8.14e-07	0.00326	0.00309	0.00234
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	75p	1.09e-08	2.12e-08	1.28e-08	0.000501	0.0200	0.00211	0.000780	0.000544	2.36e-06	8.26e-07	0.00336	0.00297	0.00256
HEN_845_804W	51	C - UA	First Reaction	FALSE	75p	8.20e-09	4.50e-08	2.62e-07	0.000501	0.0200	0.00211	0.000954	0.000618	3.45e-06	1.12e-06	0.00331	0.00315	0.00309
HEN_845_804W	51	C - UA	Second Reaction	FALSE	75p	8.48e-09	2.65e-08	3.03e-08	0.000501	0.0200	0.00211	0.000894	0.000605	3.21e-06	1.09e-06	0.00338	0.00308	0.00322
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	median	1.16e-08	9.23e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	FALSE	median	7.73e-09	8.14e-08	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	median	1.16e-08	9.23e-08	5.01e-09	0.000425	0.0170	0.00201	0.000915	0.000540	3.64e-06	1.08e-06	0.00264	0.00276	0.00159
HEN_845_804W	51	C - UA	Speciation Model	FALSE	median	7.73e-09	8.14e-08	5.01e-09	0.000425	0.0170	0.00201	0.00107	0.000672	7.10e-06	2.23e-06	0.00276	0.00271	0.00228
HEN_845_804W	21R	C - UA	First Reaction	FALSE	median	1.03e-08	3.16e-08	1.60e-07	0.000426	0.0170	0.00201	0.000721	0.000474	2.12e-06	6.97e-07	0.00278	0.00261	0.00202
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	median	1.09e-08	2.01e-08	1.03e-08	0.000426	0.0170	0.00201	0.000653	0.000459	2.01e-06	7.09e-07	0.00286	0.00251	0.00221
HEN_845_804W	51	C - UA	First Reaction	FALSE	median	8.27e-09	4.20e-08	2.29e-07	0.000426	0.0170	0.00201	0.000802	0.000522	2.92e-06	9.52e-07	0.00282	0.00267	0.00265
HEN_845_804W	51	C - UA	Second Reaction	FALSE	median	8.50e-09	2.45e-08	2.20e-08	0.000426	0.0170	0.00201	0.000753	0.000511	2.73e-06	9.30e-07	0.00288	0.00261	0.00276
HEN_845_804E	22	C - UA	Initial Soln	TRUE	25p	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	TRUE	25p	5.06e-09	1.54e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	TRUE	25p	5.06e-09	8.13e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	TRUE	25p	5.06e-09	4.58e-07	1.94e-07	0.000360	0.0144	0.00195	0.000587	0.000270	2.68e-06	6.18e-07	0.00355	0.00476	0.000463
HEN_845_804E	23	C - UA	Speciation Model	TRUE	25p	5.06e-09	1.54e-07	5.01e-09	0.000360	0.0144	0.00195	0.00101	0.000338	6.98e-05	1.17e-05	0.00193	0.00357	0.000772
HEN_845_804E	35	C - UA	Speciation Model	TRUE	25p	5.06e-09	8.13e-07	5.01e-09	0.000360	0.0144	0.00195	0.00126	0.000948	0.000202	7.61e-05	0.00201	0.00165	0.00337
HEN_845_804E	22	C - UA	First Reaction	TRUE	25p	9.68e-09	6.49e-08	1.59e-07	0.000360	0.0144	0.00195	0.000514	0.000230	1.72e-06	3.84e-07	0.00339	0.00468	0.000640
HEN_845_804E	22	C - UA	Second Reaction	TRUE	25p	8.45e-09	2.30e-08	1.29e-07	0.000360	0.0144	0.00195	0.000562	0.000243	2.13e-06	4.62e-07	0.00324	0.00463	0.000727
HEN_845_804E	23	C - UA	First Reaction	TRUE	25p	4.73e-09	1.06e-07	7.40e-09	0.000360	0.0144	0.00195	0.000802	0.000255	5.96e-06	9.49e-07	0.00186	0.00362	0.00100
HEN_845_804E	23	C - UA	Second Reaction	TRUE	25p	3.84e-09	4.75e-08	7.53e-09	0.000360	0.0144	0.00195	0.000787	0.000257	5.35e-06	8.77e-07	0.00189	0.00357	0.00106
HEN_845_804E	35	C - UA	First Reaction	TRUE	25p	2.84e-09	9.27e-07	6.66e-09	0.000360	0.0144	0.00195	0.00119	0.000595	1.06e-05	2.65e-06	0.00166	0.00204	0.00324
HEN_845_804E	35	C - UA	Second Reaction	TRUE	25p	1.96e-09	4.30e-07	5.90e-09	0.000360	0.0144	0.00195	0.00132	0.000596	8.09e-06	1.83e-06	0.00158	0.00216	0.00293
HEN_845_804E	22	C - UA	Initial Soln	TRUE	75p	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	TRUE	75p	5.06e-09	1.54e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	TRUE	75p	5.06e-09	8.13e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	TRUE	75p	5.06e-09	4.58e-07	1.94e-07	0.000500	0.0200	0.00211	0.000816	0.000375	3.73e-06	8.58e-07	0.00493	0.00662	0.000643
HEN_845_804E	23	C - UA	Speciation Model	TRUE	75p	5.06e-09	1.54e-07	5.01e-09	0.000500	0.0200	0.00211	0.00141	0.000470	9.69e-05	1.62e-05	0.00268	0.00495	0.00107
HEN_845_804E	35	C - UA	Speciation Model	TRUE	75p	5.06e-09	8.13e-07	5.01e-09	0.000500	0.0200	0.00211	0.00175	0.00132	0.000281	0.000106	0.00280	0.00230	0.00468
HEN_845_804E	22	C - UA	First Reaction	TRUE	75p	9.76e-09	8.10e-08	1.69e-07	0.000500	0.0200	0.00211	0.000695	0.000313	2.24e-06	5.05e-07	0.00477	0.00652	0.000853
HEN_845_804E	22	C - UA	Second Reaction	TRUE	75p	8.61e-09	2.77e-08	1.43e-07	0.000500	0.0200	0.00211	0.000748	0.000329	2.69e-06	5.92e-07	0.00461	0.00647	0.000950
HEN_845_804E	23	C - UA	First Reaction	TRUE	75p	4.91e-09	1.25e-07	7.34e-09	0.000500	0.0200	0.00211	0.00112	0.000353	8.61e-06	1.36e-06	0.00257	0.00505	0.00136
HEN_845_804E	23	C - UA	Second Reaction	TRUE	75p	4.06e-09	6.32e-08	7.52e-09	0.000500	0.0200	0.00211	0.00110	0.000356	7.39e-06	1.20e-06	0.00261	0.00499	0.00144
HEN_845_804E	35	C - UA	First Reaction	TRUE	75p	3.03e-09	1.09e-06	6.91e-09	0.000500	0.0200	0.00211	0.00160	0.000824	1.60e-05	4.14e-06	0.00233	0.00279	0.00462
HEN_845_804E	35	C - UA	Second Reaction	TRUE	75p	2.12e-09	5.91e-07	6.17e-09	0.000500	0.0200	0.00211	0.00177	0.000828	1.10e-05	2.59e-06	0.00223	0.00293	0.00424
HEN_845_804E	22	C - UA	Initial Soln	TRUE	median	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	TRUE	median	5.06e-09	1.54e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	TRUE	median	5.06e-09	8.13e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	TRUE	median	5.06e-09	4.58e-07	1.94e-07	0.000425	0.0170	0.00201	0.000694	0.000319	3.17e-06	7.29e-07	0.00419	0.00562	0.000547
HEN_845_804E	23	C - UA	Speciation Model	TRUE	median	5.06e-09	1.54e-07	5.01e-09	0.000425	0.0170	0.00201	0.00120	0.000400	8.24e-05	1.38e-05	0.00228	0.00421	0.000912

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	Pb	Mo	Se	Hfo_s	Hfo_w	Hao_	m_Hfo_wOH	m_Hfo_wOH2+	m_Hfo_wOHSO4-2	m_Hfo_wSO4-	m_Hfo_wOSi(OH)3	m_Hfo_wOSiO(OH)2-	m_Hfo_wHCO3
HEN_845_804E	35	C - UA	Speciation Model	TRUE	median	5.06e-09	8.13e-07	5.01e-09	0.000425	0.0170	0.00201	0.00149	0.00112	0.000239	8.98e-05	0.00238	0.00195	0.00398
HEN_845_804E	22	C - UA	First Reaction	TRUE	median	9.71e-09	7.26e-08	1.64e-07	0.000425	0.0170	0.00201	0.000599	0.000269	1.96e-06	4.40e-07	0.00403	0.00554	0.000739
HEN_845_804E	22	C - UA	Second Reaction	TRUE	median	8.52e-09	2.51e-08	1.36e-07	0.000425	0.0170	0.00201	0.000649	0.000283	2.39e-06	5.23e-07	0.00387	0.00548	0.000831
HEN_845_804E	23	C - UA	First Reaction	TRUE	median	4.82e-09	1.16e-07	7.37e-09	0.000425	0.0170	0.00201	0.000950	0.000300	7.17e-06	1.14e-06	0.00219	0.00428	0.00117
HEN_845_804E	23	C - UA	Second Reaction	TRUE	median	3.95e-09	5.49e-08	7.53e-09	0.000425	0.0170	0.00201	0.000932	0.000303	6.30e-06	1.03e-06	0.00223	0.00423	0.00124
HEN_845_804E	35	C - UA	First Reaction	TRUE	median	2.93e-09	1.01e-06	6.79e-09	0.000425	0.0170	0.00201	0.00138	0.000701	1.30e-05	3.31e-06	0.00197	0.00239	0.00388
HEN_845_804E	35	C - UA	Second Reaction	TRUE	median	2.04e-09	5.08e-07	6.03e-09	0.000425	0.0170	0.00201	0.00153	0.000704	9.47e-06	2.18e-06	0.00188	0.00252	0.00353
HEN_845_804E	22	C - UA	Initial Soln	FALSE	25p	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	FALSE	25p	5.06e-09	1.54e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	FALSE	25p	5.06e-09	8.13e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	FALSE	25p	5.06e-09	4.58e-07	1.94e-07	0.000360	0.0144	0.00195	0.000588	0.000270	2.65e-06	6.11e-07	0.00355	0.00476	0.000462
HEN_845_804E	23	C - UA	Speciation Model	FALSE	25p	5.06e-09	1.54e-07	5.01e-09	0.000360	0.0144	0.00195	0.00101	0.000338	7.01e-05	1.17e-05	0.00193	0.00356	0.000773
HEN_845_804E	35	C - UA	Speciation Model	FALSE	25p	5.06e-09	8.13e-07	5.01e-09	0.000360	0.0144	0.00195	0.00126	0.000947	0.000203	7.62e-05	0.00201	0.00165	0.00337
HEN_845_804E	22	C - UA	First Reaction	FALSE	25p	9.68e-09	6.42e-08	1.58e-07	0.000360	0.0144	0.00195	0.000513	0.000229	1.71e-06	3.84e-07	0.00339	0.00468	0.000640
HEN_845_804E	22	C - UA	Second Reaction	FALSE	25p	8.44e-09	2.28e-08	1.28e-07	0.000360	0.0144	0.00195	0.000561	0.000242	2.13e-06	4.62e-07	0.00324	0.00463	0.000726
HEN_845_804E	23	C - UA	First Reaction	FALSE	25p	4.76e-09	1.06e-07	7.44e-09	0.000360	0.0144	0.00195	0.000802	0.000255	5.93e-06	9.46e-07	0.00186	0.00361	0.00100
HEN_845_804E	23	C - UA	Second Reaction	FALSE	25p	3.87e-09	4.77e-08	7.58e-09	0.000360	0.0144	0.00195	0.000787	0.000258	5.33e-06	8.75e-07	0.00189	0.00356	0.00106
HEN_845_804E	35	C - UA	First Reaction	FALSE	25p	2.86e-09	9.31e-07	6.68e-09	0.000360	0.0144	0.00195	0.00119	0.000595	1.06e-05	2.65e-06	0.00166	0.00204	0.00324
HEN_845_804E	35	C - UA	Second Reaction	FALSE	25p	1.98e-09	4.32e-07	5.91e-09	0.000360	0.0144	0.00195	0.00132	0.000596	8.09e-06	1.83e-06	0.00158	0.00216	0.00293
HEN_845_804E	22	C - UA	Initial Soln	FALSE	75p	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	FALSE	75p	5.06e-09	1.54e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	FALSE	75p	5.06e-09	8.13e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	FALSE	75p	5.06e-09	4.58e-07	1.94e-07	0.000500	0.0200	0.00211	0.000817	0.000376	3.68e-06	8.49e-07	0.00494	0.00662	0.000642
HEN_845_804E	23	C - UA	Speciation Model	FALSE	75p	5.06e-09	1.54e-07	5.01e-09	0.000500	0.0200	0.00211	0.00141	0.000470	9.73e-05	1.63e-05	0.00268	0.00495	0.00107
HEN_845_804E	35	C - UA	Speciation Model	FALSE	75p	5.06e-09	8.13e-07	5.01e-09	0.000500	0.0200	0.00211	0.00175	0.00132	0.000281	0.000106	0.00279	0.00230	0.00468
HEN_845_804E	22	C - UA	First Reaction	FALSE	75p	9.76e-09	8.00e-08	1.68e-07	0.000500	0.0200	0.00211	0.000694	0.000313	2.23e-06	5.05e-07	0.00477	0.00653	0.000853
HEN_845_804E	22	C - UA	Second Reaction	FALSE	75p	8.61e-09	2.75e-08	1.42e-07	0.000500	0.0200	0.00211	0.000747	0.000328	2.68e-06	5.91e-07	0.00461	0.00647	0.000950
HEN_845_804E	23	C - UA	First Reaction	FALSE	75p	4.94e-09	1.26e-07	7.38e-09	0.000500	0.0200	0.00211	0.00112	0.000353	8.57e-06	1.35e-06	0.00257	0.00504	0.00136
HEN_845_804E	23	C - UA	Second Reaction	FALSE	75p	4.08e-09	6.35e-08	7.56e-09	0.000500	0.0200	0.00211	0.00110	0.000357	7.36e-06	1.20e-06	0.00261	0.00498	0.00144
HEN_845_804E	35	C - UA	First Reaction	FALSE	75p	3.05e-09	1.10e-06	6.93e-09	0.000500	0.0200	0.00211	0.00160	0.000824	1.60e-05	4.14e-06	0.00233	0.00279	0.00462
HEN_845_804E	35	C - UA	Second Reaction	FALSE	75p	2.14e-09	5.94e-07	6.18e-09	0.000500	0.0200	0.00211	0.00177	0.000828	1.10e-05	2.59e-06	0.00223	0.00293	0.00424
HEN_845_804E	22	C - UA	Initial Soln	FALSE	median	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	FALSE	median	5.06e-09	1.54e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	FALSE	median	5.06e-09	8.13e-07	5.01e-09	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	FALSE	median	5.06e-09	4.58e-07	1.94e-07	0.000425	0.0170	0.00201	0.000694	0.000319	3.13e-06	7.22e-07	0.00420	0.00563	0.000546
HEN_845_804E	23	C - UA	Speciation Model	FALSE	median	5.06e-09	1.54e-07	5.01e-09	0.000425	0.0170	0.00201	0.00120	0.000399	8.27e-05	1.38e-05	0.00228	0.00421	0.000912
HEN_845_804E	35	C - UA	Speciation Model	FALSE	median	5.06e-09	8.13e-07	5.01e-09	0.000425	0.0170	0.00201	0.00149	0.00112	0.000239	9.00e-05	0.00237	0.00195	0.00398
HEN_845_804E	22	C - UA	First Reaction	FALSE	median	9.71e-09	7.17e-08	1.63e-07	0.000425	0.0170	0.00201	0.000598	0.000268	1.96e-06	4.41e-07	0.00403	0.00554	0.000739
HEN_845_804E	22	C - UA	Second Reaction	FALSE	median	8.51e-09	2.49e-08	1.35e-07	0.000425	0.0170	0.00201	0.000648	0.000282	2.39e-06	5.22e-07	0.00388	0.00548	0.000831
HEN_845_804E	23	C - UA	First Reaction	FALSE	median	4.85e-09	1.16e-07	7.41e-09	0.000425	0.0170	0.00201	0.000950	0.000301	7.13e-06	1.13e-06	0.00219	0.00427	0.00117
HEN_845_804E	23	C - UA	Second Reaction	FALSE	median	3.97e-09	5.51e-08	7.57e-09	0.000425	0.0170	0.00201	0.000933	0.000304	6.27e-06	1.02e-06	0.00223	0.00422	0.00124
HEN_845_804E	35	C - UA	First Reaction	FALSE	median	2.95e-09	1.02e-06	6.81e-09	0.000425	0.0170	0.00201	0.00138	0.000702	1.30e-05	3.31e-06	0.00197	0.00239	0.00388
HEN_845_804E	35	C - UA	Second Reaction	FALSE	median	2.05e-09	5.10e-07	6.04e-09	0.000425	0.0170	0.00201	0.00153	0.000704	9.46e-06	2.18e-06	0.00188	0.00252	0.00353
HEN_845_804R	22	C - UA	Initial Soln	TRUE	25p	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	TRUE	25p	5.06e-09	4.58e-07	1.94e-07	0.000360	0.0144	0.00195	0.000587	0.000270	2.68e-06	6.18e-07	0.00355	0.00476	0.000463
HEN_845_804R	22	C - UA	First Reaction	TRUE	25p	9.51e-09	8.86e-08	2.12e-07	0.000360	0.0144	0.00195	0.000512	0.000214	8.13e-07	1.70e-07	0.00328	0.00484	0.000562
HEN_845_804R	22	C - UA	Second Reaction	TRUE	25p	8.26e-09	4.13e-08	1.75e-07	0.000360	0.0144	0.00195	0.000560	0.000222	9.39e-07	1.86e-07	0.00311	0.00485	0.000587
HEN_845_804R	22	C - UA	Initial Soln	TRUE	75p	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	TRUE	75p	5.06e-09	4.58e-07	1.94e-07	0.000500	0.0200	0.00211	0.000816	0.000375	3.73e-06	8.58e-07	0.00493	0.00662	0.000643
HEN_845_804R	22	C - UA	First Reaction	TRUE	75p	9.60e-09	1.07e-07	2.24e-07	0.000500	0.0200	0.00211	0.000691	0.000294	1.08e-06	2.31e-07	0.00462	0.00671	0.000770
HEN_845_804R	22	C - UA	Second Reaction	TRUE	75p	8.41e-09	4.49e-08	1.92e-07	0.000500	0.0200	0.00211	0.000747	0.000303	1.21e-06	2.46e-07	0.00443	0.00674	0.000793
HEN_845_804R	22	C - UA	Initial Soln	TRUE	median	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	TRUE	median	5.06e-09	4.58e-07	1.94e-07	0.000425	0.0170	0.00201	0.000694	0.000319	3.17e-06	7.29e-07	0.00419	0.00562	0.000547
HEN_845_804R	22	C - UA	First Reaction	TRUE	median	9.55e-09	9.71e-08	2.18e-07	0.000425	0.0170	0.00201	0.000595	0.000251	9.39e-07	1.99e-07	0.00390	0.00571	0.000658
HEN_845_804R	22	C - UA	Second Reaction	TRUE	median	8.32e-09	4.29e-08	1.84e-07	0.000425	0.0170	0.00201	0.000648	0.000259	1.07e-06	2.14e-07	0.00372	0.00573	0.000683
HEN_845_804R	22	C - UA	Initial Soln	FALSE	25p	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	FALSE	25p	5.06e-09	4.58e-07	1.94e-07	0.000360	0.0144	0.00195	0.000588	0.000270	2.65e-06	6.11e-07	0.00355	0.00476	0.000462
HEN_845_804R	22	C - UA	First Reaction	FALSE	25p	9.51e-09	8.77e-08	2.11e-07	0.000360	0.0144	0.00195	0.000511	0.000214	8.13e-07	1.70e-07	0.00328	0.00484	0.000562
HEN_845_804R	22	C - UA	Second Reaction	FALSE	25p	8.26e-09	4.12e-08	1.74e-07	0.000360	0.0144	0.00195	0.000560	0.000221	9.38e-07	1.86e-07	0.00312	0.00485	0.000586
HEN_845_804R	22	C - UA	Initial Soln	FALSE	75p	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	FALSE	75p	5.06e-09	4.58e-07	1.94e-07	0.000500	0.0200	0.00211	0.000817	0.000376	3.68e-06	8.49e-07	0.00494	0.00662	0.000642
HEN_845_804R	22	C - UA	First Reaction	FALSE	75p	9.60e-09	1.05e-07	2.23e-07	0.000500	0.0200	0.00211	0.000690	0.000294	1.08e-06	2.31e-07	0.00463	0.00671	0.000770
HEN_845_804R	22	C - UA	Second Reaction	FALSE	75p	8.40e-09	4.47e-08	1.91e-07	0.000500	0.0200	0.00211	0.000746	0.000303	1.21e-06	2.46e-07	0.00443	0.00674	0.000793
HEN_845_804R	22	C - UA	Initial Soln	FALSE	median	5.06e-09	4.58e-07	1.94e-07	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	FALSE	median	5.06e-09	4.58e-07	1.94e-07	0.000425	0.0170	0.00201	0.000694	0.000319	3.13e-06	7.22e-07	0.00420	0.00563	0.000546
HEN_845_804R	22	C - UA	First Reaction	FALSE	median	9.55e-09	9.61e-08	2.17e-07	0.000425	0.0170	0.00201	0.000594	0.000251	9.39e-07	1.99e-07	0.00391	0.00571	0.000658
HEN_845_804R	22	C - UA	Second Reaction	FALSE	median	8.32e-09	4.28e-08	1.83e-07	0.000425	0.0170	0.00201	0.000647	0.000259	1.07e-06	2.14e-07	0.00372	0.00573	0.000682

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	m_Hfo_wCO3-	m_Hfo_wPO4-2	m_Hfo_wHPO4-	m_Hfo_wH2PO4	m_Hfo_sCO3-	m_Hfo_sHCO3	m_Hfo_sHPO4-	m_Hfo_sH2BO3	m_Hfo_sH2PO4	m_Hfo_sOSi(OH)3	m_Hfo_sOSiO(OH)2-	m_Hfo_sOHSO4-2	m_Hfo_sSO4-
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	25p	0.000388	0.000377	0.000533	1.28e-05	1.49e-08	5.19e-08	2.05e-08	2.29e-11	4.92e-10	8.63e-08	9.03e-08	1.18e-10	3.48e-11
HEN_845_804W	51	C - UA	Speciation Model	TRUE	25p	0.000524	7.24e-05	0.000109	2.78e-06	3.29e-08	1.21e-07	6.84e-09	3.21e-11	1.75e-10	1.48e-07	1.45e-07	3.76e-10	1.18e-10
HEN_845_804W	21R	C - UA	First Reaction	TRUE	25p	0.000447	0.000350	0.000555	1.50e-05	2.20e-08	8.58e-08	2.74e-08	1.09e-11	7.38e-10	1.17e-07	1.09e-07	8.89e-11	2.95e-11
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	25p	0.000457	0.000335	0.000566	1.63e-05	2.34e-08	9.71e-08	2.90e-08	8.52e-12	8.33e-10	1.24e-07	1.09e-07	8.81e-11	3.12e-11
HEN_845_804W	51	C - UA	First Reaction	TRUE	25p	0.000590	7.17e-05	0.000112	2.97e-06	4.29e-08	1.64e-07	8.14e-09	1.50e-11	2.16e-10	1.74e-07	1.65e-07	1.81e-10	5.90e-11
HEN_845_804W	51	C - UA	Second Reaction	TRUE	25p	0.000588	7.09e-05	0.000115	3.19e-06	4.35e-08	1.74e-07	8.55e-09	1.22e-11	2.36e-10	1.81e-07	1.65e-07	1.73e-10	5.88e-11
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	75p	0.000539	0.000523	0.000740	1.78e-05	2.08e-08	7.20e-08	2.85e-08	3.18e-11	6.84e-10	1.20e-07	1.25e-07	1.64e-10	4.84e-11
HEN_845_804W	51	C - UA	Speciation Model	TRUE	75p	0.000727	0.000101	0.000151	3.85e-06	4.57e-08	1.69e-07	9.50e-09	4.46e-11	2.42e-10	2.05e-07	2.02e-07	5.23e-10	1.64e-10
HEN_845_804W	21R	C - UA	First Reaction	TRUE	75p	0.000611	0.000492	0.000767	2.03e-05	2.97e-08	1.14e-07	3.73e-08	1.54e-11	9.87e-10	1.59e-07	1.51e-07	1.22e-10	3.97e-11
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	75p	0.000624	0.000470	0.000784	2.22e-05	3.14e-08	1.29e-07	3.95e-08	1.22e-11	1.12e-09	1.70e-07	1.51e-07	1.20e-10	4.17e-11
HEN_845_804W	51	C - UA	First Reaction	TRUE	75p	0.000815	9.98e-05	0.000154	4.06e-06	5.88e-08	2.24e-07	1.11e-08	2.10e-11	2.93e-10	2.40e-07	2.29e-07	2.51e-10	8.13e-11
HEN_845_804W	51	C - UA	Second Reaction	TRUE	75p	0.000813	9.82e-05	0.000159	4.35e-06	5.97e-08	2.37e-07	1.17e-08	1.73e-11	3.20e-10	2.49e-07	2.28e-07	2.38e-10	8.04e-11
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	median	0.000458	0.000445	0.000629	1.51e-05	1.76e-08	6.12e-08	2.42e-08	2.71e-11	5.81e-10	1.02e-07	1.07e-07	1.39e-10	4.11e-11
HEN_845_804W	51	C - UA	Speciation Model	TRUE	median	0.000618	8.54e-05	0.000128	3.28e-06	3.89e-08	1.43e-07	8.08e-09	3.79e-11	2.06e-10	1.74e-07	1.72e-07	4.44e-10	1.40e-10
HEN_845_804W	21R	C - UA	First Reaction	TRUE	median	0.000523	0.000416	0.000654	1.75e-05	2.56e-08	9.89e-08	3.20e-08	1.30e-11	8.55e-10	1.37e-07	1.29e-07	1.04e-10	3.43e-11
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	median	0.000535	0.000397	0.000668	1.91e-05	2.72e-08	1.12e-07	3.39e-08	1.02e-11	9.69e-10	1.46e-07	1.28e-07	1.03e-10	3.61e-11
HEN_845_804W	51	C - UA	First Reaction	TRUE	median	0.000695	8.47e-05	0.000132	3.48e-06	5.03e-08	1.92e-07	9.54e-09	1.77e-11	2.52e-10	2.05e-07	1.95e-07	2.13e-10	6.93e-11
HEN_845_804W	51	C - UA	Second Reaction	TRUE	median	0.000692	8.35e-05	0.000136	3.74e-06	5.11e-08	2.03e-07	1.00e-08	1.45e-11	2.76e-10	2.13e-07	1.94e-07	2.03e-10	6.89e-11
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	25p	0.000388	0.000375	0.000531	1.28e-05	1.48e-08	5.15e-08	2.03e-08	2.27e-11	4.88e-10	8.54e-08	8.92e-08	1.18e-10	3.48e-11
HEN_845_804W	51	C - UA	Speciation Model	FALSE	25p	0.000523	7.19e-05	0.000108	2.77e-06	3.26e-08	1.20e-07	6.75e-09	3.16e-11	1.73e-10	1.46e-07	1.43e-07	3.75e-10	1.18e-10
HEN_845_804W	21R	C - UA	First Reaction	FALSE	25p	0.000446	0.000348	0.000554	1.49e-05	2.19e-08	8.55e-08	2.72e-08	1.07e-11	7.35e-10	1.16e-07	1.08e-07	8.81e-11	2.93e-11
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	25p	0.000456	0.000333	0.000565	1.63e-05	2.32e-08	9.68e-08	2.88e-08	8.37e-12	8.30e-10	1.24e-07	1.08e-07	8.74e-11	3.10e-11
HEN_845_804W	51	C - UA	First Reaction	FALSE	25p	0.000588	7.12e-05	0.000112	2.97e-06	4.24e-08	1.63e-07	8.06e-09	1.46e-11	2.15e-10	1.73e-07	1.63e-07	1.78e-10	5.83e-11
HEN_845_804W	51	C - UA	Second Reaction	FALSE	25p	0.000585	7.04e-05	0.000115	3.20e-06	4.31e-08	1.73e-07	8.47e-09	1.19e-11	2.35e-10	1.80e-07	1.62e-07	1.70e-10	5.82e-11
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	75p	0.000539	0.000521	0.000738	1.77e-05	2.06e-08	7.16e-08	2.82e-08	3.15e-11	6.78e-10	1.19e-07	1.24e-07	1.63e-10	4.84e-11
HEN_845_804W	51	C - UA	Speciation Model	FALSE	75p	0.000726	9.99e-05	0.000150	3.85e-06	4.52e-08	1.67e-07	9.37e-09	4.39e-11	2.40e-10	2.02e-07	1.99e-07	5.21e-10	1.64e-10
HEN_845_804W	21R	C - UA	First Reaction	FALSE	75p	0.000610	0.000490	0.000764	2.03e-05	2.95e-08	1.13e-07	3.70e-08	1.51e-11	9.82e-10	1.58e-07	1.50e-07	1.21e-10	3.95e-11
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	75p	0.000622	0.000467	0.000782	2.22e-05	3.12e-08	1.28e-07	3.93e-08	1.20e-11	1.12e-09	1.69e-07	1.49e-07	1.18e-10	4.14e-11
HEN_845_804W	51	C - UA	First Reaction	FALSE	75p	0.000811	9.90e-05	0.000154	4.06e-06	5.82e-08	2.22e-07	1.10e-08	2.04e-11	2.91e-10	2.37e-07	2.26e-07	2.48e-10	8.04e-11
HEN_845_804W	51	C - UA	Second Reaction	FALSE	75p	0.000809	9.74e-05	0.000158	4.36e-06	5.91e-08	2.35e-07	1.15e-08	1.68e-11	3.18e-10	2.47e-07	2.25e-07	2.35e-10	7.97e-11
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	median	0.000458	0.000443	0.000627	1.51e-05	1.75e-08	6.08e-08	2.40e-08	2.68e-11	5.76e-10	1.01e-07	1.05e-07	1.39e-10	4.11e-11
HEN_845_804W	51	C - UA	Speciation Model	FALSE	median	0.000617	8.49e-05	0.000128	3.27e-06	3.84e-08	1.42e-07	7.97e-09	3.74e-11	2.04e-10	1.72e-07	1.69e-07	4.42e-10	1.39e-10
HEN_845_804W	21R	C - UA	First Reaction	FALSE	median	0.000522	0.000414	0.000652	1.74e-05	2.55e-08	9.85e-08	3.18e-08	1.27e-11	8.51e-10	1.36e-07	1.28e-07	1.03e-10	3.40e-11
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	median	0.000533	0.000395	0.000666	1.91e-05	2.70e-08	1.12e-07	3.37e-08	1.00e-11	9.65e-10	1.45e-07	1.27e-07	1.02e-10	3.59e-11
HEN_845_804W	51	C - UA	First Reaction	FALSE	median	0.000692	8.41e-05	0.000131	3.48e-06	4.98e-08	1.91e-07	9.45e-09	1.73e-11	2.51e-10	2.03e-07	1.92e-07	2.10e-10	6.86e-11
HEN_845_804W	51	C - UA	Second Reaction	FALSE	median	0.000689	8.29e-05	0.000135	3.74e-06	5.05e-08	2.02e-07	9.91e-09	1.42e-11	2.74e-10	2.11e-07	1.92e-07	2.00e-10	6.82e-11
HEN_845_804E	22	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	TRUE	25p	0.000171	3.46e-06	3.82e-06	7.14e-08	1.26e-08	3.40e-08	2.80e-10	2.91e-11	5.25e-12	2.61e-07	3.50e-07	1.97e-10	4.54e-11
HEN_845_804E	23	C - UA	Speciation Model	TRUE	25p	0.000393	7.95e-05	6.37e-05	8.66e-07	3.55e-08	6.98e-08	5.76e-09	2.96e-10	7.83e-11	1.75e-07	3.22e-07	6.31e-09	1.06e-09
HEN_845_804E	35	C - UA	Speciation Model	TRUE	25p	0.000763	0.000138	0.000249	7.62e-06	9.67e-08	4.27e-07	3.16e-08	7.61e-10	9.66e-10	2.55e-07	2.10e-07	2.56e-08	9.64e-09
HEN_845_804E	22	C - UA	First Reaction	TRUE	25p	0.000243	4.35e-06	4.66e-06	8.48e-08	1.80e-08	4.74e-08	3.45e-10	2.14e-11	6.28e-12	2.51e-07	3.47e-07	1.27e-10	2.84e-11
HEN_845_804E	22	C - UA	Second Reaction	TRUE	25p	0.000286	5.28e-06	5.47e-06	9.62e-08	2.19e-08	5.56e-08	4.18e-10	1.89e-11	7.35e-12	2.48e-07	3.54e-07	1.63e-10	3.53e-11
HEN_845_804E	23	C - UA	First Reaction	TRUE	25p	0.000535	8.20e-05	6.25e-05	8.09e-07	5.19e-08	9.71e-08	6.06e-09	7.63e-11	7.84e-11	1.81e-07	3.51e-07	5.78e-10	9.20e-11
HEN_845_804E	23	C - UA	Second Reaction	TRUE	25p	0.000551	8.17e-05	6.40e-05	8.52e-07	5.52e-08	1.06e-07	6.42e-09	5.14e-11	8.55e-11	1.90e-07	3.58e-07	5.37e-10	8.79e-11
HEN_845_804E	35	C - UA	First Reaction	TRUE	25p	0.00110	0.000178	0.000214	4.35e-06	1.42e-07	4.18e-07	2.76e-08	1.90e-10	5.62e-10	2.14e-07	2.64e-07	1.37e-09	3.42e-10
HEN_845_804E	35	C - UA	Second Reaction	TRUE	25p	0.00110	0.000189	0.000205	3.76e-06	1.44e-07	3.82e-07	2.67e-08	1.29e-10	4.90e-10	2.06e-07	2.81e-07	1.05e-09	2.39e-10
HEN_845_804E	22	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	TRUE	75p	0.000238	4.81e-06	5.30e-06	9.92e-08	1.75e-08	4.72e-08	3.89e-10	4.04e-11	7.29e-12	3.62e-07	4.86e-07	2.74e-10	6.30e-11
HEN_845_804E	23	C - UA	Speciation Model	TRUE	75p	0.000546	0.000110	8.84e-05	1.20e-06	4.93e-08	9.70e-08	7.99e-09	4.11e-10	1.09e-10	2.42e-07	4.48e-07	8.76e-09	1.47e-09
HEN_845_804E	35	C - UA	Speciation Model	TRUE	75p	0.00106	0.000192	0.000346	1.06e-05	1.34e-07	5.94e-07	4.39e-08	1.06e-09	1.34e-09	3.54e-07	2.91e-07	3.56e-08	1.34e-08
HEN_845_804E	22	C - UA	First Reaction	TRUE	75p	0.000321	5.69e-06	6.15e-06	1.13e-07	2.38e-08	6.30e-08	4.55e-10	2.94e-11	8.35e-12	3.52e-07	4.82e-07	1.65e-10	3.73e-11
HEN_845_804E	22	C - UA	Second Reaction	TRUE	75p	0.000367	6.61e-06	6.97e-06	1.25e-07	2.80e-08	7.24e-08	5.31e-10	2.59e-11	9.50e-12	3.51e-07	4.93e-07	2.05e-10	4.51e-11
HEN_845_804E	23	C - UA	First Reaction	TRUE	75p	0.000736	0.000114	8.61e-05	1.10e-06	7.08e-08	1.31e-07	8.28e-09	1.11e-10	1.06e-10	2.47e-07	4.85e-07	8.28e-10	1.30e-10
HEN_845_804E	23	C - UA	Second Reaction	TRUE	75p	0.000755	0.000113	8.80e-05	1.16e-06	7.50e-08	1.43e-07	8.74e-09	7.44e-11	1.15e-10	2.60e-07	4.95e-07	7.35e-10	1.19e-10
HEN_845_804E	35	C - UA	First Reaction	TRUE	75p	0.00152	0.000243	0.000301	6.31e-06	1.97e-07	5.98e-07	3.89e-08	2.69e-10	8.17e-10	3.02e-07	3.61e-07	2.07e-09	5.36e-10
HEN_845_804E	35	C - UA	Second Reaction	TRUE	75p	0.00154	0.000257	0.000289	5.50e-06	2.01e-07	5.54e-07	3.77e-08	1.78e-10	7.19e-10	2.91e-07	3.83e-07	1.44e-09	3.38e-10
HEN_845_804E	22	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	TRUE	median	0.000202	4.09e-06	4.51e-06	8.43e-08	1.48e-08	4.01e-08	3.31e-10	3.43e-11	6.19e-12	3.08e-07	4.13e-07	2.33e-10	5.36e-11
HEN_845_804E	23	C - UA	Speciation Model	TRUE	median	0.000464	9.39e-05	7.52e-05	1.02e-06	4.19e-08	8.24e-08	6.79e-09	3.49e-10	9.24e-11	2.06e-07	3.81e-07	7.45e-09	1.25e-09

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	m_Hfo_wCO3-	m_Hfo_wPO4-2	m_Hfo_wHPO4-	m_Hfo_wH2PO4	m_Hfo_sCO3-	m_Hfo_sHCO3	m_Hfo_sHPO4-	m_Hfo_sH2BO3	m_Hfo_sH2PO4	m_Hfo_sOSi(OH)3	m_Hfo_sOSiO(OH)2-	m_Hfo_sOHSO4-2	m_Hfo_sSO4-
HEN_845_804E	35	C - UA	Speciation Model	TRUE	median	0.000901	0.000164	0.000294	9.00e-06	1.14e-07	5.05e-07	3.73e-08	8.98e-10	1.14e-09	3.01e-07	2.47e-07	3.03e-08	1.14e-08
HEN_845_804E	22	C - UA	First Reaction	TRUE	median	0.000280	4.98e-06	5.35e-06	9.79e-08	2.07e-08	5.47e-08	3.96e-10	2.51e-11	7.25e-12	2.98e-07	4.10e-07	1.45e-10	3.26e-11
HEN_845_804E	22	C - UA	Second Reaction	TRUE	median	0.000324	5.90e-06	6.17e-06	1.09e-07	2.47e-08	6.35e-08	4.71e-10	2.21e-11	8.35e-12	2.96e-07	4.19e-07	1.83e-10	3.99e-11
HEN_845_804E	23	C - UA	First Reaction	TRUE	median	0.000629	9.69e-05	7.35e-05	9.46e-07	6.07e-08	1.13e-07	7.09e-09	9.18e-11	9.13e-11	2.12e-07	4.13e-07	6.92e-10	1.10e-10
HEN_845_804E	23	C - UA	Second Reaction	TRUE	median	0.000646	9.64e-05	7.52e-05	9.95e-07	6.45e-08	1.23e-07	7.50e-09	6.18e-11	9.94e-11	2.22e-07	4.22e-07	6.29e-10	1.02e-10
HEN_845_804E	35	C - UA	First Reaction	TRUE	median	0.00130	0.000208	0.000254	5.25e-06	1.68e-07	5.01e-07	3.28e-08	2.26e-10	6.79e-10	2.54e-07	3.09e-07	1.68e-09	4.28e-10
HEN_845_804E	35	C - UA	Second Reaction	TRUE	median	0.00131	0.000221	0.000243	4.56e-06	1.70e-07	4.61e-07	3.18e-08	1.51e-10	5.95e-10	2.45e-07	3.29e-07	1.24e-09	2.85e-10
HEN_845_804E	22	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	FALSE	25p	0.000171	3.44e-06	3.80e-06	7.11e-08	1.26e-08	3.40e-08	2.79e-10	2.91e-11	5.23e-12	2.61e-07	3.51e-07	1.95e-10	4.50e-11
HEN_845_804E	23	C - UA	Speciation Model	FALSE	25p	0.000393	7.95e-05	6.37e-05	8.66e-07	3.55e-08	6.97e-08	5.75e-09	2.95e-10	7.81e-11	1.74e-07	3.21e-07	6.32e-09	1.06e-09
HEN_845_804E	35	C - UA	Speciation Model	FALSE	25p	0.000763	0.000139	0.000249	7.62e-06	9.66e-08	4.27e-07	3.16e-08	7.59e-10	9.64e-10	2.54e-07	2.09e-07	2.56e-08	9.64e-09
HEN_845_804E	22	C - UA	First Reaction	FALSE	25p	0.000243	4.33e-06	4.64e-06	8.44e-08	1.81e-08	4.75e-08	3.45e-10	2.15e-11	6.27e-12	2.52e-07	3.48e-07	1.27e-10	2.85e-11
HEN_845_804E	22	C - UA	Second Reaction	FALSE	25p	0.000286	5.26e-06	5.45e-06	9.58e-08	2.19e-08	5.57e-08	4.17e-10	1.90e-11	7.34e-12	2.49e-07	3.55e-07	1.63e-10	3.54e-11
HEN_845_804E	23	C - UA	First Reaction	FALSE	25p	0.000534	8.20e-05	6.26e-05	8.11e-07	5.16e-08	9.68e-08	6.05e-09	7.60e-11	7.85e-11	1.80e-07	3.49e-07	5.74e-10	9.15e-11
HEN_845_804E	23	C - UA	Second Reaction	FALSE	25p	0.000549	8.17e-05	6.41e-05	8.55e-07	5.50e-08	1.06e-07	6.42e-09	5.13e-11	8.56e-11	1.89e-07	3.56e-07	5.33e-10	8.76e-11
HEN_845_804E	35	C - UA	First Reaction	FALSE	25p	0.00110	0.000178	0.000214	4.36e-06	1.41e-07	4.17e-07	2.75e-08	1.90e-10	5.61e-10	2.13e-07	2.63e-07	1.36e-09	3.41e-10
HEN_845_804E	35	C - UA	Second Reaction	FALSE	25p	0.00110	0.000189	0.000205	3.77e-06	1.43e-07	3.81e-07	2.66e-08	1.29e-10	4.90e-10	2.06e-07	2.81e-07	1.05e-09	2.38e-10
HEN_845_804E	22	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	FALSE	75p	0.000237	4.78e-06	5.27e-06	9.88e-08	1.74e-08	4.72e-08	3.88e-10	4.05e-11	7.27e-12	3.63e-07	4.87e-07	2.71e-10	6.25e-11
HEN_845_804E	23	C - UA	Speciation Model	FALSE	75p	0.000546	0.000110	8.85e-05	1.20e-06	4.92e-08	9.68e-08	7.98e-09	4.09e-10	1.09e-10	2.42e-07	4.46e-07	8.78e-09	1.47e-09
HEN_845_804E	35	C - UA	Speciation Model	FALSE	75p	0.00106	0.000192	0.000346	1.06e-05	1.34e-07	5.93e-07	4.38e-08	1.05e-09	1.34e-09	3.53e-07	2.90e-07	3.56e-08	1.34e-08
HEN_845_804E	22	C - UA	First Reaction	FALSE	75p	0.000321	5.66e-06	6.12e-06	1.12e-07	2.38e-08	6.32e-08	4.54e-10	2.96e-11	8.34e-12	3.54e-07	4.84e-07	1.66e-10	3.74e-11
HEN_845_804E	22	C - UA	Second Reaction	FALSE	75p	0.000367	6.58e-06	6.94e-06	1.24e-07	2.80e-08	7.25e-08	5.30e-10	2.61e-11	9.48e-12	3.52e-07	4.94e-07	2.05e-10	4.51e-11
HEN_845_804E	23	C - UA	First Reaction	FALSE	75p	0.000734	0.000114	8.62e-05	1.11e-06	7.04e-08	1.31e-07	8.27e-09	1.10e-10	1.06e-10	2.47e-07	4.83e-07	8.22e-10	1.30e-10
HEN_845_804E	23	C - UA	Second Reaction	FALSE	75p	0.000753	0.000113	8.81e-05	1.16e-06	7.47e-08	1.42e-07	8.73e-09	7.42e-11	1.15e-10	2.59e-07	4.93e-07	7.30e-10	1.18e-10
HEN_845_804E	35	C - UA	First Reaction	FALSE	75p	0.00152	0.000243	0.000301	6.32e-06	1.96e-07	5.97e-07	3.88e-08	2.69e-10	8.16e-10	3.01e-07	3.60e-07	2.07e-09	5.34e-10
HEN_845_804E	35	C - UA	Second Reaction	FALSE	75p	0.00154	0.000257	0.000289	5.51e-06	2.00e-07	5.53e-07	3.77e-08	1.78e-10	7.18e-10	2.90e-07	3.82e-07	1.44e-09	3.38e-10
HEN_845_804E	22	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	FALSE	median	0.000202	4.06e-06	4.48e-06	8.40e-08	1.48e-08	4.01e-08	3.30e-10	3.44e-11	6.18e-12	3.09e-07	4.14e-07	2.30e-10	5.31e-11
HEN_845_804E	23	C - UA	Speciation Model	FALSE	median	0.000464	9.39e-05	7.52e-05	1.02e-06	4.19e-08	8.23e-08	6.78e-09	3.48e-10	9.22e-11	2.05e-07	3.79e-07	7.46e-09	1.25e-09
HEN_845_804E	35	C - UA	Speciation Model	FALSE	median	0.000901	0.000164	0.000294	9.00e-06	1.14e-07	5.04e-07	3.72e-08	8.96e-10	1.14e-09	3.00e-07	2.47e-07	3.03e-08	1.14e-08
HEN_845_804E	22	C - UA	First Reaction	FALSE	median	0.000280	4.95e-06	5.33e-06	9.75e-08	2.07e-08	5.48e-08	3.95e-10	2.52e-11	7.23e-12	2.99e-07	4.11e-07	1.45e-10	3.27e-11
HEN_845_804E	22	C - UA	Second Reaction	FALSE	median	0.000324	5.87e-06	6.14e-06	1.09e-07	2.48e-08	6.36e-08	4.70e-10	2.22e-11	8.34e-12	2.97e-07	4.20e-07	1.83e-10	4.00e-11
HEN_845_804E	23	C - UA	First Reaction	FALSE	median	0.000627	9.69e-05	7.36e-05	9.49e-07	6.04e-08	1.13e-07	7.08e-09	9.14e-11	9.14e-11	2.11e-07	4.11e-07	6.87e-10	1.09e-10
HEN_845_804E	23	C - UA	Second Reaction	FALSE	median	0.000644	9.64e-05	7.53e-05	9.99e-07	6.42e-08	1.23e-07	7.50e-09	6.16e-11	9.95e-11	2.22e-07	4.20e-07	6.25e-10	1.02e-10
HEN_845_804E	35	C - UA	First Reaction	FALSE	median	0.00130	0.000209	0.000254	5.26e-06	1.67e-07	5.00e-07	3.28e-08	2.25e-10	6.79e-10	2.54e-07	3.08e-07	1.68e-09	4.27e-10
HEN_845_804E	35	C - UA	Second Reaction	FALSE	median	0.00130	0.000221	0.000244	4.56e-06	1.70e-07	4.60e-07	3.17e-08	1.51e-10	5.94e-10	2.45e-07	3.28e-07	1.23e-09	2.84e-10
HEN_845_804R	22	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	TRUE	25p	0.000171	3.46e-06	3.82e-06	7.14e-08	1.26e-08	3.40e-08	2.80e-10	2.91e-11	5.25e-12	2.61e-07	3.50e-07	1.97e-10	4.54e-11
HEN_845_804R	22	C - UA	First Reaction	TRUE	25p	0.000228	3.73e-06	3.74e-06	6.36e-08	1.62e-08	3.98e-08	2.65e-10	1.86e-11	4.51e-12	2.33e-07	3.43e-07	5.77e-11	1.21e-11
HEN_845_804R	22	C - UA	Second Reaction	TRUE	25p	0.000252	3.92e-06	3.72e-06	6.00e-08	1.81e-08	4.23e-08	2.68e-10	1.70e-11	4.32e-12	2.24e-07	3.50e-07	6.76e-11	1.34e-11
HEN_845_804R	22	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	TRUE	75p	0.000238	4.81e-06	5.30e-06	9.92e-08	1.75e-08	4.72e-08	3.89e-10	4.04e-11	7.29e-12	3.62e-07	4.86e-07	2.74e-10	6.30e-11
HEN_845_804R	22	C - UA	First Reaction	TRUE	75p	0.000308	5.10e-06	5.19e-06	8.99e-08	2.19e-08	5.49e-08	3.70e-10	2.57e-11	6.41e-12	3.30e-07	4.78e-07	7.73e-11	1.65e-11
HEN_845_804R	22	C - UA	Second Reaction	TRUE	75p	0.000332	5.31e-06	5.16e-06	8.52e-08	2.40e-08	5.74e-08	3.73e-10	2.33e-11	6.16e-12	3.20e-07	4.87e-07	8.76e-11	1.78e-11
HEN_845_804R	22	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	TRUE	median	0.000202	4.09e-06	4.51e-06	8.43e-08	1.48e-08	4.01e-08	3.31e-10	3.43e-11	6.19e-12	3.08e-07	4.13e-07	2.33e-10	5.36e-11
HEN_845_804R	22	C - UA	First Reaction	TRUE	median	0.000265	4.36e-06	4.41e-06	7.58e-08	1.89e-08	4.68e-08	3.14e-10	2.19e-11	5.39e-12	2.78e-07	4.06e-07	6.68e-11	1.41e-11
HEN_845_804R	22	C - UA	Second Reaction	TRUE	median	0.000289	4.57e-06	4.39e-06	7.16e-08	2.09e-08	4.93e-08	3.17e-10	1.99e-11	5.17e-12	2.69e-07	4.14e-07	7.70e-11	1.55e-11
HEN_845_804R	22	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	FALSE	25p	0.000171	3.44e-06	3.80e-06	7.11e-08	1.26e-08	3.40e-08	2.79e-10	2.91e-11	5.23e-12	2.61e-07	3.51e-07	1.95e-10	4.50e-11
HEN_845_804R	22	C - UA	First Reaction	FALSE	25p	0.000228	3.70e-06	3.71e-06	6.33e-08	1.62e-08	3.99e-08	2.64e-10	1.88e-11	4.50e-12	2.33e-07	3.44e-07	5.78e-11	1.21e-11
HEN_845_804R	22	C - UA	Second Reaction	FALSE	25p	0.000252	3.90e-06	3.70e-06	5.97e-08	1.82e-08	4.23e-08	2.67e-10	1.71e-11	4.31e-12	2.25e-07	3.50e-07	6.77e-11	1.34e-11
HEN_845_804R	22	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	FALSE	75p	0.000237	4.78e-06	5.27e-06	9.88e-08	1.74e-08	4.72e-08	3.88e-10	4.05e-11	7.27e-12	3.63e-07	4.87e-07	2.71e-10	6.25e-11
HEN_845_804R	22	C - UA	First Reaction	FALSE	75p	0.000308	5.06e-06	5.17e-06	8.95e-08	2.20e-08	5.50e-08	3.69e-10	2.58e-11	6.39e-12	3.31e-07	4.80e-07	7.75e-11	1.65e-11
HEN_845_804R	22	C - UA	Second Reaction	FALSE	75p	0.000332	5.28e-06	5.13e-06	8.48e-08	2.41e-08	5.75e-08	3.72e-10	2.34e-11	6.14e-12	3.21e-07	4.88e-07	8.77e-11	1.78e-11
HEN_845_804R	22	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	FALSE	median	0.000202	4.06e-06	4.48e-06	8.40e-08	1.48e-08	4.01e-08	3.30e-10	3.44e-11	6.18e-12	3.09e-07	4.14e-07	2.30e-10	5.31e-11
HEN_845_804R	22	C - UA	First Reaction	FALSE	median	0.000265	4.34e-06	4.39e-06	7.54e-08	1.89e-08	4.69e-08	3.13e-10	2.20e-11	5.38e-12	2.79e-07	4.07e-07	6.69e-11	1.42e-11
HEN_845_804R	22	C - UA	Second Reaction	FALSE	median	0.000289	4.54e-06	4.37e-06	7.13e-08	2.09e-08	4.94e-08	3.16e-10	2.00e-11	5.16e-12	2.69e-07	4.15e-07	7.71e-11	1.55e-11

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	m_Hao_SO4-	m_Hao_OHSO4-2	m_Hao_H2BO3	m_Hao_H3BO4-	m_Hfo_sH2AsO3	m_Hfo_sH2AsO4	m_Hfo_sHAsO4-	m_Hfo_sOHAsO4-3	m_Hfo_wOHAsO4-3	m_Hfo_wHAsO4-	m_Hfo_wH2AsO4	m_Hfo_wH2AsO3	Ferrihydrite
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	25p	5.25e-15	0.000422	0.000696	2.62e-10	1.57e-12	3.67e-12	1.93e-10	2.47e-08	0.000643	5.01e-06	9.55e-08	4.07e-08	0.0720
HEN_845_804W	51	C - UA	Speciation Model	TRUE	25p	8.17e-15	0.000444	0.000622	1.58e-10	9.13e-13	9.05e-12	4.46e-10	5.08e-08	0.000808	7.10e-06	1.44e-07	1.45e-08	0.0720
HEN_845_804W	21R	C - UA	First Reaction	TRUE	25p	7.07e-15	0.000434	0.000617	1.77e-10	2.98e-09	6.01e-12	2.81e-10	2.87e-08	0.000582	5.69e-06	1.22e-07	6.04e-05	0.0721
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	25p	8.22e-15	0.000453	0.000553	1.42e-10	2.95e-09	7.58e-12	3.32e-10	2.98e-08	0.000583	6.49e-06	1.48e-07	5.76e-05	0.0721
HEN_845_804W	51	C - UA	First Reaction	TRUE	25p	8.22e-15	0.000451	0.000558	1.43e-10	4.48e-09	1.08e-11	5.14e-10	5.42e-08	0.000745	7.07e-06	1.49e-07	6.16e-05	0.0721
HEN_845_804W	51	C - UA	Second Reaction	TRUE	25p	8.98e-15	0.000467	0.000504	1.23e-10	4.50e-09	1.25e-11	5.70e-10	5.52e-08	0.000745	7.69e-06	1.69e-07	6.07e-05	0.0721
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	75p	5.70e-15	0.000458	0.000755	2.84e-10	2.17e-12	5.10e-12	2.67e-10	3.44e-08	0.000894	6.95e-06	1.33e-07	5.65e-08	0.100
HEN_845_804W	51	C - UA	Speciation Model	TRUE	75p	8.87e-15	0.000482	0.000675	1.72e-10	1.27e-12	1.26e-11	6.20e-10	7.06e-08	0.00112	9.86e-06	2.00e-07	2.02e-08	0.100
HEN_845_804W	21R	C - UA	First Reaction	TRUE	75p	7.45e-15	0.000468	0.000676	1.99e-10	3.74e-09	7.88e-12	3.75e-10	3.97e-08	0.000815	7.70e-06	1.62e-07	7.69e-05	0.100
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	75p	8.61e-15	0.000487	0.000610	1.62e-10	3.82e-09	1.00e-11	4.45e-10	4.10e-08	0.000814	8.83e-06	1.99e-07	7.59e-05	0.100
HEN_845_804W	51	C - UA	First Reaction	TRUE	75p	8.83e-15	0.000487	0.000611	1.58e-10	5.58e-09	1.47e-11	7.03e-10	7.54e-08	0.00104	9.74e-06	2.03e-07	7.74e-05	0.100
HEN_845_804W	51	C - UA	Second Reaction	TRUE	75p	9.59e-15	0.000502	0.000557	1.37e-10	5.74e-09	1.70e-11	7.78e-10	7.66e-08	0.00104	1.06e-05	2.31e-07	7.81e-05	0.100
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	median	5.43e-15	0.000437	0.000720	2.71e-10	1.85e-12	4.34e-12	2.27e-10	2.92e-08	0.000759	5.91e-06	1.13e-07	4.80e-08	0.0850
HEN_845_804W	51	C - UA	Speciation Model	TRUE	median	8.45e-15	0.000459	0.000644	1.64e-10	1.08e-12	1.07e-11	5.27e-10	6.00e-08	0.000954	8.38e-06	1.70e-07	1.71e-08	0.0850
HEN_845_804W	21R	C - UA	First Reaction	TRUE	median	7.21e-15	0.000447	0.000641	1.86e-10	3.34e-09	6.90e-12	3.25e-10	3.38e-08	0.000690	6.64e-06	1.41e-07	6.82e-05	0.0851
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	median	8.36e-15	0.000466	0.000576	1.50e-10	3.37e-09	8.75e-12	3.86e-10	3.51e-08	0.000690	7.59e-06	1.72e-07	6.63e-05	0.0851
HEN_845_804W	51	C - UA	First Reaction	TRUE	median	8.46e-15	0.000465	0.000579	1.49e-10	5.00e-09	1.26e-11	6.02e-10	6.40e-08	0.000884	8.32e-06	1.75e-07	6.90e-05	0.0851
HEN_845_804W	51	C - UA	Second Reaction	TRUE	median	9.22e-15	0.000481	0.000526	1.28e-10	5.09e-09	1.46e-11	6.67e-10	6.51e-08	0.000883	9.05e-06	1.98e-07	6.89e-05	0.0851
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	25p	5.26e-15	0.000424	0.000687	2.59e-10	1.59e-12	3.74e-12	1.96e-10	2.51e-08	0.000656	5.12e-06	9.78e-08	4.17e-08	0.0720
HEN_845_804W	51	C - UA	Speciation Model	FALSE	25p	8.19e-15	0.000446	0.000612	1.56e-10	9.29e-13	9.20e-12	4.53e-10	5.13e-08	0.000823	7.27e-06	1.48e-07	1.49e-08	0.0720
HEN_845_804W	21R	C - UA	First Reaction	FALSE	25p	7.10e-15	0.000436	0.000609	1.75e-10	3.07e-09	6.14e-12	2.86e-10	2.91e-08	0.000592	5.82e-06	1.25e-07	6.24e-05	0.0721
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	25p	8.25e-15	0.000455	0.000546	1.41e-10	3.04e-09	7.76e-12	3.39e-10	3.03e-08	0.000593	6.65e-06	1.52e-07	5.97e-05	0.0721
HEN_845_804W	51	C - UA	First Reaction	FALSE	25p	8.26e-15	0.000454	0.000549	1.41e-10	4.62e-09	1.11e-11	5.24e-10	5.48e-08	0.000759	7.25e-06	1.53e-07	6.39e-05	0.0721
HEN_845_804W	51	C - UA	Second Reaction	FALSE	25p	9.02e-15	0.000469	0.000497	1.21e-10	4.65e-09	1.28e-11	5.81e-10	5.58e-08	0.000758	7.90e-06	1.74e-07	6.31e-05	0.0721
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	75p	5.71e-15	0.000460	0.000746	2.81e-10	2.21e-12	5.19e-12	2.72e-10	3.48e-08	0.000911	7.11e-06	1.36e-07	5.79e-08	0.100
HEN_845_804W	51	C - UA	Speciation Model	FALSE	75p	8.88e-15	0.000484	0.000664	1.69e-10	1.29e-12	1.28e-11	6.29e-10	7.13e-08	0.00114	1.01e-05	2.05e-07	2.07e-08	0.100
HEN_845_804W	21R	C - UA	First Reaction	FALSE	75p	7.47e-15	0.000470	0.000668	1.97e-10	3.84e-09	8.04e-12	3.82e-10	4.03e-08	0.000831	7.88e-06	1.66e-07	7.93e-05	0.100
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	75p	8.65e-15	0.000489	0.000603	1.60e-10	3.93e-09	1.02e-11	4.54e-10	4.16e-08	0.000830	9.04e-06	2.04e-07	7.84e-05	0.100
HEN_845_804W	51	C - UA	First Reaction	FALSE	75p	8.87e-15	0.000490	0.000602	1.55e-10	5.75e-09	1.50e-11	7.17e-10	7.63e-08	0.00106	9.99e-06	2.09e-07	8.01e-05	0.100
HEN_845_804W	51	C - UA	Second Reaction	FALSE	75p	9.64e-15	0.000505	0.000549	1.35e-10	5.91e-09	1.74e-11	7.94e-10	7.75e-08	0.00106	1.09e-05	2.38e-07	8.10e-05	0.100
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	51	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	median	5.44e-15	0.000439	0.000711	2.68e-10	1.88e-12	4.41e-12	2.31e-10	2.96e-08	0.000775	6.04e-06	1.15e-07	4.92e-08	0.0850
HEN_845_804W	51	C - UA	Speciation Model	FALSE	median	8.46e-15	0.000461	0.000633	1.61e-10	1.10e-12	1.09e-11	5.35e-10	6.06e-08	0.000972	8.58e-06	1.74e-07	1.76e-08	0.0850
HEN_845_804W	21R	C - UA	First Reaction	FALSE	median	7.23e-15	0.000450	0.000633	1.84e-10	3.44e-09	7.05e-12	3.32e-10	3.43e-08	0.000703	6.79e-06	1.44e-07	7.04e-05	0.0851
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	median	8.40e-15	0.000468	0.000569	1.49e-10	3.47e-09	8.96e-12	3.94e-10	3.56e-08	0.000703	7.78e-06	1.77e-07	6.85e-05	0.0851
HEN_845_804W	51	C - UA	First Reaction	FALSE	median	8.50e-15	0.000468	0.000571	1.47e-10	5.15e-09	1.29e-11	6.14e-10	6.48e-08	0.000900	8.53e-06	1.80e-07	7.16e-05	0.0851
HEN_845_804W	51	C - UA	Second Reaction	FALSE	median	9.26e-15	0.000483	0.000518	1.26e-10	5.25e-09	1.50e-11	6.81e-10	6.59e-08	0.000899	9.29e-06	2.04e-07	7.16e-05	0.0851
HEN_845_804E	22	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	TRUE	25p	4.80e-15	0.000294	0.00105	2.99e-10	8.04e-22	2.48e-13	1.67e-11	3.53e-09	4.81e-05	2.27e-07	3.38e-09	1.10e-17	0.0720
HEN_845_804E	23	C - UA	Speciation Model	TRUE	25p	5.90e-15	0.000189	0.00148	2.21e-10	5.57e-14	1.27e-12	1.18e-10	4.73e-08	0.000523	1.30e-06	1.41e-08	6.16e-10	0.0720
HEN_845_804E	35	C - UA	Speciation Model	TRUE	25p	1.45e-14	0.000122	0.00173	6.82e-11	2.84e-21	1.04e-11	4.27e-10	3.39e-08	0.000267	3.37e-06	8.18e-08	2.24e-17	0.0720
HEN_845_804E	22	C - UA	First Reaction	TRUE	25p	4.37e-15	0.000333	0.000922	3.29e-10	6.09e-18	2.30e-13	1.59e-11	3.57e-09	4.81e-05	2.15e-07	3.10e-09	8.22e-14	0.0720
HEN_845_804E	22	C - UA	Second Reaction	TRUE	25p	5.02e-15	0.000360	0.000828	2.78e-10	3.91e-18	2.15e-13	1.54e-11	3.68e-09	4.82e-05	2.01e-07	2.81e-09	5.11e-14	0.0720
HEN_845_804E	23	C - UA	First Reaction	TRUE	25p	3.42e-15	0.000232	0.00126	3.98e-10	7.44e-13	1.18e-12	1.15e-10	5.07e-08	0.000523	1.18e-06	1.21e-08	7.68e-09	0.0720
HEN_845_804E	23	C - UA	Second Reaction	TRUE	25p	4.20e-15	0.000271	0.00111	3.36e-10	3.86e-13	1.32e-12	1.25e-10	5.24e-08	0.000523	1.25e-06	1.32e-08	3.85e-09	0.0720
HEN_845_804E	35	C - UA	First Reaction	TRUE	25p	4.89e-15	0.000175	0.00145	2.42e-10	8.08e-19	3.15e-12	1.94e-10	3.47e-08	0.000269	1.51e-06	2.44e-08	6.26e-15	0.0720
HEN_845_804E	35	C - UA	Second Reaction	TRUE	25p	4.94e-15	0.000217	0.00128	2.64e-10	7.37e-19	2.34e-12	1.60e-10	3.51e-08	0.000269	1.23e-06	1.80e-08	5.65e-15	0.0720
HEN_845_804E	22	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	TRUE	75p	5.21e-15	0.000318	0.00113	3.24e-10	1.12e-21	3.45e-13	2.32e-11	4.91e-09	6.68e-05	3.16e-07	4.69e-09	1.52e-17	0.100
HEN_845_804E	23	C - UA	Speciation Model	TRUE	75p	6.40e-15	0.000205	0.00160	2.40e-10	7.74e-14	1.77e-12	1.64e-10	6.56e-08	0.000726	1.81e-06	1.96e-08	8.56e-10	0.100
HEN_845_804E	35	C - UA	Speciation Model	TRUE	75p	1.58e-14	0.000133	0.00188	7.40e-11	3.94e-21	1.44e-11	5.93e-10	4.70e-08	0.000371	4.68e-06	1.14e-07	3.11e-17	0.100
HEN_845_804E	22	C - UA	First Reaction	TRUE	75p	4.65e-15	0.000359	0.00101	3.64e-10	9.14e-18	3.28e-13	2.25e-11	4.94e-09	6.69e-05	3.04e-07	4.43e-09	1.24e-13	0.100
HEN_845_804E	22	C - UA	Second Reaction	TRUE	75p	5.31e-15	0.000387	0.000910	3.11e-10	6.12e-18	3.13e-13	2.20e-11	5.10e-09	6.69e-05	2.89e-07	4.10e-09	8.03e-14	0.100
HEN_845_804E	23	C - UA	First Reaction	TRUE	75p	3.65e-15	0.000250	0.00137	4.39e-10	1.10e-12	1.57e-12	1.55e-10	6.98e-08	0.000726	1.61e-06	1.64e-08	1.15e-08	0.100
HEN_845_804E	23	C - UA	Second Reaction	TRUE	75p	4.38e-15	0.000291	0.00122	3.78e-10	5.87e-13	1.77e-12	1.69e-10	7.21e-08	0.000726	1.70e-06	1.78e-08	5.91e-09	0.100
HEN_845_804E	35	C - UA	First Reaction	TRUE	75p	5.66e-15	0.000188	0.00158	2.46e-10	1.10e-18	4.80e-12	2.88e-10	4.83e-08	0.000374	2.22e-06	3.71e-08	8.52e-15	0.100
HEN_845_804E	35	C - UA	Second Reaction	TRUE	75p	5.49e-15	0.000230	0.00141	2.76e-10	9.87e-19	3.63e-12	2.40e-10	4.89e-08	0.000374	1.84e-06	2.78e-08	7.55e-15	0.100
HEN_845_804E	22	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	TRUE	median	4.96e-15	0.000304	0.00108	3.09e-10	9.50e-22	2.93e-13	1.97e-11	4.17e-09	5.68e-05	2.68e-07	3.99e-09	1.29e-17	0.0850
HEN_845_804E	23	C - UA	Speciation Model	TRUE	median	6.10e-15	0.000195	0.00153	2.29e-10	6.58e-14	1.50e-12	1.39e-10	5.58e-08	0.000617	1.54e-06	1.66e-08	7.28e-10	0.0850

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	m_Hao_SO4-	m_Hao_OHSO4-2	m_Hao_H2BO3	m_Hao_H3BO4-	m_Hfo_sH2AsO3	m_Hfo_sH2AsO4	m_Hfo_sHAsO4-	m_Hfo_sOHAsO4-3	m_Hfo_wOHAsO4-3	m_Hfo_wHAsO4-	m_Hfo_wH2AsO4	m_Hfo_wH2AsO3	Ferrihydrite
HEN_845_804E	35	C - UA	Speciation Model	TRUE	median	1.50e-14	0.000126	0.00179	7.05e-11	3.35e-21	1.22e-11	5.04e-10	4.00e-08	0.000315	3.98e-06	9.66e-08	2.64e-17	0.0850
HEN_845_804E	22	C - UA	First Reaction	TRUE	median	4.48e-15	0.000344	0.000956	3.43e-10	7.47e-18	2.75e-13	1.90e-11	4.21e-09	5.68e-05	2.56e-07	3.72e-09	1.01e-13	0.0850
HEN_845_804E	22	C - UA	Second Reaction	TRUE	median	5.13e-15	0.000371	0.000861	2.91e-10	4.90e-18	2.60e-13	1.84e-11	4.34e-09	5.69e-05	2.42e-07	3.41e-09	6.41e-14	0.0850
HEN_845_804E	23	C - UA	First Reaction	TRUE	median	3.51e-15	0.000239	0.00130	4.15e-10	9.04e-13	1.36e-12	1.33e-10	5.96e-08	0.000617	1.38e-06	1.41e-08	9.36e-09	0.0850
HEN_845_804E	23	C - UA	Second Reaction	TRUE	median	4.27e-15	0.000279	0.00115	3.53e-10	4.75e-13	1.53e-12	1.46e-10	6.16e-08	0.000617	1.46e-06	1.54e-08	4.75e-09	0.0850
HEN_845_804E	35	C - UA	First Reaction	TRUE	median	5.23e-15	0.000180	0.00150	2.42e-10	9.45e-19	3.90e-12	2.37e-10	4.11e-08	0.000318	1.83e-06	3.02e-08	7.31e-15	0.0850
HEN_845_804E	35	C - UA	Second Reaction	TRUE	median	5.18e-15	0.000222	0.00133	2.67e-10	8.54e-19	2.92e-12	1.96e-10	4.15e-08	0.000318	1.50e-06	2.24e-08	6.55e-15	0.0850
HEN_845_804E	22	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	FALSE	25p	4.78e-15	0.000293	0.00105	3.01e-10	7.94e-22	2.45e-13	1.65e-11	3.47e-09	4.72e-05	2.24e-07	3.33e-09	1.08e-17	0.0720
HEN_845_804E	23	C - UA	Speciation Model	FALSE	25p	5.91e-15	0.000188	0.00148	2.20e-10	5.61e-14	1.28e-12	1.19e-10	4.76e-08	0.000527	1.32e-06	1.42e-08	6.22e-10	0.0720
HEN_845_804E	35	C - UA	Speciation Model	FALSE	25p	1.45e-14	0.000122	0.00173	6.80e-11	2.85e-21	1.04e-11	4.28e-10	3.40e-08	0.000268	3.38e-06	8.22e-08	2.25e-17	0.0720
HEN_845_804E	22	C - UA	First Reaction	FALSE	25p	4.37e-15	0.000332	0.000925	3.29e-10	5.98e-18	2.27e-13	1.57e-11	3.51e-09	4.72e-05	2.11e-07	3.05e-09	8.05e-14	0.0720
HEN_845_804E	22	C - UA	Second Reaction	FALSE	25p	5.01e-15	0.000359	0.000831	2.79e-10	3.83e-18	2.11e-13	1.51e-11	3.62e-09	4.73e-05	1.97e-07	2.76e-09	5.00e-14	0.0720
HEN_845_804E	23	C - UA	First Reaction	FALSE	25p	3.42e-15	0.000232	0.00125	3.98e-10	7.69e-13	1.19e-12	1.16e-10	5.10e-08	0.000527	1.20e-06	1.23e-08	7.95e-09	0.0720
HEN_845_804E	23	C - UA	Second Reaction	FALSE	25p	4.20e-15	0.000272	0.00111	3.36e-10	3.99e-13	1.34e-12	1.27e-10	5.28e-08	0.000527	1.27e-06	1.34e-08	3.99e-09	0.0720
HEN_845_804E	35	C - UA	First Reaction	FALSE	25p	4.89e-15	0.000175	0.00145	2.42e-10	8.17e-19	3.16e-12	1.95e-10	3.48e-08	0.000270	1.52e-06	2.45e-08	6.34e-15	0.0720
HEN_845_804E	35	C - UA	Second Reaction	FALSE	25p	4.94e-15	0.000217	0.00128	2.64e-10	7.43e-19	2.35e-12	1.61e-10	3.52e-08	0.000271	1.24e-06	1.81e-08	5.71e-15	0.0720
HEN_845_804E	22	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	FALSE	75p	5.19e-15	0.000318	0.00114	3.26e-10	1.10e-21	3.40e-13	2.29e-11	4.83e-09	6.56e-05	3.11e-07	4.62e-09	1.50e-17	0.100
HEN_845_804E	23	C - UA	Speciation Model	FALSE	75p	6.41e-15	0.000204	0.00160	2.39e-10	7.79e-14	1.78e-12	1.65e-10	6.61e-08	0.000732	1.83e-06	1.97e-08	8.64e-10	0.100
HEN_845_804E	35	C - UA	Speciation Model	FALSE	75p	1.57e-14	0.000132	0.00188	7.38e-11	3.95e-21	1.44e-11	5.95e-10	4.72e-08	0.000373	4.70e-06	1.14e-07	3.12e-17	0.100
HEN_845_804E	22	C - UA	First Reaction	FALSE	75p	4.65e-15	0.000358	0.00101	3.64e-10	8.98e-18	3.23e-13	2.21e-11	4.86e-09	6.56e-05	2.99e-07	4.36e-09	1.21e-13	0.100
HEN_845_804E	22	C - UA	Second Reaction	FALSE	75p	5.30e-15	0.000387	0.000913	3.11e-10	6.00e-18	3.08e-13	2.17e-11	5.01e-09	6.56e-05	2.84e-07	4.03e-09	7.85e-14	0.100
HEN_845_804E	23	C - UA	First Reaction	FALSE	75p	3.65e-15	0.000250	0.00137	4.39e-10	1.14e-12	1.59e-12	1.56e-10	7.02e-08	0.000733	1.63e-06	1.66e-08	1.19e-08	0.100
HEN_845_804E	23	C - UA	Second Reaction	FALSE	75p	4.38e-15	0.000291	0.00122	3.79e-10	6.07e-13	1.79e-12	1.70e-10	7.26e-08	0.000732	1.72e-06	1.80e-08	6.13e-09	0.100
HEN_845_804E	35	C - UA	First Reaction	FALSE	75p	5.66e-15	0.000188	0.00158	2.46e-10	1.11e-18	4.82e-12	2.89e-10	4.85e-08	0.000375	2.24e-06	3.73e-08	8.63e-15	0.100
HEN_845_804E	35	C - UA	Second Reaction	FALSE	75p	5.49e-15	0.000230	0.00141	2.76e-10	9.95e-19	3.65e-12	2.41e-10	4.90e-08	0.000376	1.85e-06	2.80e-08	7.63e-15	0.100
HEN_845_804E	22	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	23	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	35	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804E	22	C - UA	Speciation Model	FALSE	median	4.94e-15	0.000303	0.00108	3.11e-10	9.37e-22	2.89e-13	1.94e-11	4.10e-09	5.58e-05	2.64e-07	3.93e-09	1.27e-17	0.0850
HEN_845_804E	23	C - UA	Speciation Model	FALSE	median	6.11e-15	0.000195	0.00153	2.28e-10	6.62e-14	1.51e-12	1.40e-10	5.62e-08	0.000622	1.55e-06	1.68e-08	7.34e-10	0.0850
HEN_845_804E	35	C - UA	Speciation Model	FALSE	median	1.50e-14	0.000126	0.00179	7.03e-11	3.36e-21	1.23e-11	5.05e-10	4.01e-08	0.000317	4.00e-06	9.70e-08	2.66e-17	0.0850
HEN_845_804E	22	C - UA	First Reaction	FALSE	median	4.48e-15	0.000343	0.000959	3.44e-10	7.34e-18	2.71e-13	1.87e-11	4.14e-09	5.58e-05	2.52e-07	3.66e-09	9.89e-14	0.0850
HEN_845_804E	22	C - UA	Second Reaction	FALSE	median	5.12e-15	0.000370	0.000863	2.92e-10	4.80e-18	2.56e-13	1.82e-11	4.27e-09	5.58e-05	2.37e-07	3.35e-09	6.27e-14	0.0850
HEN_845_804E	23	C - UA	First Reaction	FALSE	median	3.51e-15	0.000240	0.00130	4.15e-10	9.34e-13	1.38e-12	1.35e-10	6.00e-08	0.000623	1.40e-06	1.43e-08	9.70e-09	0.0850
HEN_845_804E	23	C - UA	Second Reaction	FALSE	median	4.27e-15	0.000280	0.00115	3.53e-10	4.91e-13	1.55e-12	1.47e-10	6.20e-08	0.000623	1.48e-06	1.56e-08	4.93e-09	0.0850
HEN_845_804E	35	C - UA	First Reaction	FALSE	median	5.23e-15	0.000180	0.00150	2.42e-10	9.55e-19	3.91e-12	2.38e-10	4.12e-08	0.000319	1.85e-06	3.03e-08	7.40e-15	0.0850
HEN_845_804E	35	C - UA	Second Reaction	FALSE	median	5.18e-15	0.000222	0.00133	2.68e-10	8.62e-19	2.93e-12	1.97e-10	4.16e-08	0.000319	1.51e-06	2.25e-08	6.62e-15	0.0850
HEN_845_804R	22	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	TRUE	25p	4.80e-15	0.000294	0.00105	2.99e-10	8.04e-22	2.48e-13	1.67e-11	3.53e-09	4.81e-05	2.27e-07	3.38e-09	1.10e-17	0.0720
HEN_845_804R	22	C - UA	First Reaction	TRUE	25p	2.92e-15	0.000319	0.000943	4.81e-10	5.85e-18	1.81e-13	1.34e-11	3.42e-09	4.82e-05	1.88e-07	2.55e-09	8.25e-14	0.0720
HEN_845_804R	22	C - UA	Second Reaction	TRUE	25p	3.10e-15	0.000342	0.000862	4.44e-10	4.03e-18	1.56e-13	1.22e-11	3.47e-09	4.82e-05	1.69e-07	2.16e-09	5.60e-14	0.0720
HEN_845_804R	22	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	TRUE	75p	5.21e-15	0.000318	0.00113	3.24e-10	1.12e-21	3.45e-13	2.32e-11	4.91e-09	6.68e-05	3.16e-07	4.69e-09	1.52e-17	0.100
HEN_845_804R	22	C - UA	First Reaction	TRUE	75p	3.18e-15	0.000344	0.00103	5.21e-10	8.54e-18	2.65e-13	1.93e-11	4.77e-09	6.69e-05	2.70e-07	3.72e-09	1.20e-13	0.100
HEN_845_804R	22	C - UA	Second Reaction	TRUE	75p	3.36e-15	0.000367	0.000947	4.85e-10	6.11e-18	2.33e-13	1.78e-11	4.84e-09	6.69e-05	2.46e-07	3.23e-09	8.45e-14	0.100
HEN_845_804R	22	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	TRUE	median	4.96e-15	0.000304	0.00108	3.09e-10	9.50e-22	2.93e-13	1.97e-11	4.17e-09	5.68e-05	2.68e-07	3.99e-09	1.29e-17	0.0850
HEN_845_804R	22	C - UA	First Reaction	TRUE	median	3.03e-15	0.000329	0.000977	4.97e-10	7.07e-18	2.20e-13	1.61e-11	4.04e-09	5.69e-05	2.26e-07	3.09e-09	9.94e-14	0.0850
HEN_845_804R	22	C - UA	Second Reaction	TRUE	median	3.21e-15	0.000352	0.000896	4.60e-10	4.97e-18	1.91e-13	1.48e-11	4.11e-09	5.69e-05	2.04e-07	2.65e-09	6.88e-14	0.0850
HEN_845_804R	22	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	FALSE	25p	4.78e-15	0.000293	0.00105	3.01e-10	7.94e-22	2.45e-13	1.65e-11	3.47e-09	4.72e-05	2.24e-07	3.33e-09	1.08e-17	0.0720
HEN_845_804R	22	C - UA	First Reaction	FALSE	25p	2.92e-15	0.000318	0.000946	4.82e-10	5.74e-18	1.78e-13	1.32e-11	3.36e-09	4.73e-05	1.85e-07	2.51e-09	8.08e-14	0.0720
HEN_845_804R	22	C - UA	Second Reaction	FALSE	25p	3.10e-15	0.000341	0.000865	4.45e-10	3.96e-18	1.53e-13	1.20e-11	3.41e-09	4.73e-05	1.66e-07	2.12e-09	5.48e-14	0.0720
HEN_845_804R	22	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	FALSE	75p	5.19e-15	0.000318	0.00114	3.26e-10	1.10e-21	3.40e-13	2.29e-11	4.83e-09	6.56e-05	3.11e-07	4.62e-09	1.50e-17	0.100
HEN_845_804R	22	C - UA	First Reaction	FALSE	75p	3.18e-15	0.000343	0.00103	5.22e-10	8.39e-18	2.61e-13	1.90e-11	4.69e-09	6.56e-05	2.66e-07	3.66e-09	1.17e-13	0.100
HEN_845_804R	22	C - UA	Second Reaction	FALSE	75p	3.35e-15	0.000366	0.000950	4.86e-10	6.00e-18	2.30e-13	1.75e-11	4.76e-09	6.57e-05	2.42e-07	3.17e-09	8.27e-14	0.100
HEN_845_804R	22	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0	0
HEN_845_804R	22	C - UA	Speciation Model	FALSE	median	4.94e-15	0.000303	0.00108	3.11e-10	9.37e-22	2.89e-13	1.94e-11	4.10e-09	5.58e-05	2.64e-07	3.93e-09	1.27e-17	0.0850
HEN_845_804R	22	C - UA	First Reaction	FALSE	median	3.02e-15	0.000328	0.000981	4.98e-10	6.95e-18	2.16e-13	1.59e-11	3.98e-09	5.58e-05	2.22e-07	3.04e-09	9.74e-14	0.0850
HEN_845_804R	22	C - UA	Second Reaction	FALSE	median	3.20e-15	0.000351	0.000899	4.61e-10	4.87e-18	1.88e-13	1.45e-11	4.04e-09	5.58e-05	2.01e-07	2.60e-09	6.74e-14	0.0850

Attachment D. PHREEQC modeling output
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Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	d_Ferrihydrite	Gibbsite	d_Gibbsite	Barite	d_Barite	Calcite	d_Calcite	Dolomite (ordered)	d_Dolomite (ordered)	Gypsum	d_Gypsum	si_Ferrihydrite
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	2.07
HEN_845_804W	51	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	2.17
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	2.07
HEN_845_804W	51	C - UA	Speciation Model	TRUE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	2.17
HEN_845_804W	21R	C - UA	First Reaction	TRUE	25p	0.000123	0.0590	3.05e-07	2.13e-07	2.13e-07	6.00	0.00232	2.00	-1.12e-03	0	0	0
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	25p	-3.82e-06	0.0590	3.07e-07	3.96e-07	1.83e-07	6.00	0.00227	2.00	-1.19e-03	0	0	0
HEN_845_804W	51	C - UA	First Reaction	TRUE	25p	0.000126	0.0590	3.06e-07	2.06e-07	2.06e-07	6.00	0.00246	2.00	-1.35e-03	0	0	0
HEN_845_804W	51	C - UA	Second Reaction	TRUE	25p	-8.62e-08	0.0590	3.07e-07	3.89e-07	1.83e-07	6.00	0.00230	2.00	-1.26e-03	0	0	0
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	2.07
HEN_845_804W	51	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	2.17
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	2.07
HEN_845_804W	51	C - UA	Speciation Model	TRUE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	2.17
HEN_845_804W	21R	C - UA	First Reaction	TRUE	75p	0.000156	0.0640	3.04e-07	2.22e-07	2.22e-07	6.00	0.00233	2.00	-1.09e-03	0	0	0
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	75p	-3.70e-07	0.0640	3.06e-07	4.08e-07	1.86e-07	6.00	0.00224	2.00	-1.13e-03	0	0	0
HEN_845_804W	51	C - UA	First Reaction	TRUE	75p	0.000158	0.0640	3.06e-07	2.12e-07	2.12e-07	6.00	0.00251	2.00	-1.38e-03	0	0	0
HEN_845_804W	51	C - UA	Second Reaction	TRUE	75p	3.10e-06	0.0640	3.07e-07	3.97e-07	1.85e-07	6.00	0.00228	2.00	-1.22e-03	0	0	0
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	2.07
HEN_845_804W	51	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	2.17
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	2.07
HEN_845_804W	51	C - UA	Speciation Model	TRUE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	2.17
HEN_845_804W	21R	C - UA	First Reaction	TRUE	median	0.000139	0.0610	3.05e-07	2.17e-07	2.17e-07	6.00	0.00232	2.00	-1.10e-03	0	0	0
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	median	-2.15e-06	0.0610	3.06e-07	4.02e-07	1.84e-07	6.00	0.00225	2.00	-1.16e-03	0	0	0
HEN_845_804W	51	C - UA	First Reaction	TRUE	median	0.000141	0.0610	3.06e-07	2.09e-07	2.09e-07	6.00	0.00248	2.00	-1.37e-03	0	0	0
HEN_845_804W	51	C - UA	Second Reaction	TRUE	median	1.50e-06	0.0610	3.07e-07	3.93e-07	1.84e-07	6.00	0.00229	2.00	-1.24e-03	0	0	0
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	2.08
HEN_845_804W	51	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	2.19
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	2.08
HEN_845_804W	51	C - UA	Speciation Model	FALSE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	2.19
HEN_845_804W	21R	C - UA	First Reaction	FALSE	25p	0.000127	0.0590	3.05e-07	2.13e-07	2.13e-07	6.00	0.00231	2.00	-1.11e-03	0	0	0
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	25p	-3.74e-06	0.0590	3.07e-07	3.96e-07	1.83e-07	6.00	0.00227	2.00	-1.19e-03	0	0	0
HEN_845_804W	51	C - UA	First Reaction	FALSE	25p	0.000131	0.0590	3.06e-07	2.06e-07	2.06e-07	6.00	0.00246	2.00	-1.35e-03	0	0	0
HEN_845_804W	51	C - UA	Second Reaction	FALSE	25p	4.32e-08	0.0590	3.07e-07	3.89e-07	1.83e-07	6.00	0.00230	2.00	-1.26e-03	0	0	0
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	2.08
HEN_845_804W	51	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	2.19
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	2.08
HEN_845_804W	51	C - UA	Speciation Model	FALSE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	2.19
HEN_845_804W	21R	C - UA	First Reaction	FALSE	75p	0.000161	0.0640	3.04e-07	2.22e-07	2.22e-07	6.00	0.00233	2.00	-1.09e-03	0	0	0
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	75p	-1.45e-07	0.0640	3.06e-07	4.08e-07	1.86e-07	6.00	0.00223	2.00	-1.12e-03	0	0	0
HEN_845_804W	51	C - UA	First Reaction	FALSE	75p	0.000163	0.0640	3.06e-07	2.12e-07	2.12e-07	6.00	0.00251	2.00	-1.38e-03	0	0	0
HEN_845_804W	51	C - UA	Second Reaction	FALSE	75p	3.36e-06	0.0640	3.07e-07	3.98e-07	1.85e-07	6.00	0.00228	2.00	-1.22e-03	0	0	0
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	2.08
HEN_845_804W	51	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	2.19
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	2.08
HEN_845_804W	51	C - UA	Speciation Model	FALSE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	2.19
HEN_845_804W	21R	C - UA	First Reaction	FALSE	median	0.000143	0.0610	3.05e-07	2.17e-07	2.17e-07	6.00	0.00232	2.00	-1.10e-03	0	0	0
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	median	-1.99e-06	0.0610	3.06e-07	4.02e-07	1.85e-07	6.00	0.00225	2.00	-1.16e-03	0	0	0
HEN_845_804W	51	C - UA	First Reaction	FALSE	median	0.000146	0.0610	3.06e-07	2.09e-07	2.09e-07	6.00	0.00248	2.00	-1.36e-03	0	0	0
HEN_845_804W	51	C - UA	Second Reaction	FALSE	median	1.69e-06	0.0610	3.07e-07	3.93e-07	1.84e-07	6.00	0.00229	2.00	-1.24e-03	0	0	0
HEN_845_804E	22	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804E	23	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	0.783
HEN_845_804E	35	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	1.29
HEN_845_804E	22	C - UA	Speciation Model	TRUE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804E	23	C - UA	Speciation Model	TRUE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	0.783
HEN_845_804E	35	C - UA	Speciation Model	TRUE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	1.29
HEN_845_804E	22	C - UA	First Reaction	TRUE	25p	2.89e-07	0.0590	2.92e-07	0	0	6.00	0.00134	2.00	-8.49e-04	0	0	0
HEN_845_804E	22	C - UA	Second Reaction	TRUE	25p	2.89e-07	0.0590	2.93e-07	0	0	6.00	0.00119	2.00	-7.42e-04	0	0	0
HEN_845_804E	23	C - UA	First Reaction	TRUE	25p	3.04e-07	0.0590	2.93e-07	0	0	6.00	0.00129	2.00	-8.76e-04	0	0	0
HEN_845_804E	23	C - UA	Second Reaction	TRUE	25p	2.82e-07	0.0590	2.94e-07	0	0	6.00	0.00118	2.00	-7.43e-04	0	0	0
HEN_845_804E	35	C - UA	First Reaction	TRUE	25p	2.86e-07	0.0590	3.04e-07	0	0	6.00	0.00179	2.00	-1.78e-03	0	0	0
HEN_845_804E	35	C - UA	Second Reaction	TRUE	25p	2.87e-07	0.0590	3.01e-07	0	0	6.00	0.00135	2.00	-1.12e-03	0	0	0
HEN_845_804E	22	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804E	23	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	0.783
HEN_845_804E	35	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	1.29
HEN_845_804E	22	C - UA	Speciation Model	TRUE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804E	23	C - UA	Speciation Model	TRUE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	0.783
HEN_845_804E	35	C - UA	Speciation Model	TRUE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	1.29
HEN_845_804E	22	C - UA	First Reaction	TRUE	75p	2.89e-07	0.0640	2.92e-07	0	0	6.00	0.00139	2.00	-8.85e-04	0	0	0
HEN_845_804E	22	C - UA	Second Reaction	TRUE	75p	2.89e-07	0.0640	2.93e-07	0	0	6.00	0.00119	2.00	-7.35e-04	0	0	0
HEN_845_804E	23	C - UA	First Reaction	TRUE	75p	3.11e-07	0.0640	2.92e-07	0	0	6.00	0.00132	2.00	-9.22e-04	0	0	0
HEN_845_804E	23	C - UA	Second Reaction	TRUE	75p	2.78e-07	0.0640	2.93e-07	0	0	6.00	0.00117	2.00	-7.23e-04	0	0	0
HEN_845_804E	35	C - UA	First Reaction	TRUE	75p	2.86e-07	0.0640	3.05e-07	2.05e-08	2.05e-08	6.00	0.00193	2.00	-2.01e-03	0	0	0
HEN_845_804E	35	C - UA	Second Reaction	TRUE	75p	2.87e-07	0.0640	3.02e-07	0	-2.05e-08	6.00	0.00138	2.00	-1.18e-03	0	0	0
HEN_845_804E	22	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804E	23	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	0.783
HEN_845_804E	35	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	1.29
HEN_845_804E	22	C - UA	Speciation Model	TRUE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804E	23	C - UA	Speciation Model	TRUE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	0.783

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Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	d_Ferrihydrite	Gibbsite	d_Gibbsite	Barite	d_Barite	Calcite	d_Calcite	Dolomite (ordered)	d_Dolomite (ordered)	Gypsum	d_Gypsum	si_Ferrihydrite
HEN_845_804E	35	C - UA	Speciation Model	TRUE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	1.29
HEN_845_804E	22	C - UA	First Reaction	TRUE	median	2.89e-07	0.0610	2.92e-07	0	0	6.00	0.00136	2.00	-8.65e-04	0	0	0
HEN_845_804E	22	C - UA	Second Reaction	TRUE	median	2.89e-07	0.0610	2.93e-07	0	0	6.00	0.00119	2.00	-7.38e-04	0	0	0
HEN_845_804E	23	C - UA	First Reaction	TRUE	median	3.07e-07	0.0610	2.92e-07	0	0	6.00	0.00131	2.00	-8.96e-04	0	0	0
HEN_845_804E	23	C - UA	Second Reaction	TRUE	median	2.80e-07	0.0610	2.94e-07	0	0	6.00	0.00118	2.00	-7.33e-04	0	0	0
HEN_845_804E	35	C - UA	First Reaction	TRUE	median	2.86e-07	0.0610	3.04e-07	7.72e-09	7.72e-09	6.00	0.00185	2.00	-1.89e-03	0	0	0
HEN_845_804E	35	C - UA	Second Reaction	TRUE	median	2.87e-07	0.0610	3.02e-07	0	-7.72e-09	6.00	0.00137	2.00	-1.15e-03	0	0	0
HEN_845_804E	22	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804E	23	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	0.787
HEN_845_804E	35	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	1.29
HEN_845_804E	22	C - UA	Speciation Model	FALSE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804E	23	C - UA	Speciation Model	FALSE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	0.787
HEN_845_804E	35	C - UA	Speciation Model	FALSE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	1.29
HEN_845_804E	22	C - UA	First Reaction	FALSE	25p	2.89e-07	0.0590	2.92e-07	0	0	6.00	0.00134	2.00	-8.53e-04	0	0	0
HEN_845_804E	22	C - UA	Second Reaction	FALSE	25p	2.89e-07	0.0590	2.93e-07	0	0	6.00	0.00119	2.00	-7.43e-04	0	0	0
HEN_845_804E	23	C - UA	First Reaction	FALSE	25p	3.04e-07	0.0590	2.93e-07	0	0	6.00	0.00129	2.00	-8.74e-04	0	0	0
HEN_845_804E	23	C - UA	Second Reaction	FALSE	25p	2.81e-07	0.0590	2.94e-07	0	0	6.00	0.00118	2.00	-7.43e-04	0	0	0
HEN_845_804E	35	C - UA	First Reaction	FALSE	25p	2.86e-07	0.0590	3.04e-07	0	0	6.00	0.00179	2.00	-1.78e-03	0	0	0
HEN_845_804E	35	C - UA	Second Reaction	FALSE	25p	2.87e-07	0.0590	3.01e-07	0	0	6.00	0.00135	2.00	-1.12e-03	0	0	0
HEN_845_804E	22	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804E	23	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	0.787
HEN_845_804E	35	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	1.29
HEN_845_804E	22	C - UA	Speciation Model	FALSE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804E	23	C - UA	Speciation Model	FALSE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	0.787
HEN_845_804E	35	C - UA	Speciation Model	FALSE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	1.29
HEN_845_804E	22	C - UA	First Reaction	FALSE	75p	2.89e-07	0.0640	2.92e-07	0	0	6.00	0.00139	2.00	-8.90e-04	0	0	0
HEN_845_804E	22	C - UA	Second Reaction	FALSE	75p	2.89e-07	0.0640	2.93e-07	0	0	6.00	0.00119	2.00	-7.36e-04	0	0	0
HEN_845_804E	23	C - UA	First Reaction	FALSE	75p	3.12e-07	0.0640	2.92e-07	0	0	6.00	0.00132	2.00	-9.19e-04	0	0	0
HEN_845_804E	23	C - UA	Second Reaction	FALSE	75p	2.78e-07	0.0640	2.93e-07	0	0	6.00	0.00117	2.00	-7.22e-04	0	0	0
HEN_845_804E	35	C - UA	First Reaction	FALSE	75p	2.86e-07	0.0640	3.05e-07	2.06e-08	2.06e-08	6.00	0.00193	2.00	-2.01e-03	0	0	0
HEN_845_804E	35	C - UA	Second Reaction	FALSE	75p	2.87e-07	0.0640	3.02e-07	0	-2.06e-08	6.00	0.00138	2.00	-1.18e-03	0	0	0
HEN_845_804E	22	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804E	23	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	0.787
HEN_845_804E	35	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	1.29
HEN_845_804E	22	C - UA	Speciation Model	FALSE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804E	23	C - UA	Speciation Model	FALSE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	0.787
HEN_845_804E	35	C - UA	Speciation Model	FALSE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	1.29
HEN_845_804E	22	C - UA	First Reaction	FALSE	median	2.89e-07	0.0610	2.92e-07	0	0	6.00	0.00136	2.00	-8.70e-04	0	0	0
HEN_845_804E	22	C - UA	Second Reaction	FALSE	median	2.89e-07	0.0610	2.93e-07	0	0	6.00	0.00119	2.00	-7.39e-04	0	0	0
HEN_845_804E	23	C - UA	First Reaction	FALSE	median	3.07e-07	0.0610	2.92e-07	0	0	6.00	0.00130	2.00	-8.94e-04	0	0	0
HEN_845_804E	23	C - UA	Second Reaction	FALSE	median	2.80e-07	0.0610	2.94e-07	0	0	6.00	0.00118	2.00	-7.32e-04	0	0	0
HEN_845_804E	35	C - UA	First Reaction	FALSE	median	2.86e-07	0.0610	3.04e-07	7.81e-09	7.81e-09	6.00	0.00185	2.00	-1.89e-03	0	0	0
HEN_845_804E	35	C - UA	Second Reaction	FALSE	median	2.87e-07	0.0610	3.02e-07	0	-7.81e-09	6.00	0.00137	2.00	-1.15e-03	0	0	0
HEN_845_804R	22	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804R	22	C - UA	Speciation Model	TRUE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804R	22	C - UA	First Reaction	TRUE	25p	2.22e-06	0.0590	1.68e-07	1.98e-07	1.98e-07	6.00	0.000404	2.00	-3.39e-04	0	0	0
HEN_845_804R	22	C - UA	Second Reaction	TRUE	25p	2.22e-06	0.0590	1.66e-07	3.98e-07	2.00e-07	6.00	0.000234	2.00	-1.60e-04	0	0	0
HEN_845_804R	22	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804R	22	C - UA	Speciation Model	TRUE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804R	22	C - UA	First Reaction	TRUE	75p	2.22e-06	0.0640	1.68e-07	1.97e-07	1.97e-07	6.00	0.000463	2.00	-4.00e-04	0	0	0
HEN_845_804R	22	C - UA	Second Reaction	TRUE	75p	2.22e-06	0.0640	1.67e-07	3.97e-07	1.99e-07	6.00	0.000246	2.00	-1.78e-04	0	0	0
HEN_845_804R	22	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804R	22	C - UA	Speciation Model	TRUE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804R	22	C - UA	First Reaction	TRUE	median	2.22e-06	0.0610	1.68e-07	1.97e-07	1.97e-07	6.00	0.000432	2.00	-3.68e-04	0	0	0
HEN_845_804R	22	C - UA	Second Reaction	TRUE	median	2.22e-06	0.0610	1.66e-07	3.97e-07	2.00e-07	6.00	0.000240	2.00	-1.69e-04	0	0	0
HEN_845_804R	22	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804R	22	C - UA	Speciation Model	FALSE	25p	0	0.0590	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804R	22	C - UA	First Reaction	FALSE	25p	2.22e-06	0.0590	1.68e-07	1.98e-07	1.98e-07	6.00	0.000408	2.00	-3.42e-04	0	0	0
HEN_845_804R	22	C - UA	Second Reaction	FALSE	25p	2.22e-06	0.0590	1.66e-07	3.98e-07	2.00e-07	6.00	0.000234	2.00	-1.61e-04	0	0	0
HEN_845_804R	22	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804R	22	C - UA	Speciation Model	FALSE	75p	0	0.0640	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804R	22	C - UA	First Reaction	FALSE	75p	2.22e-06	0.0640	1.68e-07	1.98e-07	1.98e-07	6.00	0.000467	2.00	-4.05e-04	0	0	0
HEN_845_804R	22	C - UA	Second Reaction	FALSE	75p	2.22e-06	0.0640	1.67e-07	3.97e-07	1.99e-07	6.00	0.000247	2.00	-1.79e-04	0	0	0
HEN_845_804R	22	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0	2.00
HEN_845_804R	22	C - UA	Speciation Model	FALSE	median	0	0.0610	0	0	0	6.00	0	2.00	0	0	0	2.00
HEN_845_804R	22	C - UA	First Reaction	FALSE	median	2.22e-06	0.0610	1.68e-07	1.98e-07	1.98e-07	6.00	0.000436	2.00	-3.72e-04	0	0	0
HEN_845_804R	22	C - UA	Second Reaction	FALSE	median	2.22e-06	0.0610	1.66e-07	3.98e-07	2.00e-07	6.00	0.000240	2.00	-1.70e-04	0	0	0

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	si_Gibbsite	si_Barite	si_Calcite	si_Dolomite (ordered)	si_Gypsum
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	25p	0.793	0.881	0.154	0.0446	-1.51e+00
HEN_845_804W	51	C - UA	Initial Soln	TRUE	25p	0.877	0.428	-3.35e-02	-3.41e-01	-1.51e+00
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	25p	0.793	0.881	0.154	0.0446	-1.51e+00
HEN_845_804W	51	C - UA	Speciation Model	TRUE	25p	0.877	0.428	-3.35e-02	-3.41e-01	-1.51e+00
HEN_845_804W	21R	C - UA	First Reaction	TRUE	25p	0	0	0	0	-1.90e+00
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	25p	0	0	0	0	-1.90e+00
HEN_845_804W	51	C - UA	First Reaction	TRUE	25p	0	0	0	0	-1.88e+00
HEN_845_804W	51	C - UA	Second Reaction	TRUE	25p	0	0	0	0	-1.89e+00
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	75p	0.793	0.881	0.154	0.0446	-1.51e+00
HEN_845_804W	51	C - UA	Initial Soln	TRUE	75p	0.877	0.428	-3.35e-02	-3.41e-01	-1.51e+00
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	75p	0.793	0.881	0.154	0.0446	-1.51e+00
HEN_845_804W	51	C - UA	Speciation Model	TRUE	75p	0.877	0.428	-3.35e-02	-3.41e-01	-1.51e+00
HEN_845_804W	21R	C - UA	First Reaction	TRUE	75p	0	0	0	0	-1.90e+00
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	75p	0	0	0	0	-1.90e+00
HEN_845_804W	51	C - UA	First Reaction	TRUE	75p	0	0	0	0	-1.88e+00
HEN_845_804W	51	C - UA	Second Reaction	TRUE	75p	0	0	0	0	-1.89e+00
HEN_845_804W	21R	C - UA	Initial Soln	TRUE	median	0.793	0.881	0.154	0.0446	-1.51e+00
HEN_845_804W	51	C - UA	Initial Soln	TRUE	median	0.877	0.428	-3.35e-02	-3.41e-01	-1.51e+00
HEN_845_804W	21R	C - UA	Speciation Model	TRUE	median	0.793	0.881	0.154	0.0446	-1.51e+00
HEN_845_804W	51	C - UA	Speciation Model	TRUE	median	0.877	0.428	-3.35e-02	-3.41e-01	-1.51e+00
HEN_845_804W	21R	C - UA	First Reaction	TRUE	median	0	0	0	0	-1.90e+00
HEN_845_804W	21R	C - UA	Second Reaction	TRUE	median	0	0	0	0	-1.90e+00
HEN_845_804W	51	C - UA	First Reaction	TRUE	median	0	0	0	0	-1.88e+00
HEN_845_804W	51	C - UA	Second Reaction	TRUE	median	0	0	0	0	-1.89e+00
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	25p	0.795	0.896	0.165	0.0667	-1.50e+00
HEN_845_804W	51	C - UA	Initial Soln	FALSE	25p	0.879	0.446	-2.09e-02	-3.15e-01	-1.50e+00
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	25p	0.795	0.896	0.165	0.0667	-1.50e+00
HEN_845_804W	51	C - UA	Speciation Model	FALSE	25p	0.879	0.446	-2.09e-02	-3.15e-01	-1.50e+00
HEN_845_804W	21R	C - UA	First Reaction	FALSE	25p	0	0	0	0	-1.90e+00
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	25p	0	0	0	0	-1.90e+00
HEN_845_804W	51	C - UA	First Reaction	FALSE	25p	0	0	0	0	-1.88e+00
HEN_845_804W	51	C - UA	Second Reaction	FALSE	25p	0	0	0	0	-1.89e+00
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	75p	0.795	0.896	0.165	0.0667	-1.50e+00
HEN_845_804W	51	C - UA	Initial Soln	FALSE	75p	0.879	0.446	-2.09e-02	-3.15e-01	-1.50e+00
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	75p	0.795	0.896	0.165	0.0667	-1.50e+00
HEN_845_804W	51	C - UA	Speciation Model	FALSE	75p	0.879	0.446	-2.09e-02	-3.15e-01	-1.50e+00
HEN_845_804W	21R	C - UA	First Reaction	FALSE	75p	0	0	0	0	-1.90e+00
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	75p	0	0	0	0	-1.90e+00
HEN_845_804W	51	C - UA	First Reaction	FALSE	75p	0	0	0	0	-1.88e+00
HEN_845_804W	51	C - UA	Second Reaction	FALSE	75p	0	0	0	0	-1.89e+00
HEN_845_804W	21R	C - UA	Initial Soln	FALSE	median	0.795	0.896	0.165	0.0667	-1.50e+00
HEN_845_804W	51	C - UA	Initial Soln	FALSE	median	0.879	0.446	-2.09e-02	-3.15e-01	-1.50e+00
HEN_845_804W	21R	C - UA	Speciation Model	FALSE	median	0.795	0.896	0.165	0.0667	-1.50e+00
HEN_845_804W	51	C - UA	Speciation Model	FALSE	median	0.879	0.446	-2.09e-02	-3.15e-01	-1.50e+00
HEN_845_804W	21R	C - UA	First Reaction	FALSE	median	0	0	0	0	-1.90e+00
HEN_845_804W	21R	C - UA	Second Reaction	FALSE	median	0	0	0	0	-1.90e+00
HEN_845_804W	51	C - UA	First Reaction	FALSE	median	0	0	0	0	-1.88e+00
HEN_845_804W	51	C - UA	Second Reaction	FALSE	median	0	0	0	0	-1.89e+00
HEN_845_804E	22	C - UA	Initial Soln	TRUE	25p	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804E	23	C - UA	Initial Soln	TRUE	25p	0.828	0.737	-4.11e-01	-7.56e-01	-9.68e-01
HEN_845_804E	35	C - UA	Initial Soln	TRUE	25p	1.00	0.840	-3.76e-01	-1.45e+00	-4.10e-01
HEN_845_804E	22	C - UA	Speciation Model	TRUE	25p	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804E	23	C - UA	Speciation Model	TRUE	25p	0.828	0.737	-4.11e-01	-7.56e-01	-9.68e-01
HEN_845_804E	35	C - UA	Speciation Model	TRUE	25p	1.00	0.840	-3.76e-01	-1.45e+00	-4.10e-01
HEN_845_804E	22	C - UA	First Reaction	TRUE	25p	0	-1.04e-01	0	0	-1.82e+00
HEN_845_804E	22	C - UA	Second Reaction	TRUE	25p	0	-1.02e-01	0	0	-1.81e+00
HEN_845_804E	23	C - UA	First Reaction	TRUE	25p	0	-6.63e-02	0	0	-1.77e+00
HEN_845_804E	23	C - UA	Second Reaction	TRUE	25p	0	-1.10e-01	0	0	-1.82e+00
HEN_845_804E	35	C - UA	First Reaction	TRUE	25p	0	-6.60e-03	0	0	-1.64e+00
HEN_845_804E	35	C - UA	Second Reaction	TRUE	25p	0	-1.31e-01	0	0	-1.80e+00
HEN_845_804E	22	C - UA	Initial Soln	TRUE	75p	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804E	23	C - UA	Initial Soln	TRUE	75p	0.828	0.737	-4.11e-01	-7.56e-01	-9.68e-01
HEN_845_804E	35	C - UA	Initial Soln	TRUE	75p	1.00	0.840	-3.76e-01	-1.45e+00	-4.10e-01
HEN_845_804E	22	C - UA	Speciation Model	TRUE	75p	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804E	23	C - UA	Speciation Model	TRUE	75p	0.828	0.737	-4.11e-01	-7.56e-01	-9.68e-01
HEN_845_804E	35	C - UA	Speciation Model	TRUE	75p	1.00	0.840	-3.76e-01	-1.45e+00	-4.10e-01
HEN_845_804E	22	C - UA	First Reaction	TRUE	75p	0	-1.03e-01	0	0	-1.82e+00
HEN_845_804E	22	C - UA	Second Reaction	TRUE	75p	0	-1.02e-01	0	0	-1.81e+00
HEN_845_804E	23	C - UA	First Reaction	TRUE	75p	0	-5.10e-02	0	0	-1.75e+00
HEN_845_804E	23	C - UA	Second Reaction	TRUE	75p	0	-1.10e-01	0	0	-1.82e+00
HEN_845_804E	35	C - UA	First Reaction	TRUE	75p	0	0	0	0	-1.59e+00
HEN_845_804E	35	C - UA	Second Reaction	TRUE	75p	0	-1.03e-01	0	0	-1.79e+00
HEN_845_804E	22	C - UA	Initial Soln	TRUE	median	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804E	23	C - UA	Initial Soln	TRUE	median	0.828	0.737	-4.11e-01	-7.56e-01	-9.68e-01
HEN_845_804E	35	C - UA	Initial Soln	TRUE	median	1.00	0.840	-3.76e-01	-1.45e+00	-4.10e-01
HEN_845_804E	22	C - UA	Speciation Model	TRUE	median	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804E	23	C - UA	Speciation Model	TRUE	median	0.828	0.737	-4.11e-01	-7.56e-01	-9.68e-01

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
West Ash Pond System
Hennepin Power Plant
Hennepin, IL

program_id	Location	Location Description	Model	Charge Balance	Solids Summary	si_Gibbsite	si_Barite	si_Calcite	si_Dolomite (ordered)	si_Gypsum
HEN_845_804E	35	C - UA	Speciation Model	TRUE	median	1.00	0.840	-3.76e-01	-1.45e+00	-4.10e-01
HEN_845_804E	22	C - UA	First Reaction	TRUE	median	0	-1.03e-01	0	0	-1.82e+00
HEN_845_804E	22	C - UA	Second Reaction	TRUE	median	0	-1.02e-01	0	0	-1.81e+00
HEN_845_804E	23	C - UA	First Reaction	TRUE	median	0	-5.91e-02	0	0	-1.76e+00
HEN_845_804E	23	C - UA	Second Reaction	TRUE	median	0	-1.10e-01	0	0	-1.82e+00
HEN_845_804E	35	C - UA	First Reaction	TRUE	median	0	0	0	0	-1.61e+00
HEN_845_804E	35	C - UA	Second Reaction	TRUE	median	0	-1.20e-01	0	0	-1.80e+00
HEN_845_804E	22	C - UA	Initial Soln	FALSE	25p	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804E	23	C - UA	Initial Soln	FALSE	25p	0.829	0.742	-4.08e-01	-7.50e-01	-9.64e-01
HEN_845_804E	35	C - UA	Initial Soln	FALSE	25p	1.00	0.843	-3.74e-01	-1.45e+00	-4.08e-01
HEN_845_804E	22	C - UA	Speciation Model	FALSE	25p	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804E	23	C - UA	Speciation Model	FALSE	25p	0.829	0.742	-4.08e-01	-7.50e-01	-9.64e-01
HEN_845_804E	35	C - UA	Speciation Model	FALSE	25p	1.00	0.843	-3.74e-01	-1.45e+00	-4.08e-01
HEN_845_804E	22	C - UA	First Reaction	FALSE	25p	0	-1.04e-01	0	0	-1.82e+00
HEN_845_804E	22	C - UA	Second Reaction	FALSE	25p	0	-1.02e-01	0	0	-1.81e+00
HEN_845_804E	23	C - UA	First Reaction	FALSE	25p	0	-6.64e-02	0	0	-1.77e+00
HEN_845_804E	23	C - UA	Second Reaction	FALSE	25p	0	-1.10e-01	0	0	-1.82e+00
HEN_845_804E	35	C - UA	First Reaction	FALSE	25p	0	-6.50e-03	0	0	-1.64e+00
HEN_845_804E	35	C - UA	Second Reaction	FALSE	25p	0	-1.31e-01	0	0	-1.80e+00
HEN_845_804E	22	C - UA	Initial Soln	FALSE	75p	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804E	23	C - UA	Initial Soln	FALSE	75p	0.829	0.742	-4.08e-01	-7.50e-01	-9.64e-01
HEN_845_804E	35	C - UA	Initial Soln	FALSE	75p	1.00	0.843	-3.74e-01	-1.45e+00	-4.08e-01
HEN_845_804E	22	C - UA	Speciation Model	FALSE	75p	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804E	23	C - UA	Speciation Model	FALSE	75p	0.829	0.742	-4.08e-01	-7.50e-01	-9.64e-01
HEN_845_804E	35	C - UA	Speciation Model	FALSE	75p	1.00	0.843	-3.74e-01	-1.45e+00	-4.08e-01
HEN_845_804E	22	C - UA	First Reaction	FALSE	75p	0	-1.03e-01	0	0	-1.82e+00
HEN_845_804E	22	C - UA	Second Reaction	FALSE	75p	0	-1.02e-01	0	0	-1.81e+00
HEN_845_804E	23	C - UA	First Reaction	FALSE	75p	0	-5.10e-02	0	0	-1.76e+00
HEN_845_804E	23	C - UA	Second Reaction	FALSE	75p	0	-1.10e-01	0	0	-1.82e+00
HEN_845_804E	35	C - UA	First Reaction	FALSE	75p	0	0	0	0	-1.59e+00
HEN_845_804E	35	C - UA	Second Reaction	FALSE	75p	0	-1.03e-01	0	0	-1.79e+00
HEN_845_804E	22	C - UA	Initial Soln	FALSE	median	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804E	23	C - UA	Initial Soln	FALSE	median	0.829	0.742	-4.08e-01	-7.50e-01	-9.64e-01
HEN_845_804E	35	C - UA	Initial Soln	FALSE	median	1.00	0.843	-3.74e-01	-1.45e+00	-4.08e-01
HEN_845_804E	22	C - UA	Speciation Model	FALSE	median	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804E	23	C - UA	Speciation Model	FALSE	median	0.829	0.742	-4.08e-01	-7.50e-01	-9.64e-01
HEN_845_804E	35	C - UA	Speciation Model	FALSE	median	1.00	0.843	-3.74e-01	-1.45e+00	-4.08e-01
HEN_845_804E	22	C - UA	First Reaction	FALSE	median	0	-1.03e-01	0	0	-1.82e+00
HEN_845_804E	22	C - UA	Second Reaction	FALSE	median	0	-1.02e-01	0	0	-1.81e+00
HEN_845_804E	23	C - UA	First Reaction	FALSE	median	0	-5.91e-02	0	0	-1.76e+00
HEN_845_804E	23	C - UA	Second Reaction	FALSE	median	0	-1.10e-01	0	0	-1.82e+00
HEN_845_804E	35	C - UA	First Reaction	FALSE	median	0	0	0	0	-1.61e+00
HEN_845_804E	35	C - UA	Second Reaction	FALSE	median	0	-1.20e-01	0	0	-1.80e+00
HEN_845_804R	22	C - UA	Initial Soln	TRUE	25p	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804R	22	C - UA	Speciation Model	TRUE	25p	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804R	22	C - UA	First Reaction	TRUE	25p	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Second Reaction	TRUE	25p	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Initial Soln	TRUE	75p	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804R	22	C - UA	Speciation Model	TRUE	75p	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804R	22	C - UA	First Reaction	TRUE	75p	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Second Reaction	TRUE	75p	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Initial Soln	TRUE	median	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804R	22	C - UA	Speciation Model	TRUE	median	0.634	0.216	-1.18e-01	-4.57e-01	-1.60e+00
HEN_845_804R	22	C - UA	First Reaction	TRUE	median	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Second Reaction	TRUE	median	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Initial Soln	FALSE	25p	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804R	22	C - UA	Speciation Model	FALSE	25p	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804R	22	C - UA	First Reaction	FALSE	25p	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Second Reaction	FALSE	25p	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Initial Soln	FALSE	75p	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804R	22	C - UA	Speciation Model	FALSE	75p	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804R	22	C - UA	First Reaction	FALSE	75p	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Second Reaction	FALSE	75p	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Initial Soln	FALSE	median	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804R	22	C - UA	Speciation Model	FALSE	median	0.633	0.205	-1.24e-01	-4.70e-01	-1.61e+00
HEN_845_804R	22	C - UA	First Reaction	FALSE	median	0	0	0	0	-2.14e+00
HEN_845_804R	22	C - UA	Second Reaction	FALSE	median	0	0	0	0	-2.14e+00

NOTES:
All model results are in units of moles with the exceptions of:
pH and pe (standard units) Results beginning with 'd_' (change from prior model step)
charge (equivalents) Results beginning with 'si_' (saturation index)

APPENDIX B
DRAWINGS AND MATERIALS SPECIFICATIONS FOR SOURCE CONTROL WITH CONTINUOUS CONTAINMENT SYSTEM

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CORRECTIVE ACTION PERMIT-LEVEL DESIGN

WEST ASH POND SYSTEM

HENNEPIN POWER PLANT

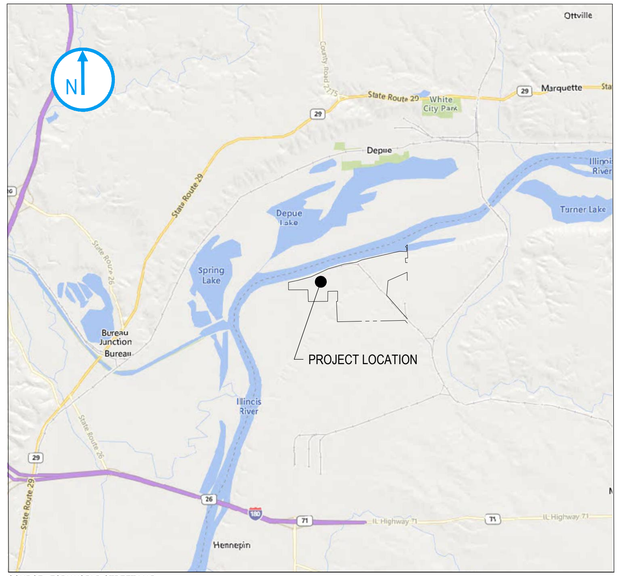
HENNEPIN, ILLINOIS

AERIAL IMAGERY: ESRI WORLD IMAGERY

LOCATION MAP

500' 0 500'

SCALE: 1"=500'



SOURCE: ESRI WORLD STREET MAP

VICINITY MAP

5000' 0 5000'

SCALE: 1"=5000'

INDEX OF DRAWINGS	
GENERAL	
G-000	COVER
CIVIL	
C-101	OVERALL SITE PLAN
C-301	CROSS SECTIONS A-A' & B-B'
C-302	CROSS SECTIONS C-C' & F-F'
C-303	CROSS SECTION DETAILS

DYNEGY MIDWEST GENERATION, LLC

HENNEPIN POWER PLANT
13498 E 800TH ST
HENNEPIN, IL 61327

APRIL 2025

RAMBOLL

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

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ILLINOIS RIVER

LIMITS OF FINAL COVER EXTENTION. EXISTING ANCHOR TRENCH IN THIS AREA SHALL BE REPLACED.

EXISTING ANCHOR TRENCH

PROPOSED CUTOFF WALL

EXISTING ANCHOR TRENCH

OLD WEST ASH POND
(CLOSED IN PLACE IN 2020)

OLD WEST
POLISHING POND
(CLOSED BY REMOVAL OF CCR IN 2020)

EXISTING SHEET PILE WALL (TO BE REMOVED)

EXISTING ANCHOR TRENCH

APPROXIMATE LIMITS OF DISTURBANCE

PROPOSED CUTOFF WALL

B1/LPZ1

B3/LPZ3

B5/LPZ5

21R

23

24

L4

51

49

50

22

20

35

36

A

A'

B

B'

C

C'

F

F'

LEGEND

EXISTING

- 360 — MAJOR CONTOUR
- 358 — MINOR CONTOUR
- APPROXIMATE SITE BOUNDARY
- CCR UNIT BOUNDARY (SEE NOTE 11)
- 100-YR FLOODPLAIN (APPROXIMATE LIMITS)
- WETLANDS (APPROXIMATE LIMITS)
- BODY OF WATER (LAKE, POND, RAVINE, ETC.) (APPROXIMATE LIMITS)
- MONITORING WELLS
- BOLTONIA POINTS (APPROXIMATE LOCATION)
- BOLTONIA AREAS (APPROXIMATE LIMITS)
- SHEETPILE WALL
- EXISTING ANCHOR TRENCH
- GRAVEL ACCESS ROAD

PROPOSED

- CUTOFF WALL
- LIMITS OF FINAL COVER
- LOD — APPROXIMATE LIMITS OF DISTURBANCE

NOTE:

1. EXISTING CONTOURS ARE BASED ON FINAL CLOSURE DRAWINGS OF OLD WEST ASH POND AND OLD WEST POLISHING POND, COMPLETED BY CEC, OCTOBER 2020.
2. HORIZONTAL DATUM: ILLINOIS STATE PLANE (NAD83, IN US FEET).
3. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88, IN US FEET).
4. CROSS SECTION LOCATIONS BASED ON THE SEPTEMBER 2017 GEOTECHNICAL SITE PLAN, PREPARED BY GEOSYNTEC AS PART OF THE 2017 CLOSURE AND POST-CLOSURE CARE PLAN FOR THE HEN OWAP AND OWPP.
5. WETLANDS REPRESENTED AS PER ILLINOIS NATIONAL WETLANDS INVENTORY AND ADAPTED TO REPRESENT ACTUAL SITE CONDITIONS.
6. BOLTONIA PLANTS AND AREAS BASED ON SCI'S DECURRENT FALSE ASTER SURVEY, SEPTEMBER 27, 2019.
7. 100-YEAR FLOODPLAIN REPRESENTED AS PER FEDERAL EMERGENCY MANAGEMENT AGENCY,"FLOOD INSURANCE RATE MAP, PUTNAM COUNTY, ILLINOIS AND UNINCORPORATED AREAS," NATIONAL FLOOD INSURANCE PROGRAM, JUNE 23, 2022 AND ADAPTED TO REPRESENT BASE FLOOD LEVEL EL. 461.9 FT.
8. THE CONTINUOUS CONTAINMENT SYSTEM DESIGN WILL BE FURTHER REFINED AS PART OF FINAL DESIGN ACTIVITIES THAT WILL BE INITIATED AFTER A CORRECTIVE ACTION CONSTRUCTION PERMIT HAS BEEN ISSUED FOR THE WEST ASH POND SYSTEM THESE ACTIVITIES MAY INCLUDE, BUT ARE NOT LIMITED TO, THE COLLECTION OF ADDITIONAL SITE SURVEY AND/OR SUBSURFACE INVESTIGATION DATA, MORE REFINED DESIGN EVALUATIONS, ADDITIONAL ENGINEERING ANALYSES, AND/OR PERMIT-RELATED CONSIDERATIONS. ELEMENTS OF THE CONTINUOUS CONTAINMENT SYSTEM DESIGN THAT WILL BE REFINED INCLUDE, BUT ARE NOT LIMITED TO, THE LIMITS OF DISTURBANCE, THE DIMENSIONS AND GEOMETRY OF THE WORK PAD, LIMITS OF THE FINAL COVER SYSTEM, TIE-IN DETAILS BETWEEN THE FINAL COVER SYSTEM, TIE-IN DETAILS BETWEEN THE DEEP CUTOFF WALL AND STORMWATER MANAGEMENT FEATURES, AND THE LOCATION OF THE DEEP CUTOFF WALL WITHIN THE WEST ASH POND SYSTEM PERIMETER DIKES.
9. CONSTRUCTION ENTRANCES, ACCESS ROADS, STAGING AREAS, AND OTHER LOGISTICAL ELEMENTS WILL BE DEFINED DURING FINAL DESIGN.
10. STORMWATER BEST MANAGEMENT PRACTICES (BMPS) WILL BE DEFINED DURING FINAL DESIGN IN ACCORDANCE WITH A SITE-SPECIFIC STORMWATER POLLUTION PREVENTION PLAN (SWPP) THAT WILL BE OBTAINED AS PART OF FINAL DESIGN ACTIVITIES.
11. CCR UNIT BOUNDARY REFLECTS THE FORMER COMBINED BOUNDARY OF THE OLD WEST ASH POND AND THE OLD WEST POLISHING POND, WHICH ARE TOGETHER THE WEST ASH POND SYSTEM. ALL CCR WAS REMOVED FROM THE OLD WEST POLISHING POND AS PART OF THE COMPLETED 2020 CLOSURE, THEREFORE THE UNIT BOUDNARY REFLECTS THE APPROXIMATE FORMER LIMITS OF CCR, BUT EXPANDS BEYOND THE CURRENT LIMITS OF CCR.

OVERALL SITE PLAN

100' 0 100'
SCALE: 1"=100'

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DATE: 4/2025

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Project Details: **DYNEGY MIDWEST GENERATION, LLC** WEST ASH POND SYSTEM HENNEPIN POWER PLANT 13498 E 800TH ST HENNEPIN, IL 61327	Drawing Title: **OVERALL SITE PLAN**				RAMBOLL **RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.**
Location:	Designer / Professional Engineer Responsible: B. RICHTER				
Project Number **194011024 1-006**	Designed by S. LEE	Drawn by B. LEMMON	Checked by B. RICHTER	Approved by L. CARR	Date APRIL 2025
Project Status CORRECTIVE ACTION PERMIT-LEVEL DESIGN	Drawing Number **C-101**			Scale AS NOTED	Sc x / Rev. x

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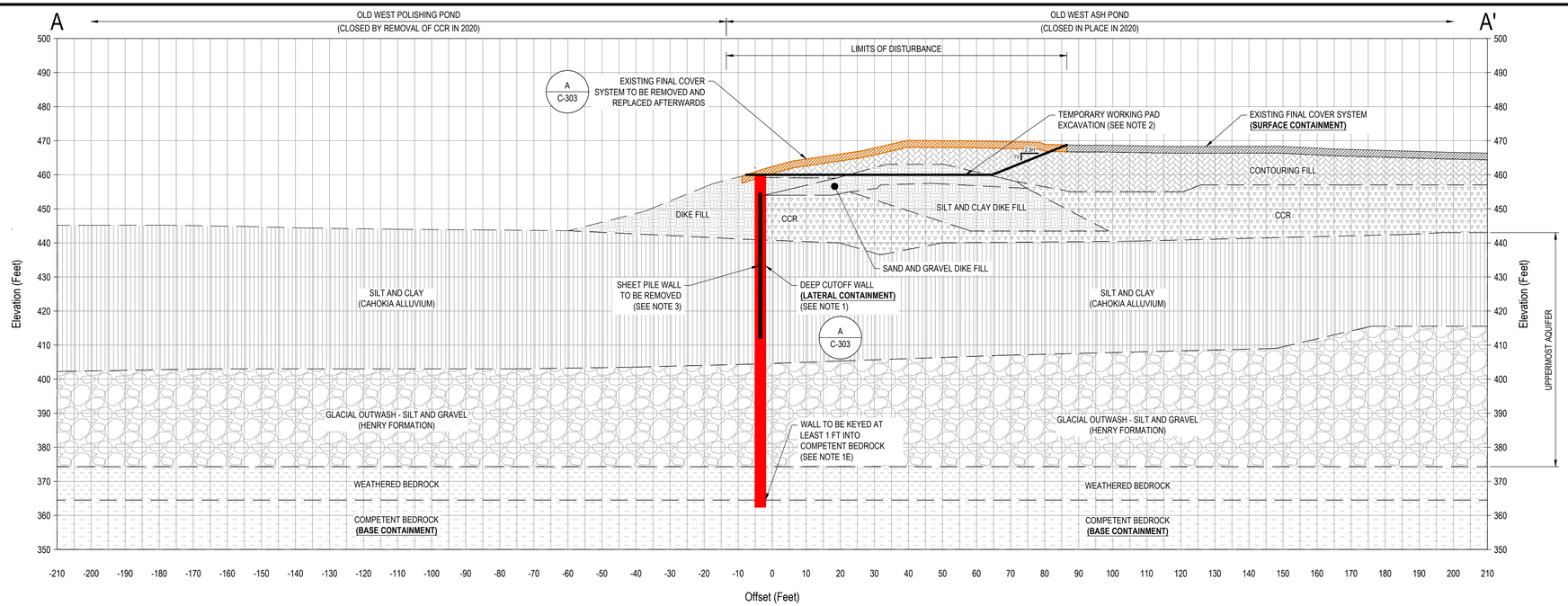
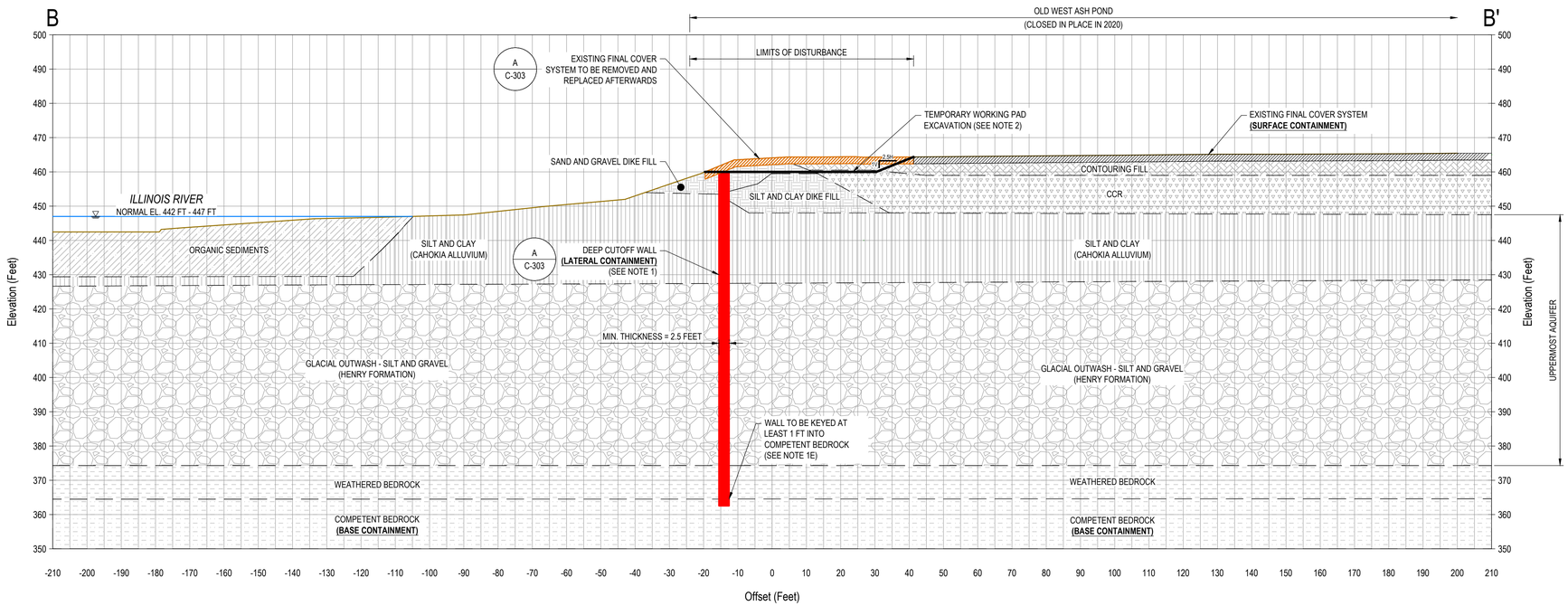


CROSS SECTION A-A'

SCALE HORZ. 1" = 20'

SCALE: VERT. 1"=20'



CROSS SECTION B-B'

SCALE HORZ. 1" = 20'

SCALE: VERT. 1"=20'

NOTES:

1. THE DEEP CUTOFF WALL IS TO:
   a. BE CONSTRUCTED USING SOIL-BENTONITE OR CEMENT-BENTONITE MATERIALS
   b. HAVE A DESIGN HYDRAULIC CONDUCTIVITY OF 1X10^{-7}CENTIMETERS PER SECOND
   c. HAVE A THICKNESS OF AT LEAST 2.5 FEET
   d. HAVE A DESIGN COMPRESSIVE STRENGTH OF 50 PSI AFTER 28 DAYS OF CURING, UNLESS A LOWER STRENGTH IS JUSTIFIED BASED ON A STABILITY ANALYSIS
   e. BE KEYED AT LEAST 1 FT INTO COMPETENT SHALE BEDROCK, AS DETERMINED BY THE OBSERVATIONS OF CUTTINGS AND MACHINE INSTRUMENTATION OBTAINED DURING WALL INSTALLATION
2. THE TEMPORARY WORKING PLATFORM IS TO BE CONSTRUCTED AFTER THE FINAL COVER SYSTEM IS REMOVED AND BEFORE WALL CONSTRUCTION IS COMPLETED.
3. THE EXISTING NZ-26 STEEL SHEET PILE WALL IS TO BE REMOVED BEFORE OR AFTER WORKING PAD CONSTRUCTION BUT PRIOR TO INSTALLATION OF THE CUTOFF WALL.
4. ALL SUBSURFACE MATERIAL INTERFACES ARE APPROXIMATE AND ARE BASED ON THE INTERPOLATION OF AVAILABLE INVESTIGATION DATA. ADDITIONAL SUBSURFACE INVESTIGATIONS WILL BE ADVANCED ALONG THE CUTOFF WALL PROFILE AS PART OF FUTURE PRE-DESIGN INVESTIGATION ACTIVITIES TO VERIFY MATERIAL INTERFACES AND REFINE THE DESIGN PROFILE OF THE CUTOFF WALL.
5. SUBSURFACE LAYERING WAS TAKEN FROM THE 2020 GEOSYNTEC FINAL CLOSURE DESIGN GEOTECHNICAL CALCULATIONS.
6. THE TOP OF WEATHERED BEDROCK AND COMPETENT BEDROCK (BASE CONTAINMENT) WERE ARE GENERALIZED AND WERE SELECTED BASED ON BORINGS AND PACKER TESTING COMPLETED BY RAMBOLL IN 2024.
7. THE CONTINUOUS CONTAINMENT SYSTEM DESIGN WILL BE FURTHER REFINED AS PART OF FINAL DESIGN ACTIVITIES THAT WILL BE INITIATED AFTER A CORRECTIVE ACTION CONSTRUCTION PERMIT HAS BEEN ISSUED FOR THE WEST ASH POND SYSTEM THESE ACTIVITIES MAY INCLUDE, BUT ARE NOT LIMITED TO, THE COLLECTION OF ADDITIONAL SITE SURVEY AND/OR SUBSURFACE INVESTIGATION DATA, MORE REFINED DESIGN EVALUATIONS, ADDITIONAL ENGINEERING ANALYSES, AND/OR PERMIT-RELATED CONSIDERATIONS. ELEMENTS OF THE CONTINUOUS CONTAINMENT SYSTEM DESIGN THAT WILL BE REFINED INCLUDE, BUT ARE NOT LIMITED TO, THE LIMITS OF DISTURBANCE, THE DIMENSIONS AND GEOMETRY OF THE WORK PAD, LIMITS OF THE FINAL COVER SYSTEM, TIE-IN DETAILS BETWEEN THE FINAL COVER SYSTEM, TIE-IN DETAILS BETWEEN THE DEEP CUTOFF WALL AND STORMWATER MANAGEMENT FEATURES, AND THE LOCATION OF THE DEEP CUTOFF WALL WITHIN THE WEST ASH POND SYSTEM PERIMETER DIKES.
8. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88, IN US FEET).

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DATE: 4/2025

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Project Details: **DYNEGY MIDWEST GENERATION, LLC**, WEST ASH POND SYSTEM, HENNEPIN POWER PLANT, 13498 E 800TH ST HENNEPIN, IL 61327	Drawing Title: **CROSS SECTIONS A-A' & B-B'**					RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.
Location:	Designer / Professional Engineer Responsible: B. RICHTER					
Project Number: **1940110241-006**	Designed by: S. LEE	Drawn by: B. LEMMON	Checked by: B. RICHTER	Approved by: I. CARR	Date: APRIL 2025	
Project Status: CORRECTIVE ACTION PERMIT-LEVEL DESIGN	Drawing Number: **C-301**			Scale: AS NOTED	Sc: x	Rev.: x

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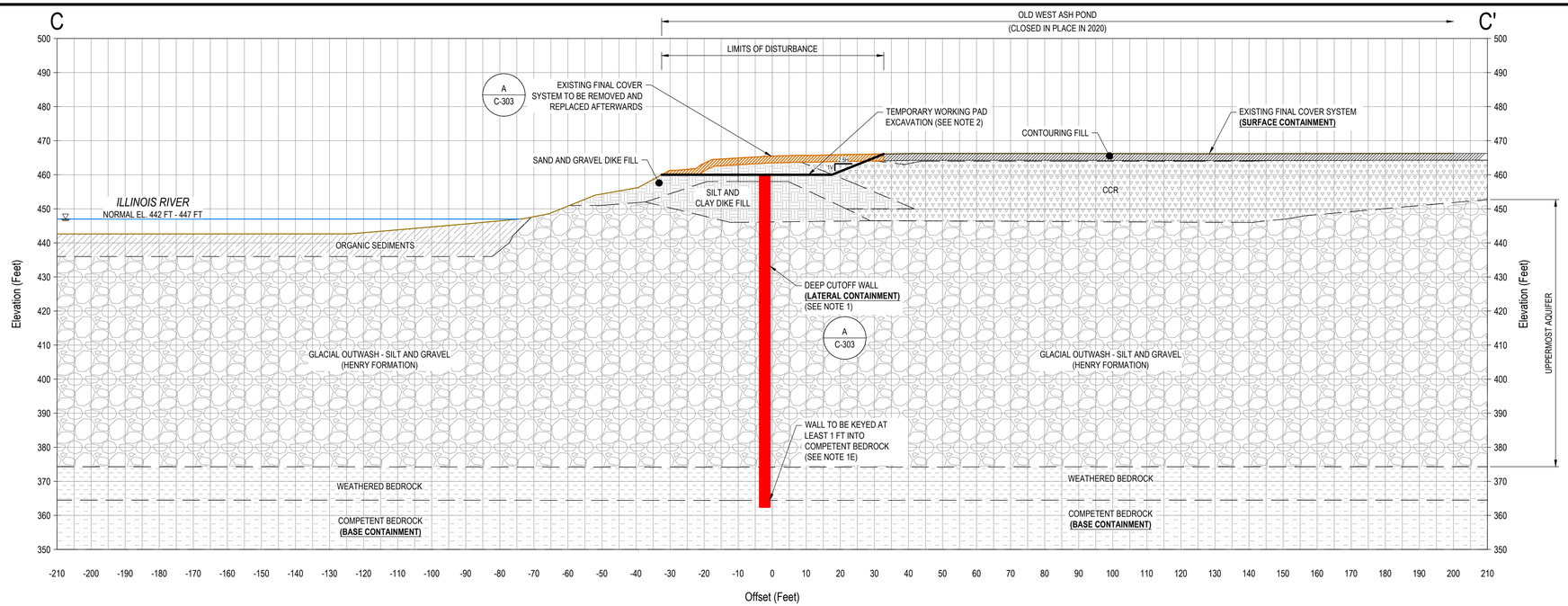
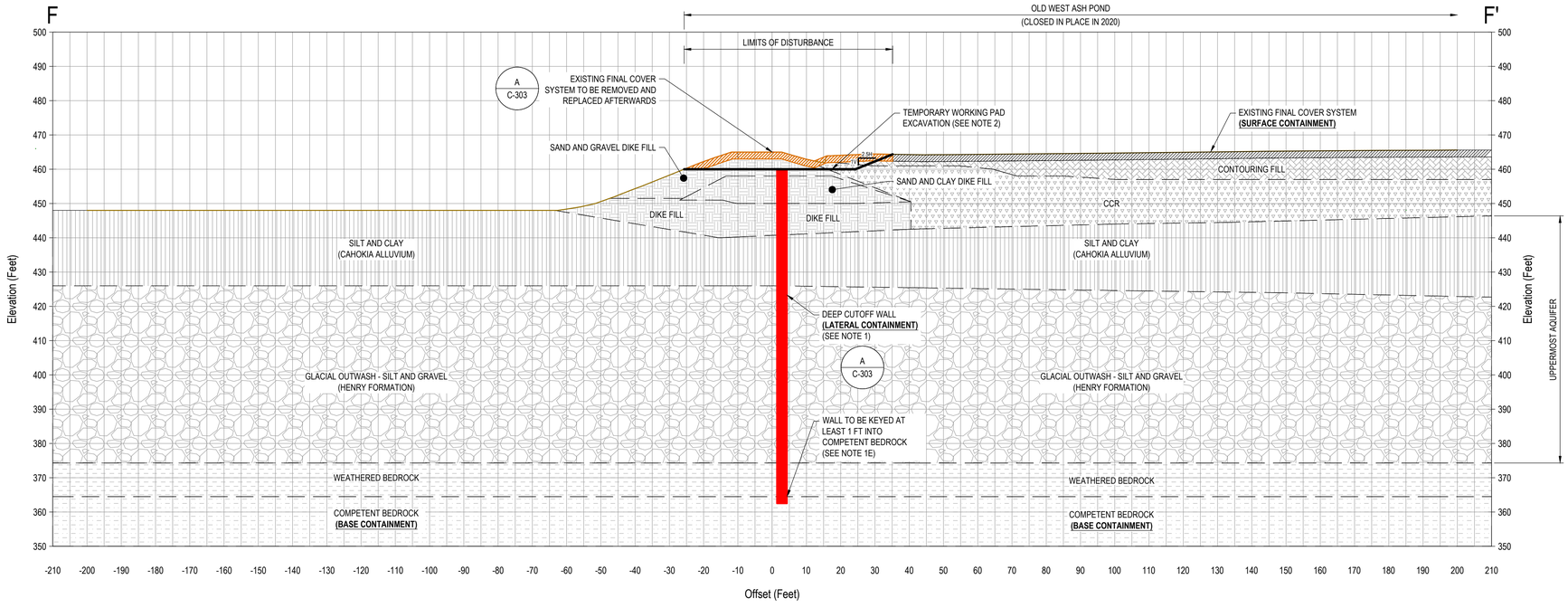


CROSS SECTION C-C'

SCALE HORZ. 1" = 20'

SCALE: VERT. 1"=20'



CROSS SECTION F-F'

SCALE HORZ. 1" = 20'

SCALE: VERT. 1"=20'

NOTES:

1. THE DEEP CUTOFF WALL IS TO:
   a. BE CONSTRUCTED USING SOIL-BENTONITE OR CEMENT-BENTONITE MATERIALS
   b. HAVE A DESIGN HYDRAULIC CONDUCTIVITY OF 1X10^{-7}CENTIMETERS PER SECOND
   c. HAVE A THICKNESS OF AT LEAST 2.5 FEET
   d. HAVE A DESIGN COMPRESSIVE STRENGTH OF 50 PSI AFTER 28 DAYS OF CURING, UNLESS A LOWER STRENGTH IS JUSTIFIED BASED ON A STABILITY ANALYSIS
   e. BE KEYED AT LEAST 1 FT INTO COMPETENT SHALE BEDROCK, AS DETERMINED BY THE OBSERVATIONS OF CUTTINGS AND MACHINE INSTRUMENTATION OBTAINED DURING WALL INSTALLATION
2. THE TEMPORARY WORKING PLATFORM IS TO BE CONSTRUCTED AFTER THE FINAL COVER SYSTEM IS REMOVED AND BEFORE WALL CONSTRUCTION IS COMPLETED.
3. THE EXISTING NZ-26 STEEL SHEET PILE WALL IS TO BE REMOVED BEFORE OR AFTER WORKING PAD CONSTRUCTION BUT PRIOR TO INSTALLATION OF THE CUTOFF WALL.
4. ALL SUBSURFACE MATERIAL INTERFACES ARE APPROXIMATE AND ARE BASED ON THE INTERPOLATION OF AVAILABLE INVESTIGATION DATA. ADDITIONAL SUBSURFACE INVESTIGATIONS WILL BE ADVANCED ALONG THE CUTOFF WALL PROFILE AS PART OF FUTURE PRE-DESIGN INVESTIGATION ACTIVITIES TO VERIFY MATERIAL INTERFACES AND REFINE THE DESIGN PROFILE OF THE CUTOFF WALL.
5. SUBSURFACE LAYERING WAS TAKEN FROM THE 2020 GEOSYNTEC FINAL CLOSURE DESIGN GEOTECHNICAL CALCULATIONS.
6. THE TOP OF WEATHERED BEDROCK AND COMPETENT BEDROCK (BASE CONTAINMENT) WERE ARE GENERALIZED AND WERE SELECTED BASED ON BORINGS AND PACKER TESTING COMPLETED BY RAMBOLL IN 2024.
7. THE CONTINUOUS CONTAINMENT SYSTEM DESIGN WILL BE FURTHER REFINED AS PART OF FINAL DESIGN ACTIVITIES THAT WILL BE INITIATED AFTER A CORRECTIVE ACTION CONSTRUCTION PERMIT HAS BEEN ISSUED FOR THE WEST ASH POND SYSTEM THESE ACTIVITIES MAY INCLUDE, BUT ARE NOT LIMITED TO, THE COLLECTION OF ADDITIONAL SITE SURVEY AND/OR SUBSURFACE INVESTIGATION DATA, MORE REFINED DESIGN EVALUATIONS, ADDITIONAL ENGINEERING ANALYSES, AND/OR PERMIT-RELATED CONSIDERATIONS. ELEMENTS OF THE CONTINUOUS CONTAINMENT SYSTEM DESIGN THAT WILL BE REFINED INCLUDE, BUT ARE NOT LIMITED TO, THE LIMITS OF DISTURBANCE, THE DIMENSIONS AND GEOMETRY OF THE WORK PAD, LIMITS OF THE FINAL COVER SYSTEM, TIE-IN DETAILS BETWEEN THE FINAL COVER SYSTEM, TIE-IN DETAILS BETWEEN THE DEEP CUTOFF WALL AND STORMWATER MANAGEMENT FEATURES, AND THE LOCATION OF THE DEEP CUTOFF WALL WITHIN THE WEST ASH POND SYSTEM PERIMETER DIKES. .
8. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88, IN US FEET).

NO.	REV DATE	REVISION	INT.

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DATE: 4/2025

Project Details
DYNEGY MIDWEST GENERATION, LLC
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
13498 E 800TH ST HENNEPIN, IL 61327

Drawing Title
CROSS SECTIONS C-C' & F-F'

RAMBOLL
RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

Location:

Designer / Professional Engineer Responsible:
B. RICHTER

Project Number **1940110241-006**

Designed by S. LEE | Drawn by B. LEMMON | Checked by B. RICHTER | Approved by L. CARR | Date APRIL 2025

Project Status CORRECTIVE ACTION PERMIT-LEVEL DESIGN

Drawing Number **C-302**

Scale AS NOTED | Sc x | Rev. x

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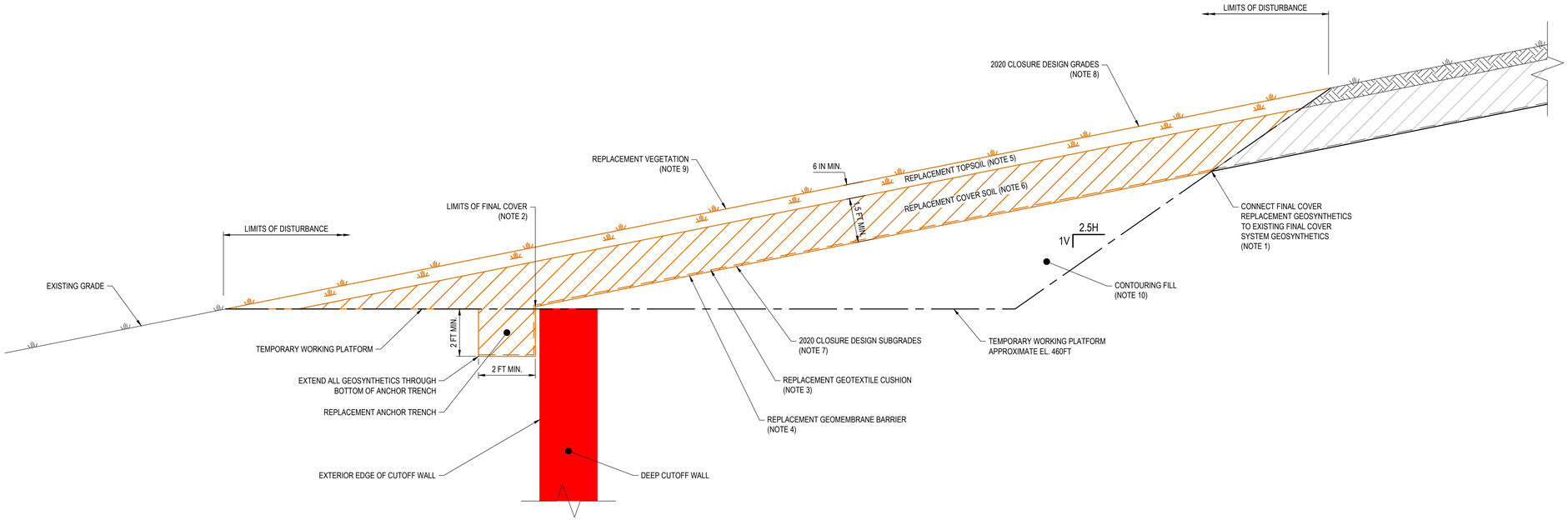

A FINAL COVER REPLACEMENT DETAIL

NOT TO SCALE

NOTES:

1. THE FINAL COVER REPLACEMENT GEOSYNTHETICS IS TO BE CONNECTED TO THE EXISTING FINAL COVER GEOSYNTHETICS AT THE LIMITS OF DISTURBANCE. THIS SHOULD INCLUDE THE FOLLOWING:
   a. FUSION OR EXTRUSION OF THE REPLACEMENT GEOMEMBRANE TO THE EXISTING GEOMEMBRANE
   b. ATTACHING THE REPLACEMENT GEOTEXTILE CUSHION TO THE EXISTING GEOTEXTILE CUSHION BY OVERLAPPING IT BY AT LEAST ONE FOOT AND EITHER MACHINE-SEWING OR THERMALLY BONDING THEM TO ONE ANOTHER.

2. WHERE THE EXISTING FINAL COVER SYSTEM EXTENDS BEYOND THE DEEP CUTOFF WALL, THE LIMITS OF THE FINAL COVER IS TO BE EQUAL TO THE LIMITS OF THE 2020 FINAL CLOSURE (E.G. EXISTING ANCHOR TRENCH LOCATION). WHERE THE CUTOFF WALL IS LOCATED BEYOND THE LIMITS OF THE EXISTING FINAL COVER SYSTEM (E.G., BEYOND THE LIMITS OF THE EXISTING ANCHOR TRENCH), THE REPLACEMENT FINAL COVER SYSTEM IS TO BE EXTENDED BEYOND THE LIMITS OF THE CUTOFF WALL, WITH THE REPLACEMENT ANCHOR TRENCH INSTALLED IMMEDIATELY ADJACENT TO THE EXTERIOR EDGE OF THE CUTOFF WALL.

3. THE REPLACEMENT GEOTEXTILE IS TO CONSIST OF A NONWOVEN POLYPROPYLENE MATERIAL THAT MANUFACTURED IN ACCORDANCE WITH THE LATEST VERSION OF GEOSYNTHETIC INSTITUTE GRI-GT12(A) STANDARD SPECIFICATION, AND WITH THE FOLLOWING REQUIREMENTS:
   a. MINIMUM MASS PER UNIT AREA OF 16 OZ/YD2 (PER ASTM D5261)
   b. MINIMUM GRAB STRENGTH OF 270 LB (PER ASTM D4632)
   c. MINIMUM TEAR STRENGTH OF 105 LB (PER ASTM D4533), AND
   d. MINIMUM PUNCTURE STRENGTH OF 725 LB (PER ASTM D6241).

   GEOTEXTILE SEAMS ARE TO BE OVERLAPPED BY 1 FT DURING PLACEMENT AND EITHER MACHINE SEWN OR THERMALLY BONDED TO ONE ANOTHER.

4. THE REPLACEMENT GEOMEMBRANE IS TO CONSIST OF A LINEAR, LOW-DENSITY POLYETHYLENE (LLDPE) MATERIAL, TEXTURED ON BOTH SIDES, MANUFACTURED IN ACCORDANCE WITH THE LATEST VERSION OF GEOSYNTHETIC INSTITUTE GM17 STANDARD SPECIFICATION, AND WITH THE FOLLOWING REQUIREMENTS:
   a. MINIMUM NOMINAL HEIGHT OF 40 MIL (PER ASTM D5994)
   b. MINIMUM ASPERITY HEIGHT OF 16 MIL (PER ASTM D7466)
   c. MAXIMUM DENSITY OF 0.939 G/ML (PER ASTM D792, OR ASTM D1505)
   d. MINIMUM TENSILE STRENGTH AT BREAK OF 60 LB/IN (PER ASTM D6693)
   e. MINIMUM ELONGATION AT BREAK OF 250% (PER ASTM D6693)
   f. MINIMUM TEAR RESISTANCE OF 22 LB (PER ASTM D1004), AND
   g. MINIMUM PUNCTURE RESISTANCE OF 44 LB (PER ASTM D3895)

   GEOMEMBRANE SEAMS ARE TO BE FUSION WELDED; REPAIRS AND PENETRATION FOR PIPE BOOTS ARE TO BE EXTRUSION WELDED.

5. THE REPLACEMENT TOPSOIL IS TO CONSIST OF A NATURAL SOIL MATERIAL THAT IS RELATIVELY HOMOGENOUS, FREE OF DEBRIS, FOREIGN OBJECTS, AND LARGE ROCK FRAGMENTS. THE TOPSOIL IS TO:
   a. BE CLASSIFIED AS A SC, CL, ML, OR OL (PER ASTM D2487), AND
   b. BE FERTILIZED, AS NECESSARY, BASED ON AGRONOMIC TESTING TO SUPPORT VEGETATION GROWTH AT THE SITE.

   TOPSOIL REMOVED FROM THE EXISTING FINAL COVER SYSTEM, WITHIN THE LIMITS OF DISTURBANCE, MAY BE STOCKPILED AND RE-USED AS REPLACEMENT TOPSOIL, IF APPROPRIATELY SEGREGATED.

6. THE REPLACEMENT COVER SOIL IS TO CONSIST OF A NATURAL SOIL MATERIAL THAT IS RELATIVELY HOMOGENEOUS, FREE OF DEBRIS, FOREIGN OBJECTS, AND LARGE ROCK FRAGMENTS. THE COVER SOIL IS TO:
   a. BE CLASSIFIED AS A CL, CH, SL-CH, CL-ML, SC, SM, SP, SW, OR SW-SP (PER ASTM D2487), AND
   b. HAVE A MAXIMUM PARTICLE SIZE OF 1.5 INCHES (PER ASTM D422 OR D6943), OR LARGER IF SUPPORTED BY A GEOMEMBRANE PUNCTURE ANALYSIS.

   COVER SOIL REMOVED FROM THE EXISTING FINAL COVER SYSTEM, WITHIN THE LIMITS OF DISTURBANCE, MAY BE STOCKPILED AND RE-USED WITH REPLACEMENT TOPSOIL, IF APPROPRIATELY SEGREGATED.

7. THE FINAL COVER SYSTEM WITHIN THE LIMITS OF DISTURBANCE IS TO BE RECONSTRUCTED TO THE SAME DESIGN SUBGRADES AS THE COMPLETED 2020 FINAL CLOSURE.

8. THE FINAL COVER SYSTEM WITHIN THE LIMITS OF DISTURBANCE IS TO BE RECONSTRUCTED TO THE SAME SURFACE GRADES AS THE COMPLETED 2020 FINAL CLOSURE.

9. VEGETATION IS TO BE RESTORED AFTER THE RECONSTRUCTION OF THE FINAL COVER SYSTEM.

10. CONTOURING FILL OR COMPACTED CCR IS TO CONSIST OF MATERIAL REMOVED DURING CONSTRUCTION TO CREATE THE WORKING PLATFORM. THE MATERIALS ARE TO BE REPLACED AFTER WALL CONSTRUCTION TO CREATE THE FINAL COVER SYSTEM SUBGRADES.

11. ANY STORMWATER CHUTES DISTURBED DURING CONSTRUCTION SHOULD BE RECONSTRUCTED TO THE SAME CONFIGURATION AS THE COMPLETED 2020 FINAL CLOSURE.

12. THE CONTINUOUS CONTAINMENT SYSTEM DESIGN WILL BE FURTHER REFINED AS PART OF FINAL DESIGN ACTIVITIES THAT WILL BE INITIATED AFTER A CORRECTIVE ACTION CONSTRUCTION PERMIT HAS BEEN ISSUED FOR THE WEST ASH POND SYSTEM THESE ACTIVITIES MAY INCLUDE, BUT ARE NOT LIMITED TO, THE COLLECTION OF ADDITIONAL SITE SURVEY AND/OR SUBSURFACE INVESTIGATION DATA, MORE REFINED DESIGN EVALUATIONS, ADDITIONAL ENGINEERING ANALYSES, AND/OR PERMIT-RELATED CONSIDERATIONS. ELEMENTS OF THE CONTINUOUS CONTAINMENT SYSTEM DESIGN THAT WILL BE REFINED INCLUDE, BUT ARE NOT LIMITED TO, THE LIMITS OF DISTURBANCE, THE DIMENSIONS AND GEOMETRY OF THE WORK PAD, LIMITS OF THE FINAL COVER SYSTEM, TIE-IN DETAILS BETWEEN THE FINAL COVER SYSTEM, TIE-IN DETAILS BETWEEN THE DEEP CUTOFF WALL AND STORMWATER MANAGEMENT FEATURES, AND THE LOCATION OF THE DEEP CUTOFF WALL WITHIN THE WEST ASH POND SYSTEM PERIMETER DIKES.

ISSUED FOR PERMIT REVIEW NOT FOR CONSTRUCTION

DATE: 4/2025

NO.	REV DATE	REVISION	INT.

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Project Details
DYNEGY MIDWEST GENERATION, LLC
WEST ASH POND SYSTEM
HENNEPIN POWER PLANT
13498 E 800TH ST HENNEPIN, IL 61327

Drawing Title
CROSS SECTION DETAILS

RAMBOLL
RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

Location:

Designer / Professional Engineer Responsible:
B. RICHTER

Project Number	Designed by	Drawn by	Checked by	Approved by	Date
1940110241-006	S. LEE	B. LEMMON	B. RICHTER	L. CARR	APRIL 2025

Project Status	Drawing Number	Scale	Sc	Rev.
CORRECTIVE ACTION PERMIT-LEVEL DESIGN	**C-303**	AS NOTED	x	x

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APPENDIX H
GEOTECHNICAL INFORMATION

APPENDIX H.1
SLURRY TRENCH STABILITY CALCULATION PACKAGE

RAMBOLL

ENVIRONMENT
& HEALTH

Slurry Trench Stability Calculation Package

Project name	**Corrective Action Plan, Hennepin Power Plant, West Ash Pond System**
Project no.	**1940110241-006**
Client	**Dynegy Midwest Generation, LLC**
Version	**Issued for Permit Submittal**
Prepared by	**Peter Nso**
Checked by	**Marco D'Ignazio**
Approved by	**Lucas P. Carr, P.E.**

Date April 17, 2025

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1 Introduction

This calculation package represents a preliminary, concept-level stability calculations performed to support the permit-level design of a continuous containment system (CCS) that will be constructed as part of groundwater corrective action for the West Ash Pond System (WAPS) at the Hennepin Power Plant (Hennepin). Specifically, the calculations are the stability of slurry trenches associated with installing the deep cutoff DCW (DCW) portion of the CCS. The DCW will be a cement-bentonite or soil-bentonite subsurface barrier that will encircle the perimeter of the WAPS, thereby acting as lateral containment for coal combustion residuals (CCR) contained within the WAPS.

The DCW was assumed to be installed with conventional crane-mounted construction equipment from the crest of the WAPS embankment, although alternative construction methods could be evaluated at a later phase of the design. For the purpose of this assessment, it was assumed that the crane would be positioned inboard of the DCW and will utilize a clamshell, slurry cutter, and/or hydromill to construct the DCW.

During DCW excavation, the DCW was assumed to be continuously full of a bentonite fluid slurry, in order to reduce the potential for the trench collapse. Depending on a construction method, the bentonite slurry would either be combined with soil and left in the subsurface (e.g., a soil-bentonite DCW), or displaced with a cement-bentonite slurry (e.g., a cement-bentonite DCW). Both construction methods, after completion, would form the low-permeability DCW.

Stability assessment of the slurry trench was performed to as a proof-of-concept assessment to evaluate the constructability of a slurry DCW for the WAPS, including evaluating not only the stability of the trench itself but the potential for construction to adversely impact the integrity of the WAPS perimeter embankments. Specifically, the stability assessment evaluated:

- The geometry of the working pad and offset of crane loading to avoid excessive trench deformations; and
- The expected factor of safety and deformations of the slurry trench DCW and perimeter dike under temporary construction surcharge and slurry trench loading.

After the DCW has hardened and the construction equipment has been removed, it was assumed that the structural integrity of the embankment will be similar to or improved relative to current conditions.

The information provided in this calculation includes:

- Information on the analysis methodology.
- A summary of material parameters utilized for the analysis.
- A discussion of analysis input parameters and boundary conditions, and
- Results of the analysis.

2 Analysis Methodology

2.1 Selected Analysis Type

PLAXIS 2D finite element software [1] was used to model the stability of the cutoff DCW trench considering the irregular geometries of the embankments or dikes, complex interactions with the surrounding soil and groundwater systems, and unspecified failure geometry of planar and/or curved (log-spiral or circular failure) sliding surfaces failures in a limit-equilibrium framework and analytical solutions [2, 3]. This 2D analysis approach allows for a representative geometry of the facility including the non-horizontal stratigraphy of the various subsurface materials, the limited width of the slurry trench parallel to the centerline of the embankment, and the crane loading during construction. More specifically, the capabilities of the software in analyzing conditions during and after DCW installation include:

- Replicating the two-dimensional field configuration of the DCW installation (i.e., position of crane, dimensions of slurry trench) in a numerical model setup.
- Considering coupled flow-deformation analyses for evaluating effective stresses under varying groundwater conditions, in addition to time-dependent behaviors such as consolidation, as well as undrained behavior of relevant soil layers for the short-term stability assessment of the cutoff DCW.
- Modeling of the interaction between the DCW and surrounding soil and the stability of the DCW under operational loads (e.g., surcharge load from crane, body forces of underlying soils and embankments or dikes). This feature provides insights into stress transfer and deformation patterns that cannot be obtained from a limit-equilibrium framework.
- Utilizing staged construction feature of the software to consider the transient simulation of excavation and slurry backfilling.
- Generating data visualization graphics showing displacement contours to support results interpretation on the stability of the DCW.
- Assessing the potential for internal deformations, such as shear strain localization and progressive failure mechanisms, which can impact the stability of the slurry trench.

2.2 Analysis Cross-Sections

Previous stability assessments were performed by Geosyntec in 2020 [4] to support the final design of the completed WAPS closure. These assessments are included as Appendix H.3 to the Construction Permit Application. This included evaluating two slope stability cross-sections, including A-A', B-B', C-C', and F-F', as shown in the geotechnical site plan figure for Hennepin (Appendix H.2 to the Construction permit Application). Ramboll reviewed the Geosyntec cross-sections and selected two, A – A' and F – F' (for preliminary analysis), based on the characteristics listed below:

- **Cross-Section A-A'**, which represents the Splitter Dike between the Old West Ash Pond (WAP) and the Old West Polishing Pond (OWPP), has a dike height of 21.5 feet and a relatively steep downstream slope of 3.4H:1V. According to the 2020 Geosyntec Calculation Report, the undrained, post-earthquake safety factor for this section is 1.31, indicating a potential risk of instability during both the construction and post-construction phases of the slurry trench.
- **Cross-Section F – F'** on the south side was selected for the slurry trench stability analysis due to the cross-section's relatively steep dike slope (2.9H:1V) downstream and a substantial thickness of silt and clay alluvium (approximately 19 feet). These characteristics make this location a critical area for assessing the effects of construction loading and long-term stability especially under transient conditions. In addition, undrained, post-earthquake analysis carried out by Geosyntec in the year 2020 calculated a factor of safety of 1.32.

Other, additional cross-sections will be evaluated as part of future final design activities that will be initiated after approval of the WAPS Correction Action Plan by the Illinois Environmental Protection Agency (IEPA).

3 Development of Material Parameters

3.1 Source Data

The slurry trench stability calculations and analyses are based on various subsurface investigations and laboratory testing programs conducted at the HEN WAPS site. These investigations are compiled in the 2020 Geosyntec final closure design calculations [4]. The information was supplemented with bedrock borings advanced by Ramboll in late 2024. A summary of each data source is provided below:

- 2020 Geosyntec Calculations [4]
    - The calculation packages included new data collected by Geosyntec and a summary of historical data collected by others.
    - Subsurface explorations including cone penetration tests, borings with standard penetration tests, permeability tests, soil corrosivity indication series tests, and installation of piezometers to monitor groundwater levels.
    - Laboratory testing including: Atterberg limits, dry unit weight, grain size analyses, moisture content, drained direct shear tests, unconfined compressive strength tests and isotopically consolidated undrained (CIU) tests.
    - Information on typical groundwater levels.
    - These calculations are provided in Appendix H.3 of the Construction Permit Application.
    - Other historical data utilized by the Geosyntec calculations but not contained within them included supplemental investigations completed by Geosyntec in 2018 and investigations

completed by AECOM in 2016. The Geosyntec report is provided in Appendix H.4 of the Construction Permit Application, while the AECOM investigations are provided as Appendix D.2 to the 2017 Hydrogeologic Site Characterization Report, which is Appendix B.2 of the Construction Permit Application.

- 2024 Ramboll Investigations
    - Three borings advanced into bedrock for the purposes of supporting permit-level design of the deep DCW.
    - A memorandum documenting these investigations, including boring logs and packer testing data, is provided as an attachment to the Nature and Extent Report for the Hennepin WAPS. The Nature and Extent Report is provided Appendix D of the Corrective Action Alternatives Analysis, which is provided as Appendix A of the Corrective Action Plan, which is in turn provided as Appendix G of the Construction Permit Application.

The 2020 Geosyntec calculations [4] included the identification and assignment of design unit weight, drained shear strength, and undrained shear strength parameters for multiple soil units[1] at cross-sections A-A' and F-F'. This information was also utilized for the DCW assessment. Specific soil units identified by Geosyntec, and described in more detail in their report [4], include:

- CCR
- Buttress
- Contouring Fill
- Sand and Gravel Dike Fill
- Silt and Clay Dike Fill
- Structural Fill with CCR
- Silt and Clay Alluvium
- Sand and Gravel Alluvium

The 2020 Geosyntec models were expanded by Ramboll to include deeper layers of weathered shale and competent shale bedrock that were identified in the 2024 Ramboll site investigation. Additional information on the weathered and competent shale is provided in the Ramboll memorandum (see the Nature and Extent Report, which is Appendix D of the Corrective Action Alternatives Analysis, which is Appendix A of the Corrective Action Plan, which is in turn Appendix G of the Construction Permit Application).

3.2 Development of Elastic Parameters

Cone penetration tests with pore pressure measurements (CPTu tests) were carried out by AECOM in 2015 as provided in Appendix H.5 of the Construction Permit Application. Ramboll utilized this data to estimate the Young's Modulus (E) of each soil unit for CPTu soundings HEN-C002 and HEN-C010. Notably, CPTu HENC010 is located on cross-section F – F' whilst HENC002 is located approximately 50 ft from cross-section A – A', as shown in the geotechnical site plan (Appendix H.2 of the Construction Permit Application).

[1] The soil units utilized by Geosyntec are geotechnical soil units and use a different naming convention that hydrogeological soil units assigned by Ramboll within the Hydrogeologic Site Characterization Report for the Hennepin WAPS (see Appendix B.2 of the Construction Permit Application). For this calculation package, the geotechnical soil unit names assigned by Geosyntec were utilized. All other documents utilize the hydrogeologic unit naming convention described in the Hydrogeologic Site Characterization Report.

Young's Modulus were estimated using the CPeT-IT software [5] based on empirical correlations on cone resistance and soil behavior type as provided by Robertson and Cabal [6]. Additionally, Poisson Ratio (v) of the soils were estimated from literature values [7, 8] and engineering judgement. Different elastic parameters were selected for each section, based on the results of this assessment. The CPT soundings and corresponding estimations of Young's modulus are provided in **Attachment A** to this memorandum.

3.3 Selection of Constitutive Models

Four constitutive soil models were used in the analysis of the slurry trench stability, as described below.

- The Hardening Soil (HS) model [1, 9] was selected to capture the stress dependent stiffness and hardening behavior of soils. These behaviors cannot be accurately represented using simpler models like Mohr-Coulomb.
    - In addition, the HS model accounts for plastic deformation from the early stages of loading by incorporating both deviatoric (shear) and volumetric (cap) hardening, allowing it to simulate soil strengthening and densification under stress. The following material units were assigned HS model to simulate the non-linear stress-strain relationship and long-term behavior including settlement due to consolidation:
        - Compacted material units such as Silt and Clay Dike fill, Sand and Gravel Dike fill, Buttress/structural fill with CCR, contouring fills and Sand and Gravel alluvium at depth.
        - HS material and strength parameters as provided by Surarak et al. [10] were assigned to simulate the stiff clay or weathered Shale.
- Cohesive soils such as Silt and Clay alluvium exhibit high compressibility, contractive behavior during undrained shearing, consolidation and time dependent settlement, making the Soft Soil model [1] a reasonable approximation of the undrained behavior of normally consolidated and lightly over-consolidated clays.
- Contractive, loose and saturated materials like CCR typically experience a rapid loss of shear strength when subjected to undrained loading [11] and the likelihood of static liquefaction. The Hardening Soil model with small-strain stiffness (HSS) can simulate the gradual softening process by incorporating both shear and volumetric plastic strains, unlike traditional models that assume instant failure [12].
    - Therefore, the CCR was assigned HSS constitutive model accounting for nonlinear stress-strain behavior and stiffness degradation at small strains. This is necessary for modeling the buildup of excess pore pressure during undrained loading and capturing the progressive failure of flow liquefaction in the case of an instability during slurry trench excavation.
- The Linear Elastic model [1] was assigned to the competent bedrock Shale unit which is relatively unweathered and competent. This is because the behavior of competent bedrock, unlike that of soils, can be approximated as linear and elastic with minimal plastic deformation under small to moderate stress levels or loading conditions.

The constitutive models required the assignment of additional engineering parameters including, but not limited to, initial void ratio, compressibility information, stiffness parameters, and shear modulus. These parameters were assigned based on a combination of laboratory compressibility data and engineering correlations, where feasible. Where the parameters were not available from the existing laboratory data, default Plaxis parameters were utilized for this concept-level stability analysis.

3.4 Selection of Shear Strength and Unit Weight Parameters

Engineering parameters including Mohr-Coulomb shear strengths (friction angles, effective cohesion, and undrained shear strength) and unit weight were developed by Geosyntec in 2020 [4] (Appendix H.3 of the Construction Permit Application) to support their limit-equilibrium shear strength characterization. The shear strength parameters were based on laboratory and in-situ testing. Ramboll utilized the same shear strength materials for each soil unit Geosyntec utilized for their calculations.

It should be noted that the Geosyntec characterization used anisotropic shear strengths (effective stress friction angle) for cohesive materials, including silt and clay alluvium and silt and clay dike fill, based on differing test results from triaxial compression and direct shear strength testing. For the silt and clay alluvium, Ramboll utilized the direct shear test results as provided in Geosyntec 2020 report, as a simplifying and conservative assumption for this concept-level analysis. Triaxial compression tests results were used for all other materials, which were not indicated to exhibit strength anisotropy.

3.5 Selection of Hydraulic Parameters

Hydraulic parameters including horizontal and vertical hydraulic conductivity were obtained from existing three-dimensional MODFLOW site groundwater modeling performed for the site by Ramboll and Natural Resources Technology, Inc. (NRT) [13, 14] and were supplemented by bedrock investigation data, including packer testing, collected by Ramboll in 2024 (see the Nature and Extent Report, which is Appendix D of the Corrective Action Alternatives Analysis, which is Appendix A of the Corrective Action Plan, which is in turn Appendix G of the Construction Permit Application).

3.6 Summary of Selected Material Parameters

The selected shear strength parameters, elastic parameters, hydraulic parameters, drainage assumptions and constitutive models utilized for the various soil and bedrock materials considered in the slurry trench stability analyses are summarized in **Table 1, 2, 3** and **4** respectively.

Table 1. Strength and Elastic Properties assigned to cross-section A – A' and F – F' for slurry trench stability analyses

Shear Strength and Unit Weight Parameters					Elastic Parameters				
					Section A-A'		Section F-F'		
Soil Material	Total Unit Weight (pcf)	Friction Angle, ϕ' (deg)	Cohesion, c' (psf)	Sources	Young's Modulus, E (ksf)	Poisson Ratio (v)	Young's Modulus, E (ksf)	Poisson Ratio (v)	Sources
CCR	99	33	0	2020 Geosyntec Calculations [4]	31	0.20	31	0.20	Correlations with CPTu data [Attachment A, [4] [15]]
Silt and Clay Dike Fill	115	30	75		1,177	0.25	2,130	0.25	
Sand & Gravel Dike Fill	120	38	0		2,280	0.25	2,300	0.25	
Structural Fill with CCR	125	34	75		Not Present		1,730	0.30	
Silt and Clay Alluvium	110	25	0[3]		Not Applicable	0.25	Not Applicable	0.25	
Sand and Gravel Alluvium	Unsaturated[2]; 115 Saturated[2]: 125	38	0		2,629	0.25	1,860	0.25	
Contouring Fill	102	33	20[4]		400	0.20	400	0.20	
Buttress	125	34	75		2,280	0.30	Not Present		
Weathered Shale (Stiff Clay)	127	30	240	Literature [7, 8] [10]	198	0.20	198	0.20	Literature [10]
Competent Bedrock[1]	156	Assumed liner-elastic due to depth below grade			208,900	0.30	208,900	0.30	Literature [7, 8]

[1]Note: Required input parameters for Linear elastic material behavior are only the Young's Modulus and Poisson Ratio

[2]The 2020 Geosyntec calculations utilized a unit weight of 115 pcf above 20 ft in depth below grade and 125 pct below 20 ft in depth. This was simplified into an unsaturated unit weight of 115 pcf and a saturated unit weight of 125 pcf for this assessment.

[3]Cohesion was conservatively neglected for the Silt and Clay Alluvium material as a simplifying and conservative assumption for this concept-level analysis.

[4]A small amount of cohesion (20 psf) was assumed for the contouring fill material within the model to avoid numerical convergence issues.

Table 2. Hydraulic Properties assigned to cross-section A – A' and F – F' for slurry trench stability analysis

Material Parameters - Hydraulic			
Soil Material	Hydraulic Conductivity Ratio (k_y/k_h)	Horizontal Hydraulic Conductivity (k_h) ft/day	Sources
CCR	1	0.05	Zone 10 in MODFLOW site groundwater model [13]; Contouring Fill assumed to have the same parameters as CCR as it is primarily CCR material
Contouring Fill	1		
Sand & Gravel Dike Fill	1	0.05	Zone 10 in MODFLOW site groundwater model [13]; Assumed the same as CCR and Contouring Fill, as these materials are not included in the MODFLOW model and limited testing data is available for them
Silt and Clay Dike Fill	1	0.05	
Organic Sediments	0.1	1.4	Zone 4 in MODFLOW site groundwater model [13]
Silt and Clay Alluvium	0.1	1.5	Zone 3 in MODFLOW site groundwater model [13]
Sand and Gravel Alluvium	0.5	200	Zone 2 in MODFLOW site groundwater model [13]
Glacial Outwash	0.5	100	Zone 12 in MODFLOW site groundwater model [13]
Weathered Bedrock	0.33	0.10	Testing perfomed by Geosytnec in 2021 at the East Ash Pond [14]
Competent Bedrock	0.33	0.007	Geometric mean value from B100 & B102 in the 2024 Ramboll Packer Test Investigation *(see the Nature and Extent Report, which is Appendix D of the Corrective Action Alternatives Analysis, which is Appendix A of the Corrective Action Plan, which is in turn Appendix G of the Construction Permit Application);* k_y/k_h ratio was conservatively assumed based on Ramboll experience.

Table 3. Constitutive models and input parameters used in Plaxis 2D Numerical Simulations

Soil Material	Constitutive Model Input Parameters										
	Soil Model	Initial void ratio (e_{init})	λ[1]	k[2]	m[3]	ψ[4]	k_0nc[5]	P_{ref}[6] (psf)	R_f[7]	G_0^{ref} [8] (ksf)	$\gamma_{0.7}$[9]
CCR	Hardening Soil small strains (HSs)	0.84	-	-	1.00	0	0.4554	2089	0.90	1,880	0.0001
Silt and Clay Dike Fill	Hardening Soil (HS)	0.50	-	-	0.50	0	0.5000	2089	0.90	-	-
Sand & Gravel Dike Fill	Hardening Soil (HS)	0.50	-	-	0.50	0	0.3840	2089	0.90	-	-
Structural Fill with CCR	Hardening Soil (HS)	0.50	-	-	0.50	0	0.4554	2089	0.90	-	-
Sand and Gravel Alluvium	Hardening Soil (HS)	0.50	-	-	0.50	0	0.3840	2089	0.90	-	-
Contouring Fill	Hardening Soil (HS)	0.50	-	-	1.00	0	0.4550	2089	0.90	-	-
Buttress	Hardening Soil (HS)	0.50	-	-	0.50	0	0.4408	2089	0.90	-	-
Silt and Clay Alluvium	Soft Soil (SS)	1.28	0.05225	0.00686	-	0	0.7339	-	-	-	-
Weathered Shale (Stiff Clay)	Hardening Soil (HS)	0.50	-	-	1.00	0	0.5000	2089	0.90	-	-
Competent Bedrock	Linear Elastic (LE)	0.50	-	-	-	-	-	-	-	-	-

Notes

[1] Modified compression index. Calculated from compressibility parameters provided in Geosyntec report [4], and assumed initial void ratio is 0.50 (default value from Plaxis) for all other materials.

[2] Modified swelling index. Calculated from compressibility parameters provided in Geosyntec report [4].

[3] m is power for stress-level dependency of stiffness, where 1.0 is soft soil and 0.5 is relatively stiff soil [1].

[4] Angle of dilatancy. Materials are assumed to behave in a non-associated flow rule plasticity and $\psi=0$, where $\phi \neq \psi$. Geomaterials can contract or dilate during plastic deformation.

[5] K_o value for normal consolidation, calculated as $1-\sin(\phi)$.

[6] Reference stress for stiffnesses, assumed as 100 kPa per Plaxis default settings.

[7] Failure ratio, assumed as 0.90 per Plaxis default settings.

[8] Small strain shear modulus, used for CCR only due to use of HSs model. Assigned value obtained from Sottile (2024) [15].

[9] Strain level at which the shear modulus has reduced to about 70% of the small strain shear modulus used for CCR only due to use of HSs model. Assigned value obtained from Sottile (2024) [15].

Table 4. Drainage and Elastic parameters used in Plaxis 2D Numerical Simulations

Soil Material	Drainage Assumptions		Elastic Parameters							
			Section A-A'			Section F-F'			Data Sources	Notes
	Drainage during DCW Construction Phase	Undrained Strength, Su (psf)	E_{50}^{ref} [1] (ksf)	E_{oed}^{ref} [2] (ksf)	E_{ur}^{ref} [3] (ksf)	E_{50}^{ref} (ksf)	E_{oed}^{ref} (ksf)	E_{ur}^{ref} (ksf)		
CCR	Undrained	N/A	31	25	274	31	25	274	CPTu data [Attachment A] [4, 15]	Stiffness parameters were estimated based on compressibility parameters from Geosyntec 2020 report [4].
Silt and Clay Dike Fill	Undrained	1,000	1,177	1,177	3,531	2,130	2,130	6,390		Silt and clay dike fill assumed to behave in an undrained manner during DCW construction
Sand & Gravel Dike Fill	Drained	N/A	2,280	2,280	6,840	2,300	2,300	6,900		
Sand and Gravel Alluvium	Drained	N/A	2,629	2,629	7,880	1,860	1,860	5,580		
Contouring Fill	Drained	N/A	400	400	1,200	400	400	1,200		
Structural Fill with CCR	Drained	900	Not Present			1,730	1,730	5,190		Buttress material assumed to behave in an undrained manner during DCW construction.
Buttress	Undrained	900	2,280	2,280	6,840	Not Present				
Silt and Clay Alluvium	Undrained	N/A	N/A			N/A				-
Weathered Shale (Stiff Clay)	Undrained	N/A	198	251	627	198	251	627	Literature [11]	-
Competent Bedrock	Undrained	N/A	208,900	N/A		208,900	N/A		Literature [8, 9]	-

Notes

[1] Secant stiffness in standard drained triaxial test

[2] Tangent stiffness for primary oedometer loading
[3] Unloading/reloading stiffness (by default $E_{ur}^{ref} = 3E_{50}^{ref}$)
N/A – Not Applicable

4 Analysis Parameters and Boundary Conditions

4.1 Analysis Geometry and Groundwater Conditions

The geometry and dimensions for both cross-sections A-A' and F–F' that were utilized in the PLAXIS 2D model were developed based on limit-equilibrium SLIDE stability analyses performed by Geosyntec in 2020 [4]. Additional information about how each cross-section was developed, including the subsurface layering and source data, is provided in the 2020 Geosyntec calculations (see Appendix H.3 of the Construction Permit Application). The cross-sections were modified by Ramboll for use in this assessment by adding in weathered and competent bedrock, at elevations determined from the 2024 Ramboll field investigations (see the Nature and Extent Report, which is Appendix D of the Corrective Action Alternatives Analysis, which is Appendix A of the Corrective Action Plan, which is in turn Appendix G of the Construction Permit Application of the Corrective Action Plan). These material layers were added beneath the Sand and Gravel Alluvium soil layer assigned by Geosyntec and included a top elevation of 374.3 feet for the weathered bedrock and 364.5 feet for the competent bedrock. The bottom of the model was extended to El. 350 feet, thereby considering a total thickness of 14.5 feet of competent bedrock. The groundwater elevations utilized during the assessment were assumed to be El. 447 ft, which is the upper-normal assumption made by Geosyntec for their SLIDE stability analyses.

4.2 Conversion of 2D Limit Equilibrium Analysis to 2D Plaxis Analysis

The model geometry for Cross-sections A – A' and F – F' were scaled into PLAXIS 2D from the Geosyntec analyses. This process included assigning all ground surface elevations, subsurface layering, and other model features to the same locations and elevations used by the 2020 Geosyntec analyses.

4.3 Boundary Conditions

The boundary conditions of the slurry trench stability analyses (2D models) were assigned as follows:

- The horizontal bottom of model was assigned fixed displacement constraint where zero horizontal and vertical movements in x, and y directions were applied, thereby representing no movements in the deep competent shale bedrock
- The left and right vertical sides of the model were assigned as “rollers” where the model can move in y directions respectively, thereby allowing for settlement of the model.

Figures 1 and **2** illustrate the boundary conditions and model setup, for cross-sections A-A' and F-F', respectively.

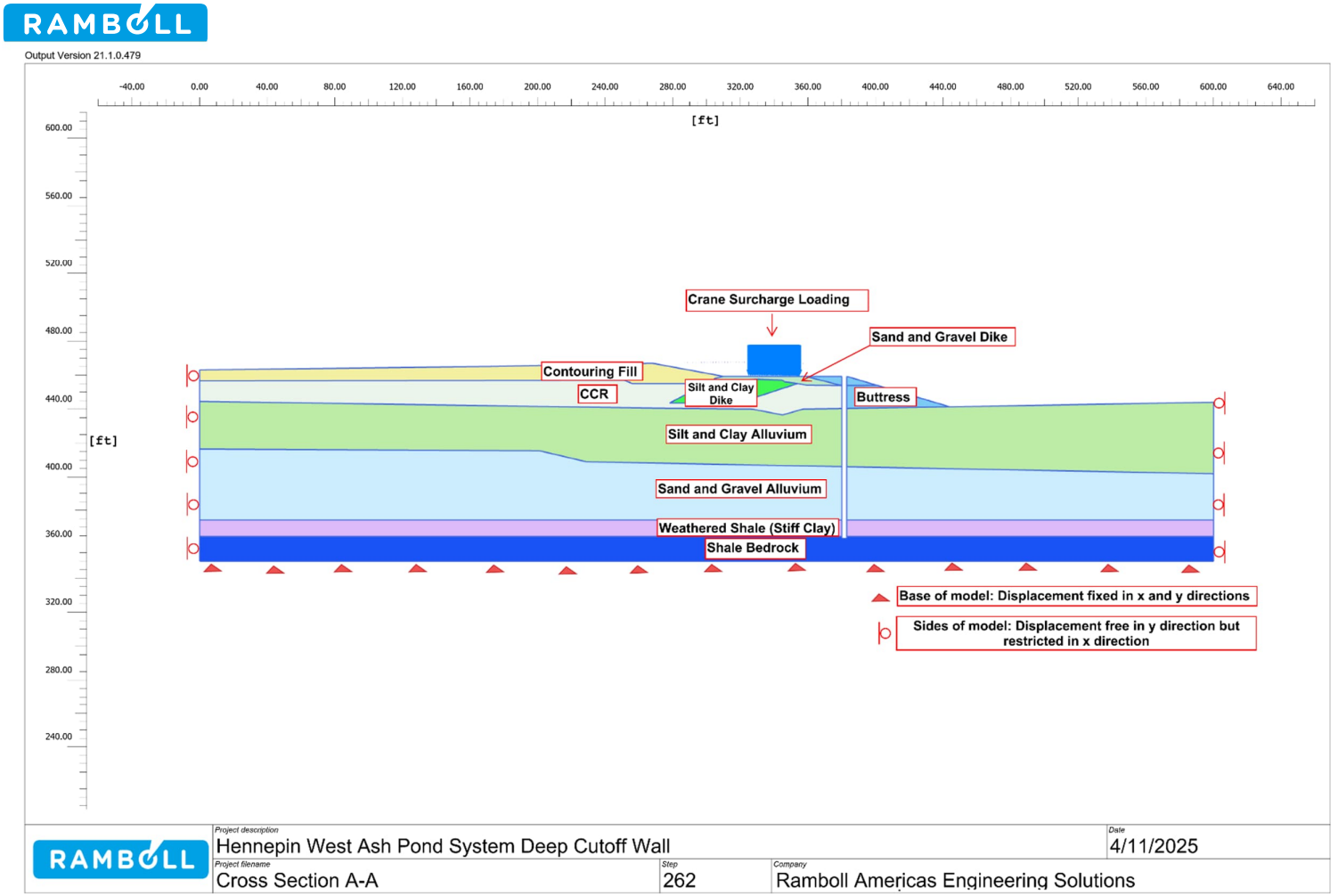

Figure 1. Numerical Model setup and boundary conditions for cross-section A-A'

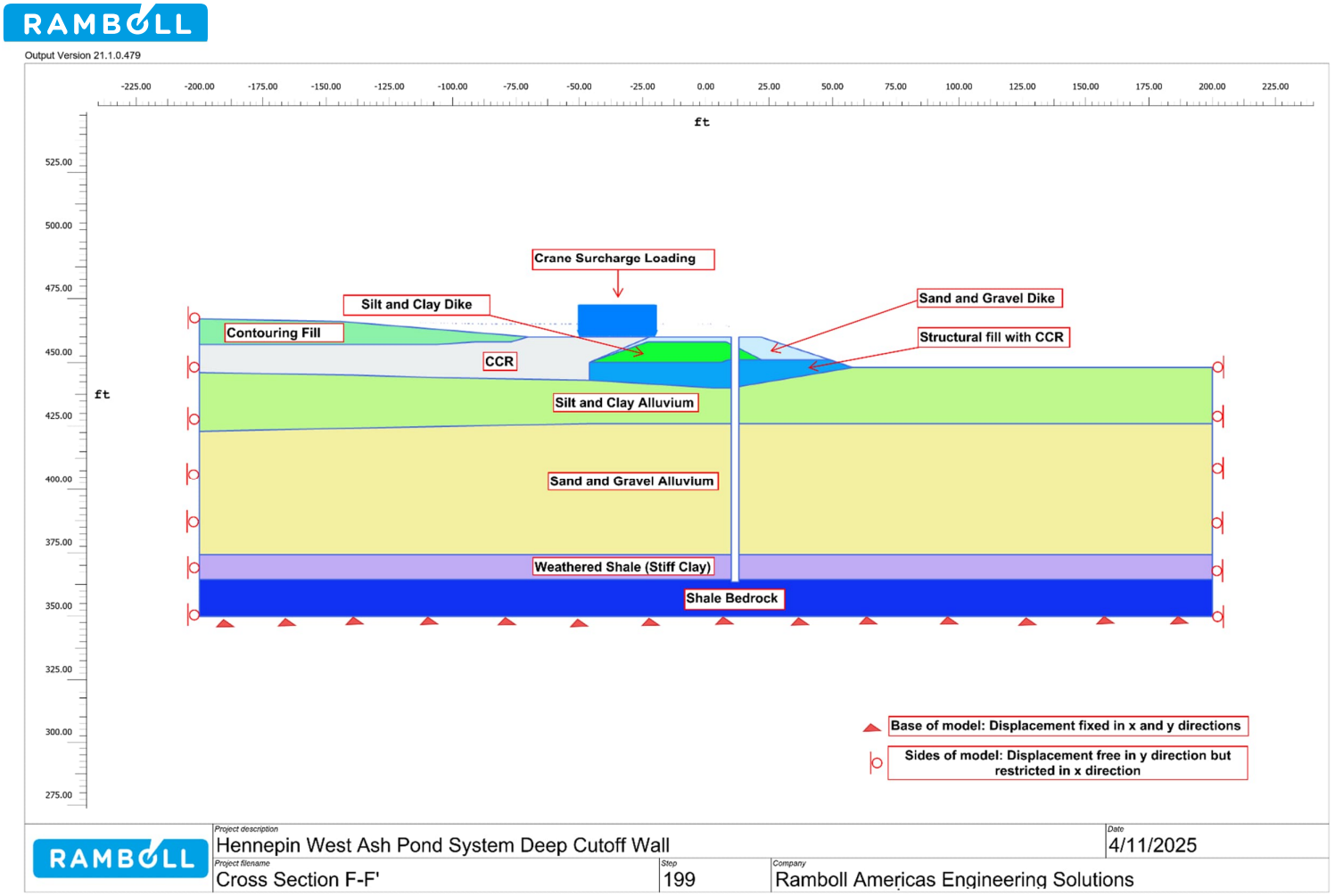

Figure 2. Numerical Model setup and boundary conditions for cross-section F-F'

4.4 Crane and Slurry Loading Surcharges

The crane used to install the slurry DCW was assumed to be a 110-ton unit (Manitowoc 11000, per the specification sheet in **Attachment B** to this calculation package), with a total working weight of approximately 198,5000 pounds, along with an additional 30,000 lbs of DCW installation equipment attached to the crane. The crane was assumed to be placed on rigid crane pads (i.e., heavy timbers) with a 30 ft footprint (in-plane of 2D model), resulting in a surcharge load of approximately 254 pounds per square foot per foot out of plane that was uniformly applied in Plaxis 2D. The crane mat was assumed to be positioned 25 feet inside of the inner edge of the slurry trench.

Slurry loading surcharge application began with the trench excavation phase. The slurry was modeled as a hydrostatic fluid surcharge (i.e., zero shear-strength), where it was represented as a hydrostatic pressure of the cement-bentonite slurry with a unit weight of 68 pounds per cubic foot (pcf), which was assigned based on Ramboll's experience. The hydrostatic fluid surcharge was applied to the trench sides and the bottom of the trench. The hydrostatic pressure was calculated based on the slurry unit weight and the height difference between the assumed working pad ground surface (460 ft elevation for cross section F – F' and 459.2 ft for cross section A – A') and the bottom elevation of the slurry trench. The model settings were also adjusted to verify that only the hydrostatic slurry pressure (i.e., 68 pcf) was applied in the trench, rather than applying both the hydrostatic slurry pressure and groundwater pressure (i.e., 62.4 pcf).

4.5 Model Stages

The staged construction process of the slurry trench DCW stability analysis in PLAXIS 2D followed a systematic sequence to simulate the stress-history of the WAPS embankments and CCR, starting prior to their construction and ending at the excavation and backfill process. This process included the following stages:

- **Stage 1: Prior to WAPS Construction**: This stage corresponds to site conditions prior to the construction of the WAPS. The geostatic stress state is established using the k_o-procedure, and groundwater conditions are set. This initial stage is based on the assumption that the initial stresses in a soil body are influenced by the weight of the soil, the water conditions and the history of its formation. All materials were assumed drained in this stage.
- **Stage 2: WAPS Initial Construction:** This stage represents the initial construction of the WAPS, which occurred in the 1950s and 1960s. It includes the corresponding stress changes, consolidation, and deformations induced in the foundation materials by these activities. The consolidation theory used follows Biot [16], Darcy's law for fluid flow [17] and elastic behavior of the soil skeleton are also assumed. This approach analyzes the fully coupled fluid and deformation without additional loading until all excess pore pressures have decreased or dissipated. It was assigned by activating elements of the CCR and dikes for a 20-year consolidation duration (as a simplifying assumption). All materials were assumed drained in this stage.
- **Stage 3: WAPS Dike Raise:** This stage is similar to Stage 2 represents the raise of the splitter dike between the former Old West Ash Pond and the former Old West Polishing Pond. It includes activating the dike raise and allowing a 20-year consolidation duration (as a simplifying assumption). All materials were assumed drained in this stage.
- **Stage 4: WAPS Closure:** This stage is similar to Stages 2 and 3 and represents closure of the WAPS, placement of contouring fill, and construction of a buttress between the Old West Ash Pond

and Old West Polishing Pond. It includes activating these materials and allowing a 10 year consolidation duration. Since the closure was completed in 2020, this assumes that the next stage will start around 2030. All materials were assumed drained in this stage.

- **Stage 5: Working Platform Construction:** This phase is 30 days of work pad excavation prior to slurry trench excavation. The weathered and competent shale bedrock, silt and clay alluvium, silt and clay dike fill, and buttress materials were assumed undrained for this stage. All other materials were assumed to be drained.
- **Stage 6: Deep Cutoff Wall Construction**: This stage represents placement of the crane, excavation of the slurry trench (after 30 days of work pad excavation), and concurrent backfill with a bentonite slurry. The excavation duration was set to 7-day period assuming, representing the period that the bentonite was assumed behave in a low-stress manner prior to initial curing and strength gain. Stress changes and DCW performance are monitored through plastic analysis and safety analysis conducted to assess potential failure modes. Material drainage assumptions were the same as Stage 5.

5 Design Criteria and Analysis Results

5.1 Design Criteria

Minimum safety factors for CCR surface impoundments are provided in 35 Illinois Administrative Code (I.A.C.) Part § 845.460(a) (Part 845) [18]. However, Part 845 does not specify minimum safety factors for temporary loading conditions applied to existing CCR surface impoundment dikes, like DCW construction. However, Part 845 does provide minimum safety factors for end-of-construction conditions for new CCR surface impoundment dikes. This is a different type of temporary loading condition that corresponds to the stability of a CCR impoundment dike immediately after construction, and typically utilized undrained shear strengths in applicable soil materials. The minimum safety factor required for this loading condition by Part 845 is 1.30.

The minimum safety factor for temporary DCW construction was assumed to be 1.30, in the absence of a specific regulatory guidance for temporary loading conditions for existing CCR surface impoundments. This is because the end-of-construction loading condition described in temporary loading conditions, the minimum end-of-construction safety factor for a new CCR surface impoundment was utilized for this assessment. This is because the 845.460(a) end-of-construction loading conditions also represents a temporary condition.

5.2 Safety Factor Assessment Results

The results of each of the evaluated cross sections slurry trench stability analyses is presented in **Table 5**. The factor of safety (FOS) was computed using the shear strength reduction method in Plaxis 2D [1], where shear strength parameters frictional angle and cohesion are successively reduced until excessive deformations occur, which are indicative of failure (i.e., a limit state). Safety factors were estimated for both pre-construction conditions and conditions after the slurry trench have been installed. Detailed results output from Plaxis 2D is provided in **Attachment D** to this calculation package for each of the evaluated cross sections.

5.3 Deformation and Strain Assessment Results

All deformations are presented as phase displacements from the Plaxis 2D [1] output. Phase deformations represent displacement changes occurring between the end of the previous phase and the end of the current phase. For this assessment, the phase deformations represent deformations between the WAPS construction

phase and the trench excavation phase, or deformations that are expected to occur during placement of the crane and construction of the deep cutoff wall. The output was displayed as phase displacement (|Pu|), which illustrates the magnitude of movement in that calculated phase, and as individual displacement components (Pu_x and Pu_y), which separately represent the horizontal and vertical displacements computed in that phase or calculation step.

Similarly, phase strains were also exported to provide an assessment of accumulated strain increments in the whole calculation phase, relative to the preceding calculation phase. As with the deformation assessment, this corresponds to strains between the end of the WAPS construction phase and the trench excavation phase, or strains that are expected to occur during placement of the crane and construction of the deep cutoff wall. The output was presented as deviatoric strain ($P\varepsilon_q$), which corresponds to shear deformation and was used to identify potential zones of concentrated shear strain, which could be indicative of failure zones.

Table 6 provides a summary of the estimated phase deformations and deviatoric strains during trench construction. The results are presented in terms of maximum vertical deformation of the crane pad (i.e., settlement), maximum deformation of the soil mass into the slurry trench, and maximum deviatoric strains within the soil mass. Detailed results output, with annotations indicating deformations and strains, are provided in **Attachment D** of this calculation package.

Table 5. Factor of Safety results of slurry trench stability analyses

Calculated Factor of Safety				
Cross-Section	Safety Factor Before Trench Excavation	Safety Factor After Trench Excavation	Minimum Allowable Safety Factor per 845.460(a)	Meets / Does Not Meet 845.460(a) Criteria
A-A'	1.88	1.33	1.30	Meets
F-F'	1.77	1.30		Meets

Table 6. Deformation and deviatoric strain results after slurry trench stability analyses

Estimated Deformations							Estimated Deviatoric Strain			
Cross Section	Crane Pad Side of DCW				Outer Dike Side of DCW		Crane Pad Side of DCW		Outer Dike Side of DCW	
	Max. Vertical crane pad deformations (i.e., settlement)[1]		Max. Horizontal deformation of the slurry trench sidewall[2]		Max. Horizontal deformation of slurry trench sidewall[2]		Max. Localized deviatoric strain along trench sidewall		Max. Localized deviatoric strain along slurry trench sidewall	
	ft	in	ft	in	ft	in	unitless	%	unitless	%
A - A'	0.16	1.9	0.16	1.9	0.08	1.0	0.02	2	0	0
F- F'	0.08	1.0	0.08	1.0	0.04	0.5	0.024	2.4	0.012	1.2

Notes

1. Positive vertical deformation represents settlement (i.e., moving downward in elevation).
2. Positive horizontal deformation represents horizontal displacements of the trench sidewall into the slurry trench.

6 Conclusions and Recommendations

The preliminary, concept-level stability analysis indicates that safety factors during trench construction are expected to meet or exceed the minimum 1.30 requirements listed in 845.460(a) [18]. During construction, predicted deformations of the crane pad are expected to be on the order of 1 to 2 inches of settlement, while deformation of the trench sidewalls into the trench are expected to be on the order of 1 to 2 inches. These deformations are relatively minor and are not expected to result in structural distress of the crane pad or the WAPS embankments. Furthermore, the estimated deviatoric strains around the order of 1 to 2% occur in localized areas at the bottom of the excavated trench and at material interfaces near the bottom of the trench.

Additional investigation and analysis should be performed during final design of the DCW, after a construction permit has been issued, to further refine the assessment. This should include collecting additional subsurface data along the DCW alignment to refine the input parameters for the numerical models. The analysis should also be updated based on the actual expected slurry densities, crane weight and geometry, and final crane pad details. This may include analyzing additional cross-sections beyond the two cross-sections presented herein. The analyses should retain the same design criteria of providing a safety factor of at least 1.30 while limiting expected deformations and induced strains to tolerable levels that are unlikely to result in significant distress to either the crane pad or the WPAS embankments. Three-dimensional analyses could also be warranted to consider three-dimensional stabilization effects that are neglected by the conservative two-dimensional analysis, which would be expected to reduce estimated deformations and shear strains, while increasing calculated safety factors above values presented in this calculation package.

Additionally, a geotechnical instrumentations system should be developed to monitor the crane pad and slurry trench during DCW construction. The instrumentation system may include instruments such as piezometers, inclinometers, and settlement measurement devices. During construction, the system should be monitored at near-continuous intervals, and actual embankment and slurry trench performance should be compared to expected performance obtained from the refined stability analyses completed as part of final design. Threshold levels should be developed to trigger additional investigation and/or work stoppages in the event that instrument readings and/or other observations indicate signs of adverse embankment and/or slurry trench performance.

7 References

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8 Attachments

Attachment A – CPTu Interpretation
Attachment B – Crane Loading
Attachment C – Analysis Results

Attachment A

CPT Interpretation

RAMBOLL

CONETEC

AECOM

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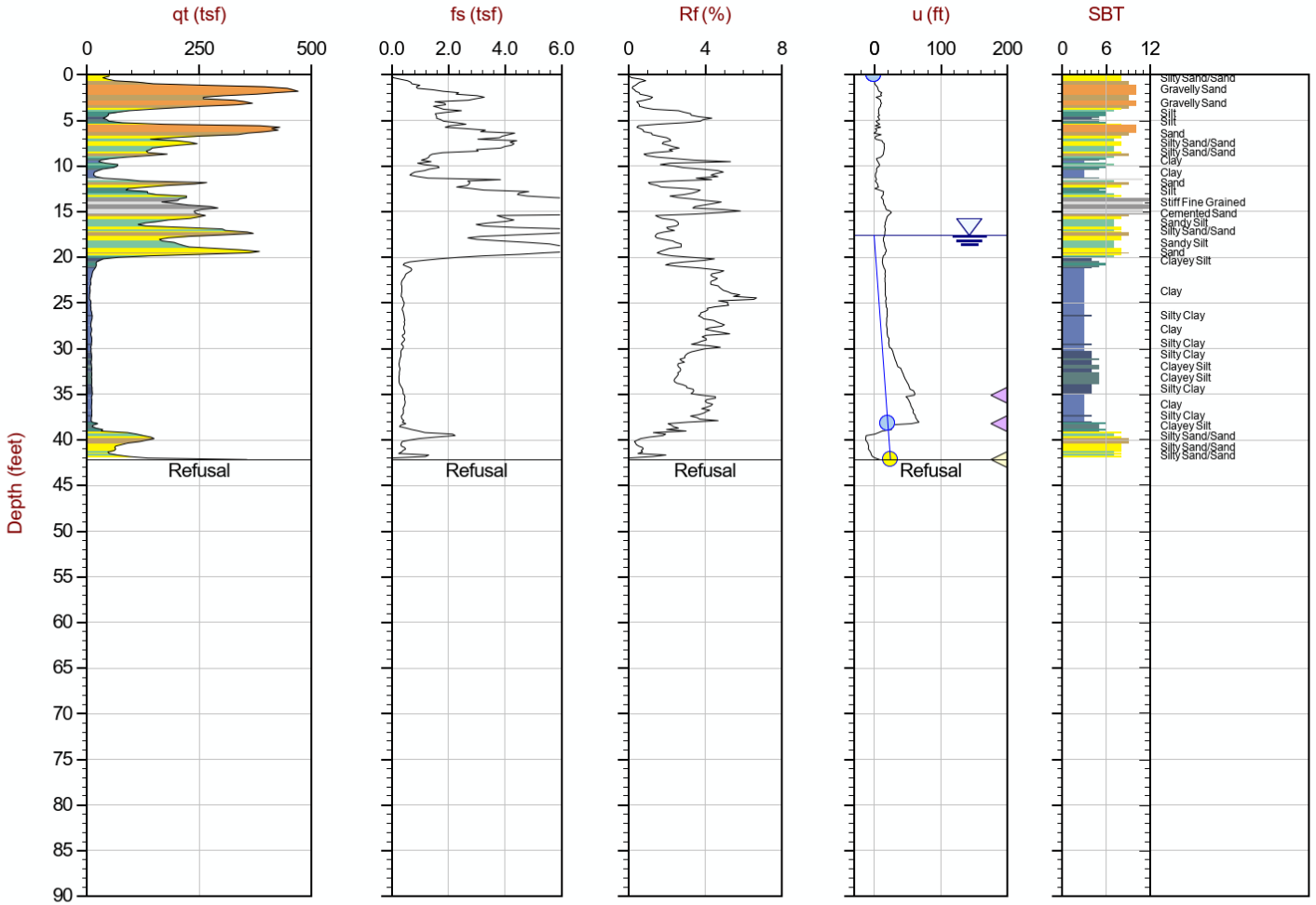

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Avg Int: Every Point

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SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574593m E: 305262m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

RAMBOLL

CONETEC

AECOM

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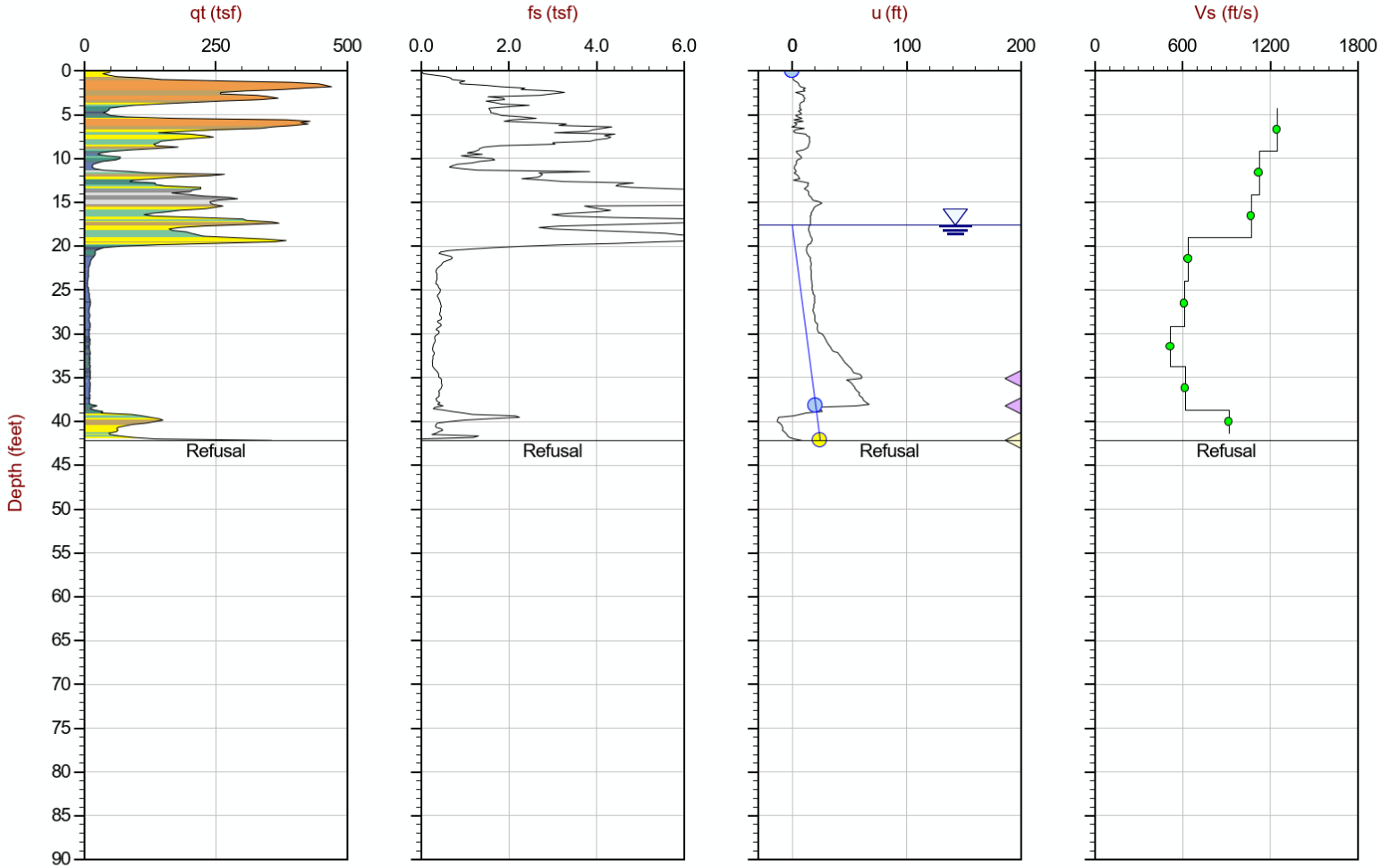

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Coords: UTM Zone 16 N: 4574593m E: 305262m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

RAMBOLL

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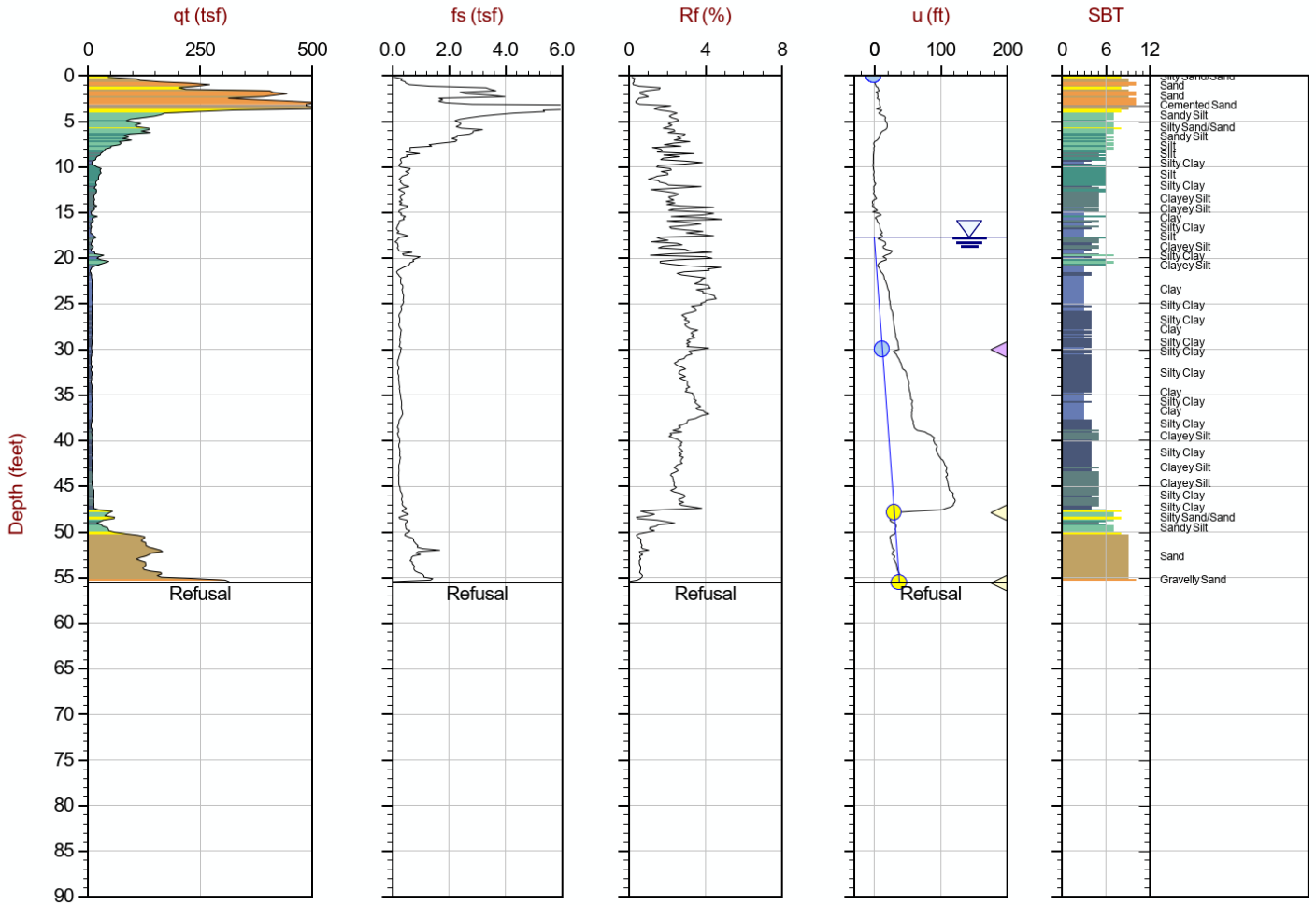

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SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574662m E: 305168m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Note: qt, fs and u data were extracted from the pdf reports generated by AECOM 2016 on CPTu sounding. These extracted data were then processed as input parameters to the CPET-IT software for interpretation and the generated reports that follow below.

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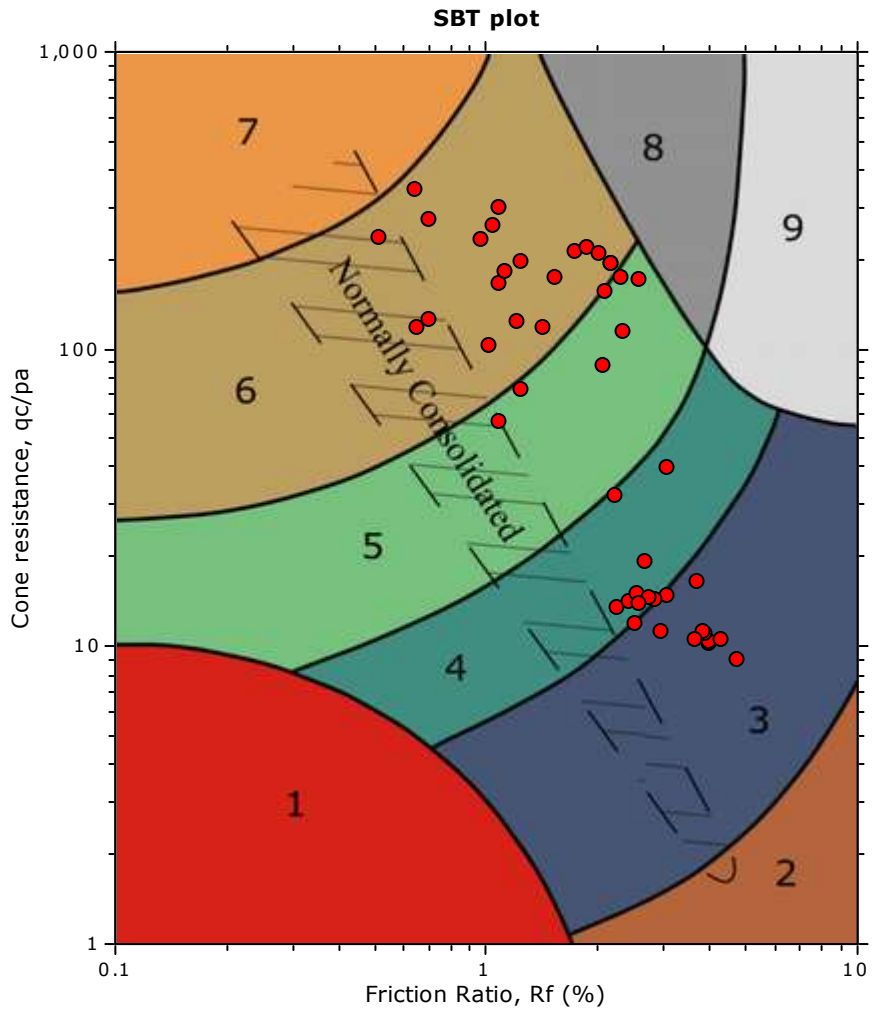
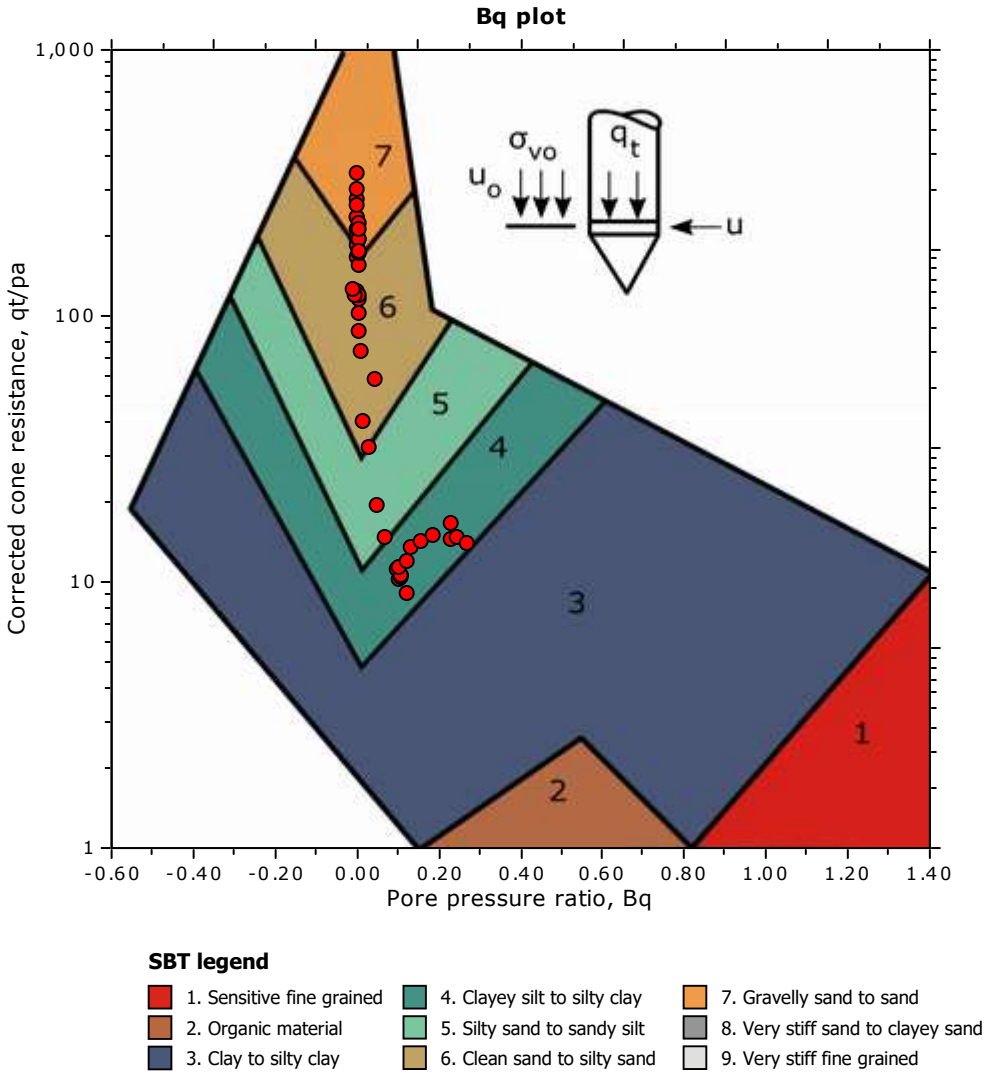
CPT: Sheet1
Total depth: 42.01 ft, Date: 3/17/2025
Surface Elevation: 0.00 ft
Coords: UTM Zone 16N
4574593mE
305262m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC010
Location: Hennepin Powr Station, Hennepin, IL

SBT - Bq plots

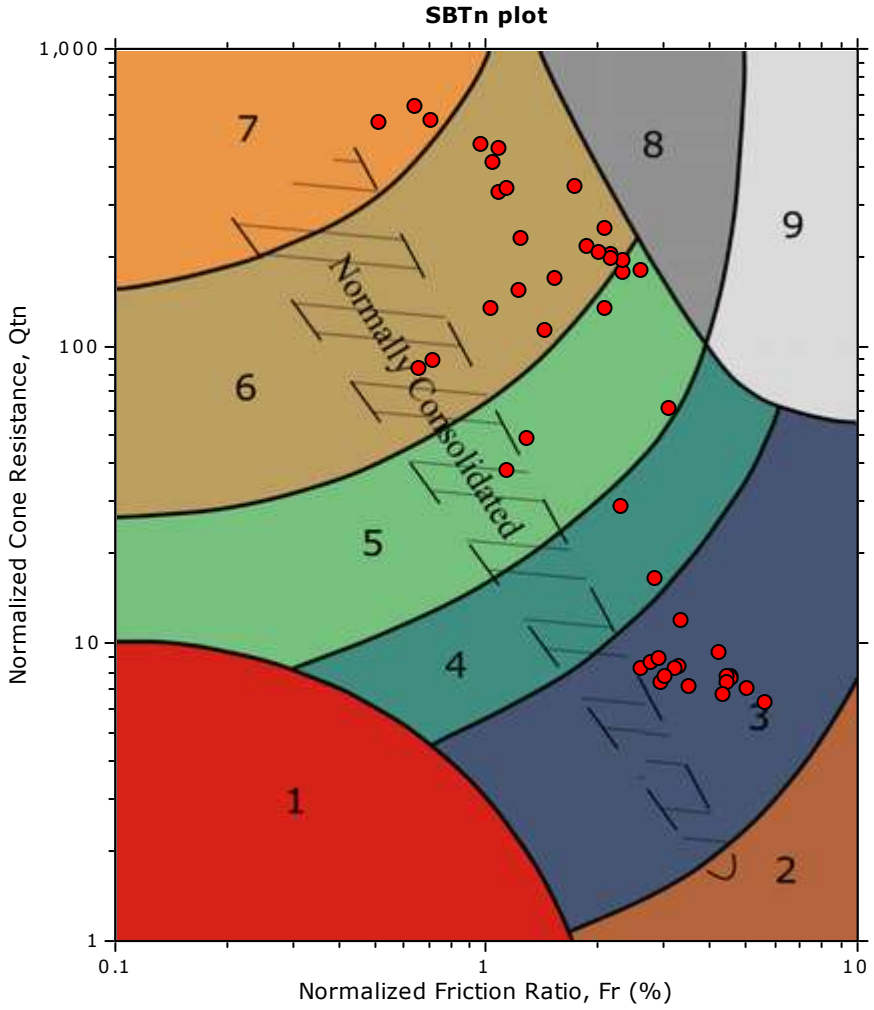


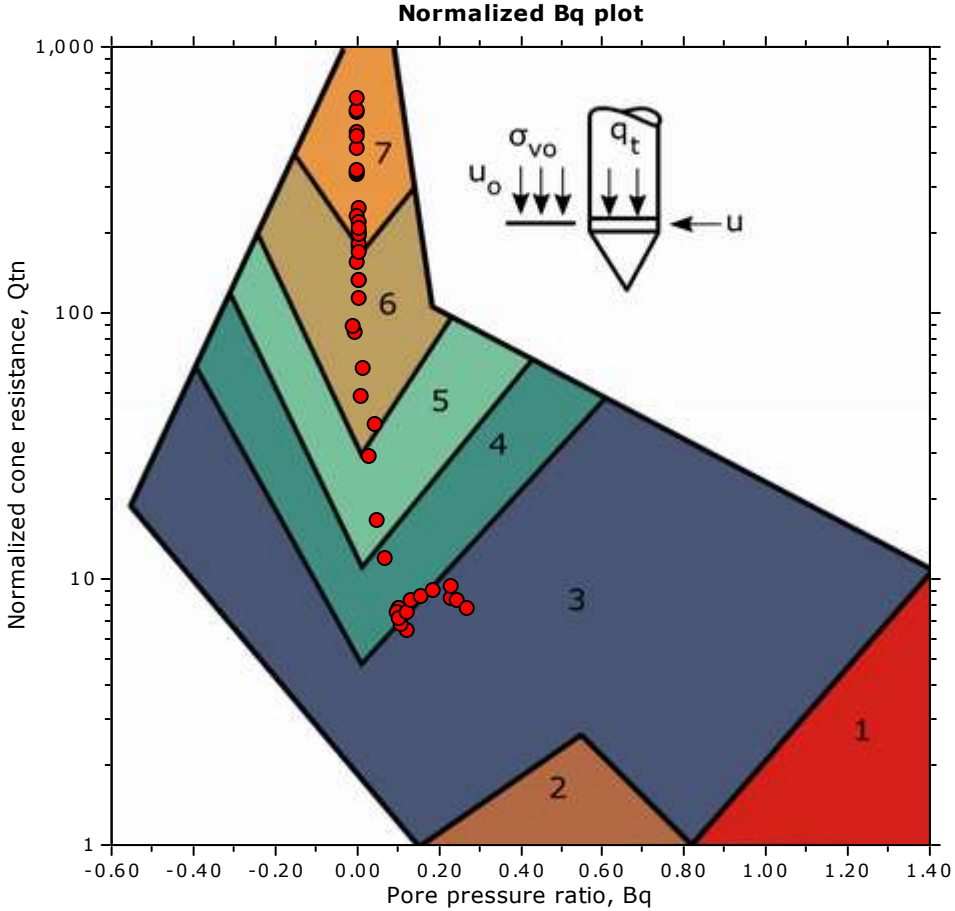


SBT legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

SBT - Bq plots (normalized)

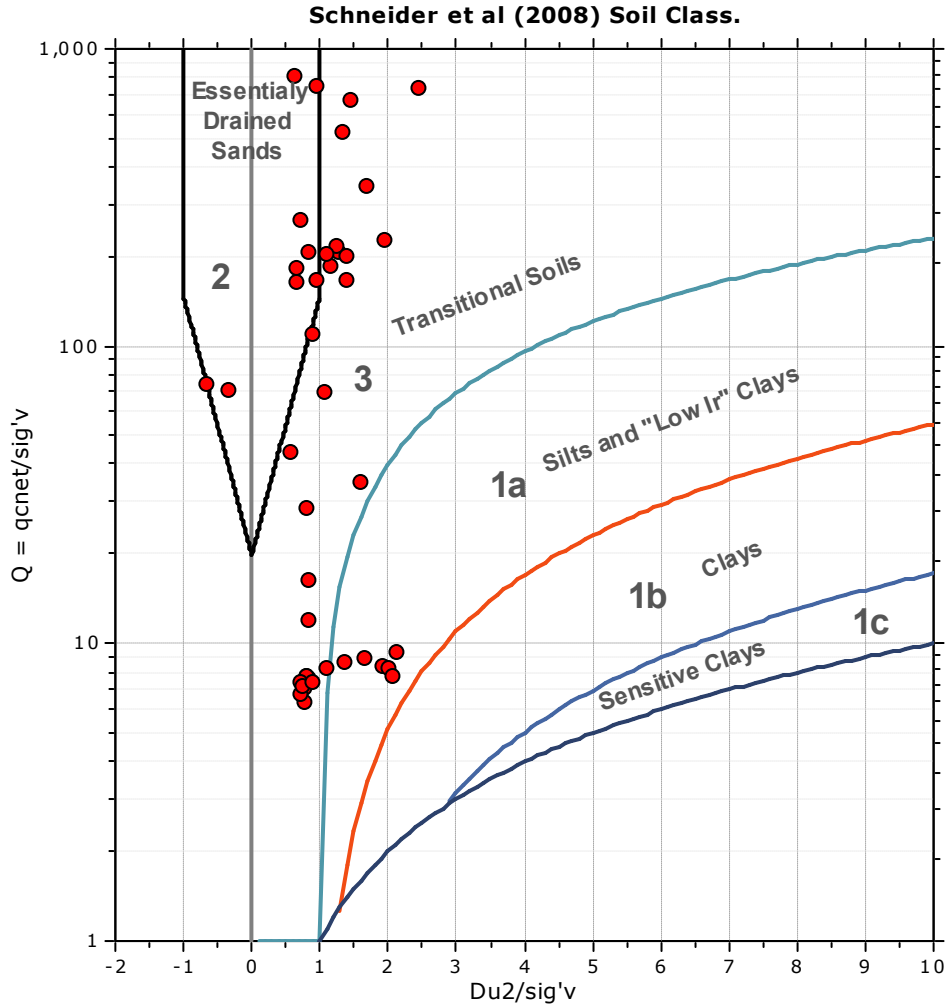


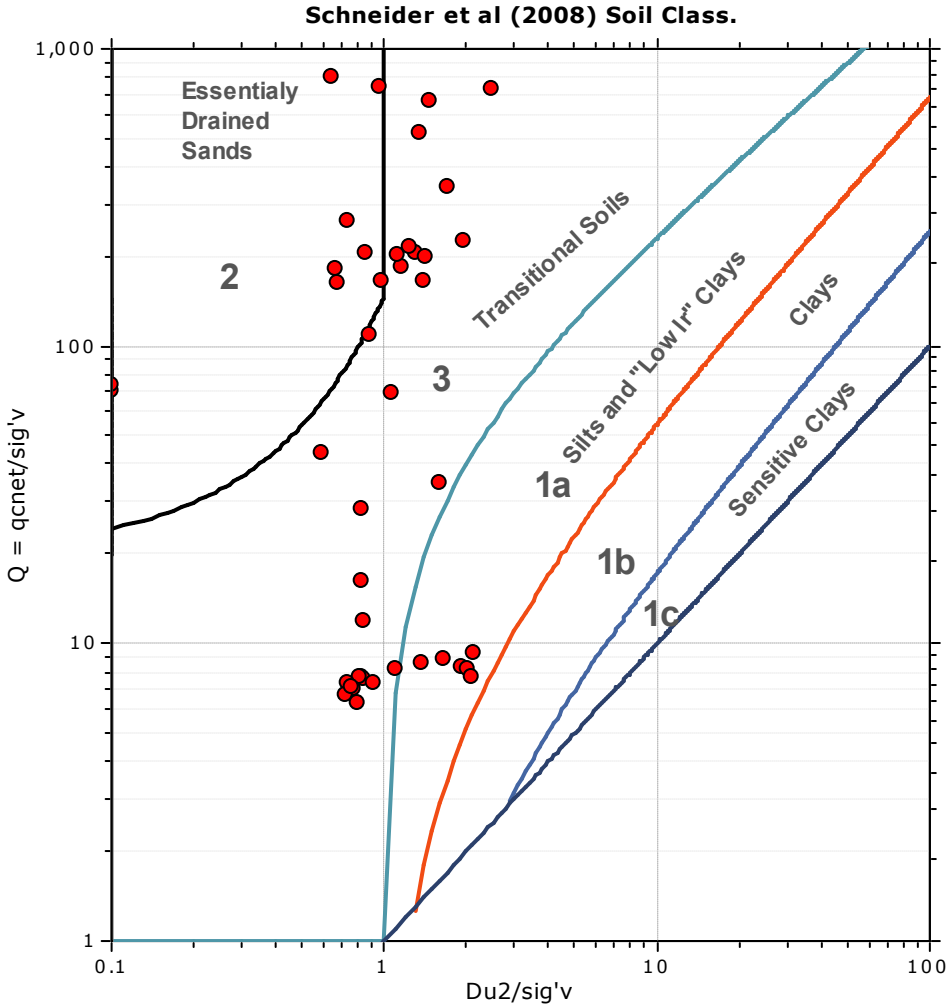


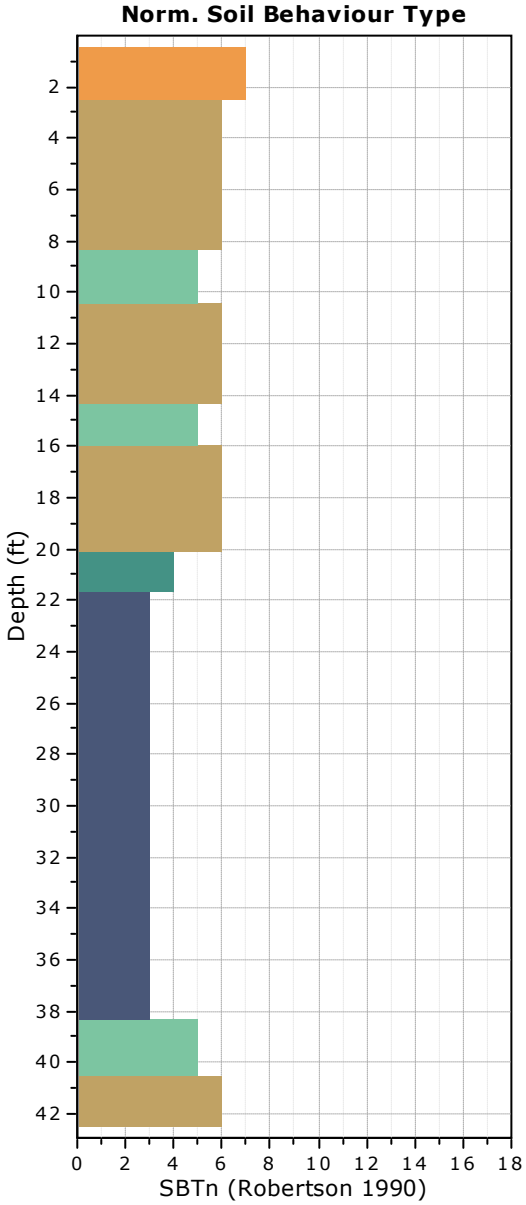
SBTn legend

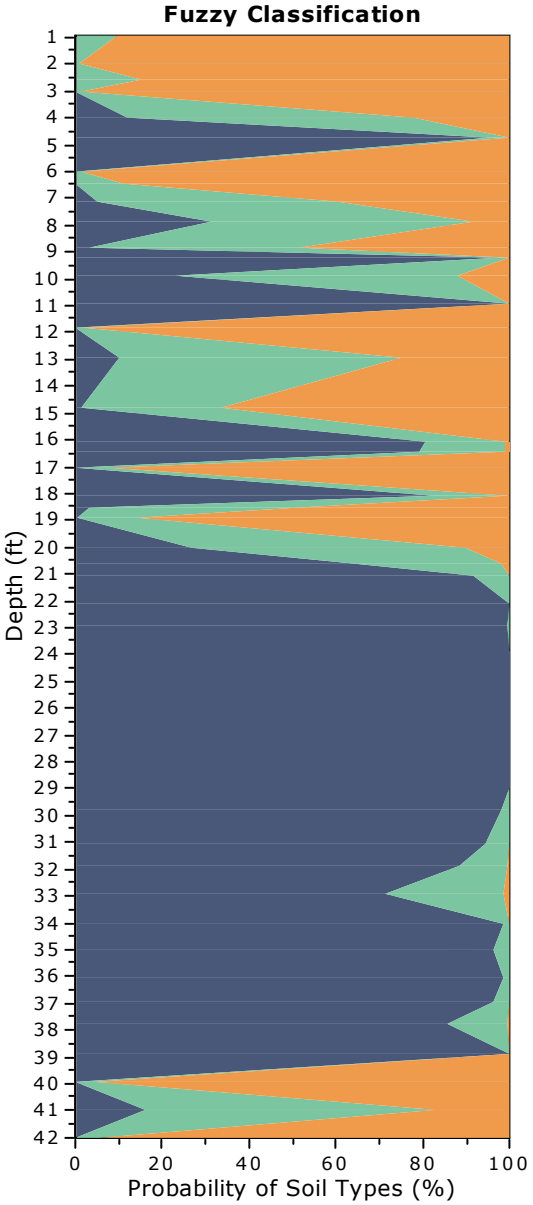
1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Bq plots (Schneider)









Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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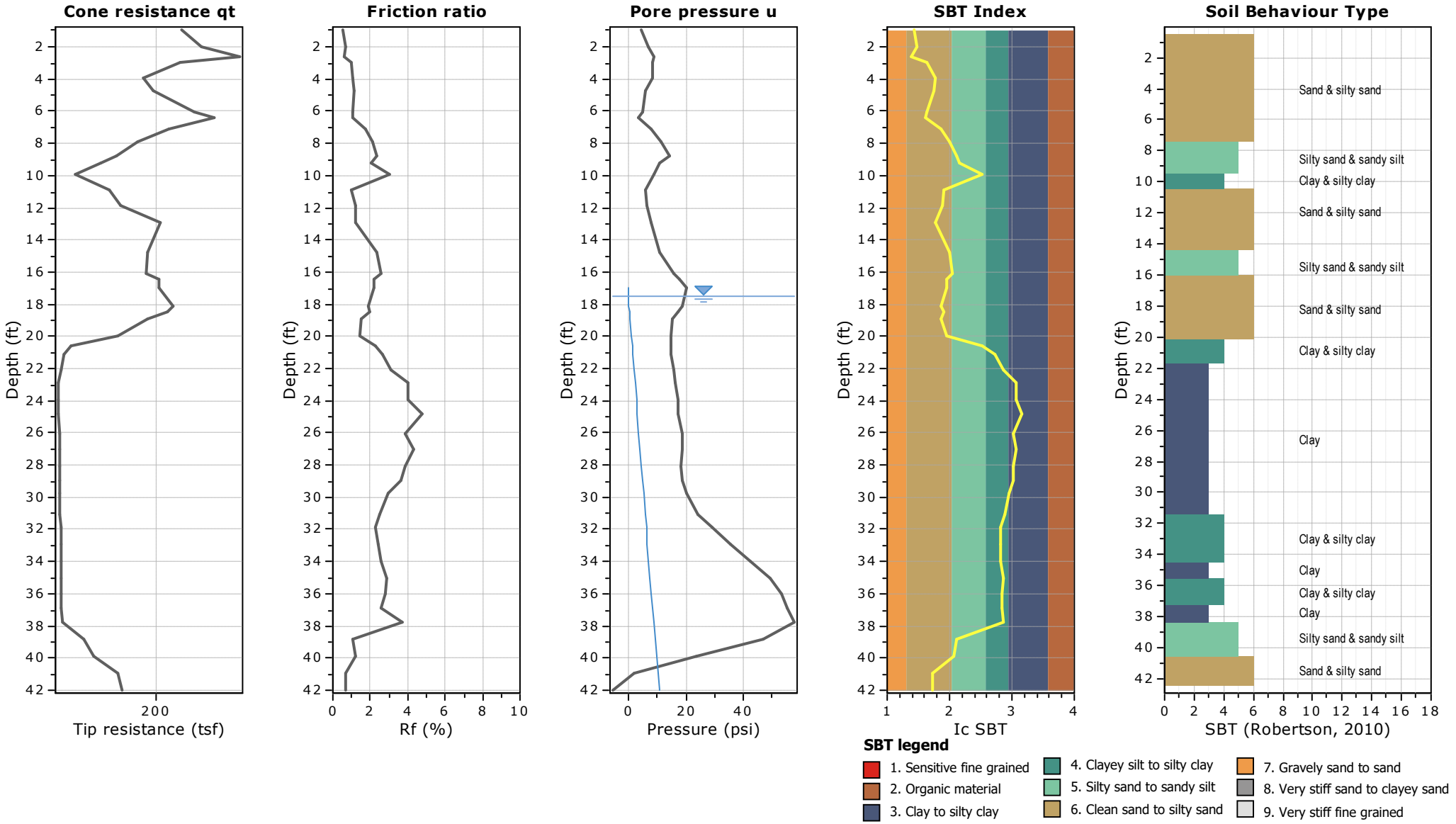
CPT: Sheet1
Total depth: 42.01 ft, Date: 3/17/2025
Surface Elevation: 0.00 ft
Coords: UTM Zone 16N
4574662mE
305168m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL



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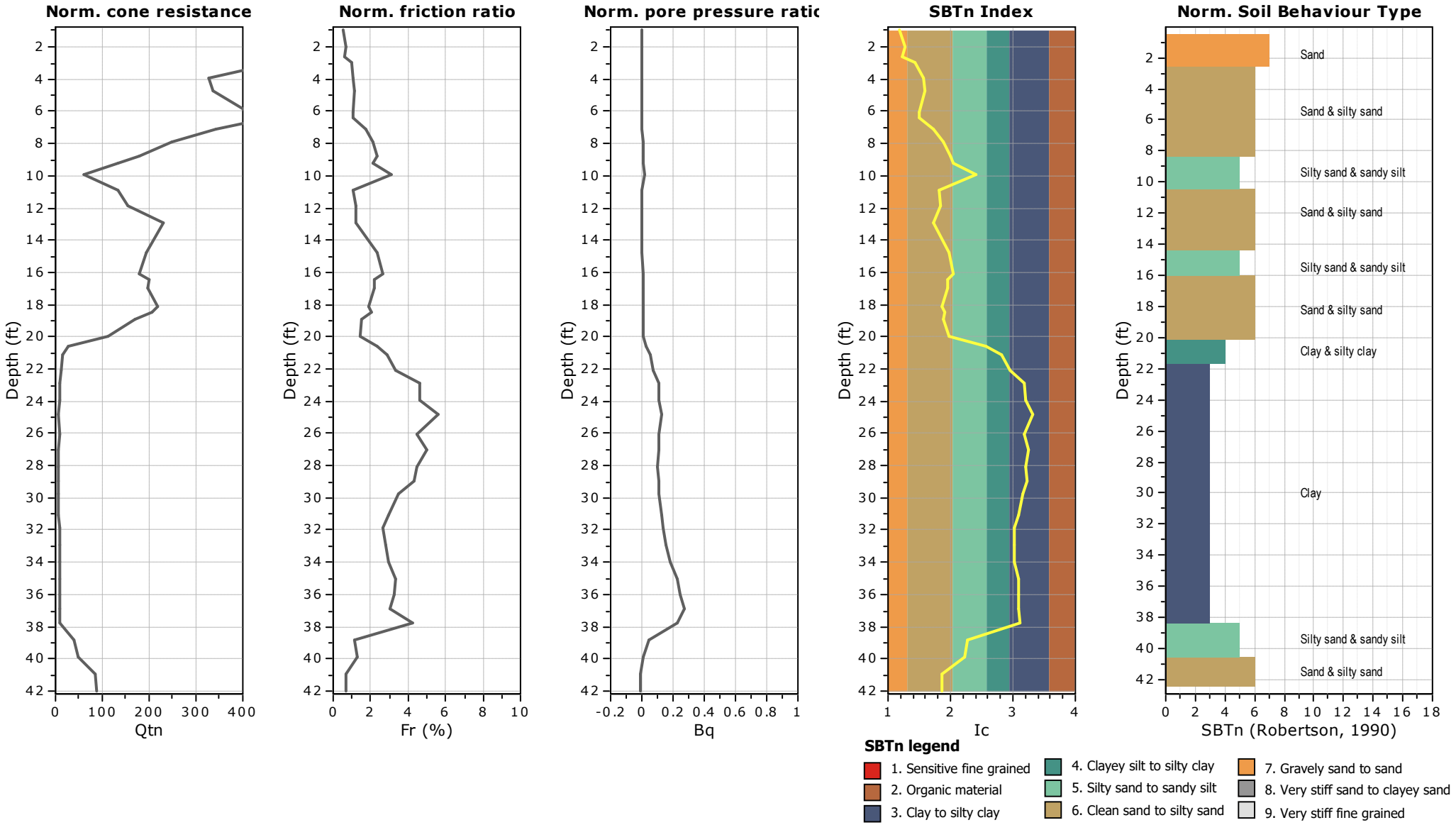

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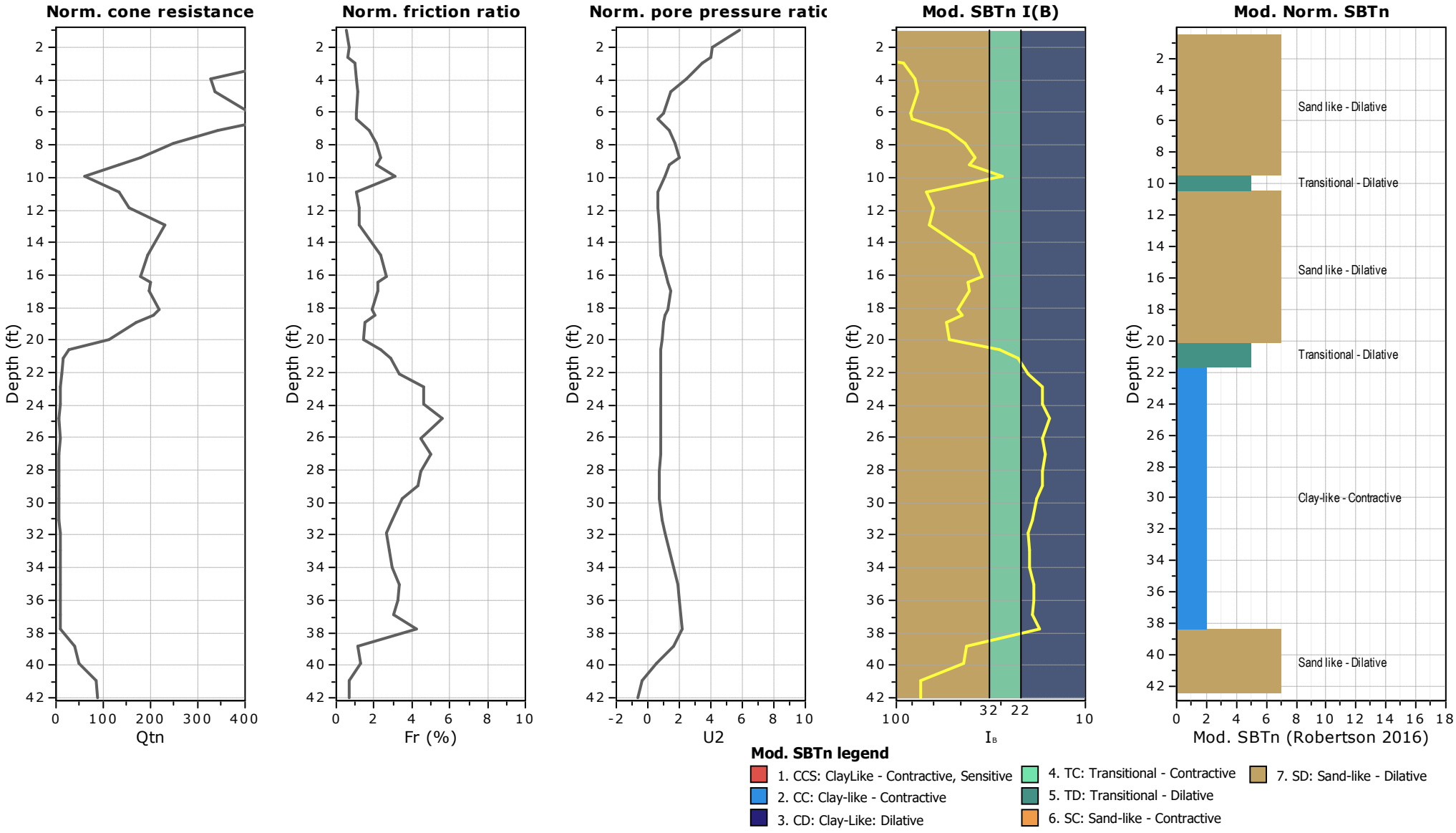

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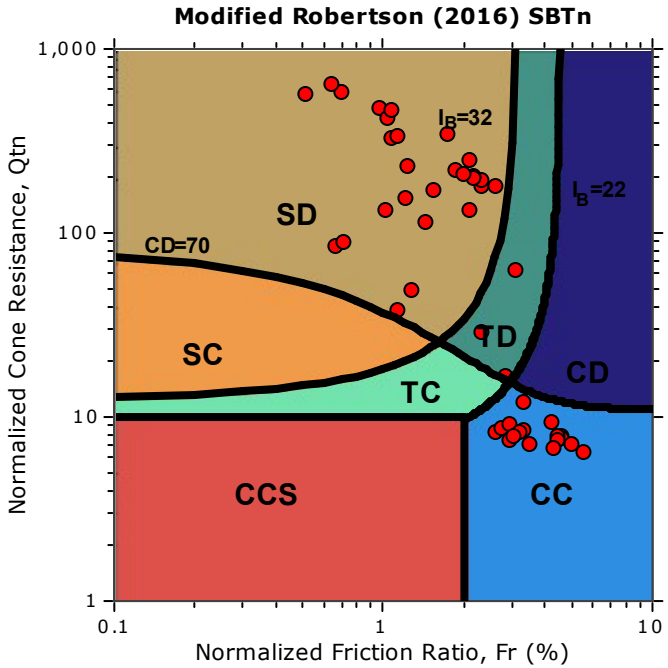
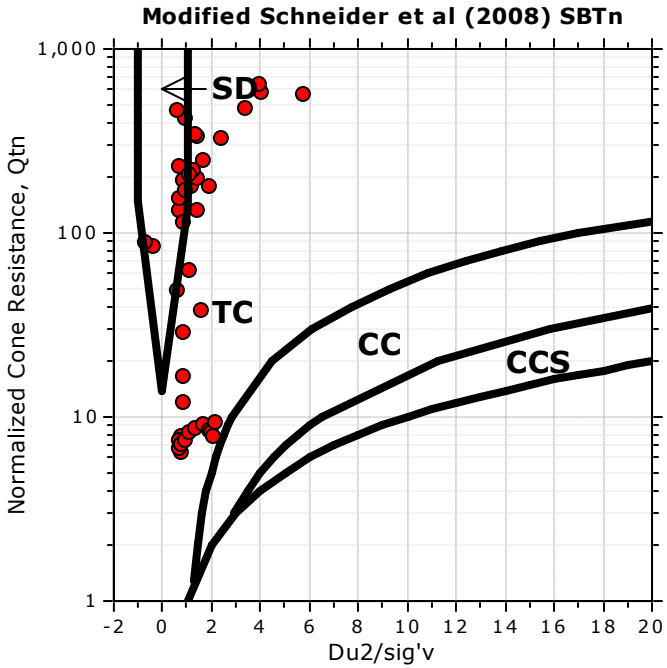
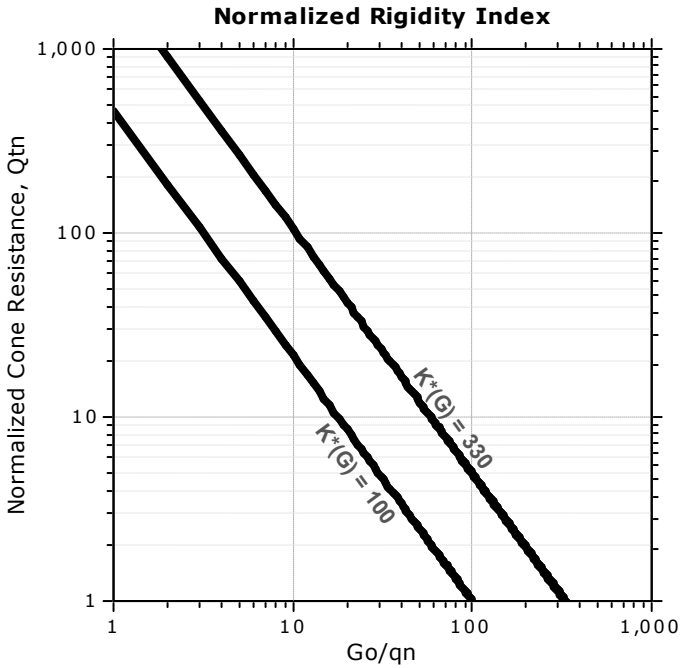
Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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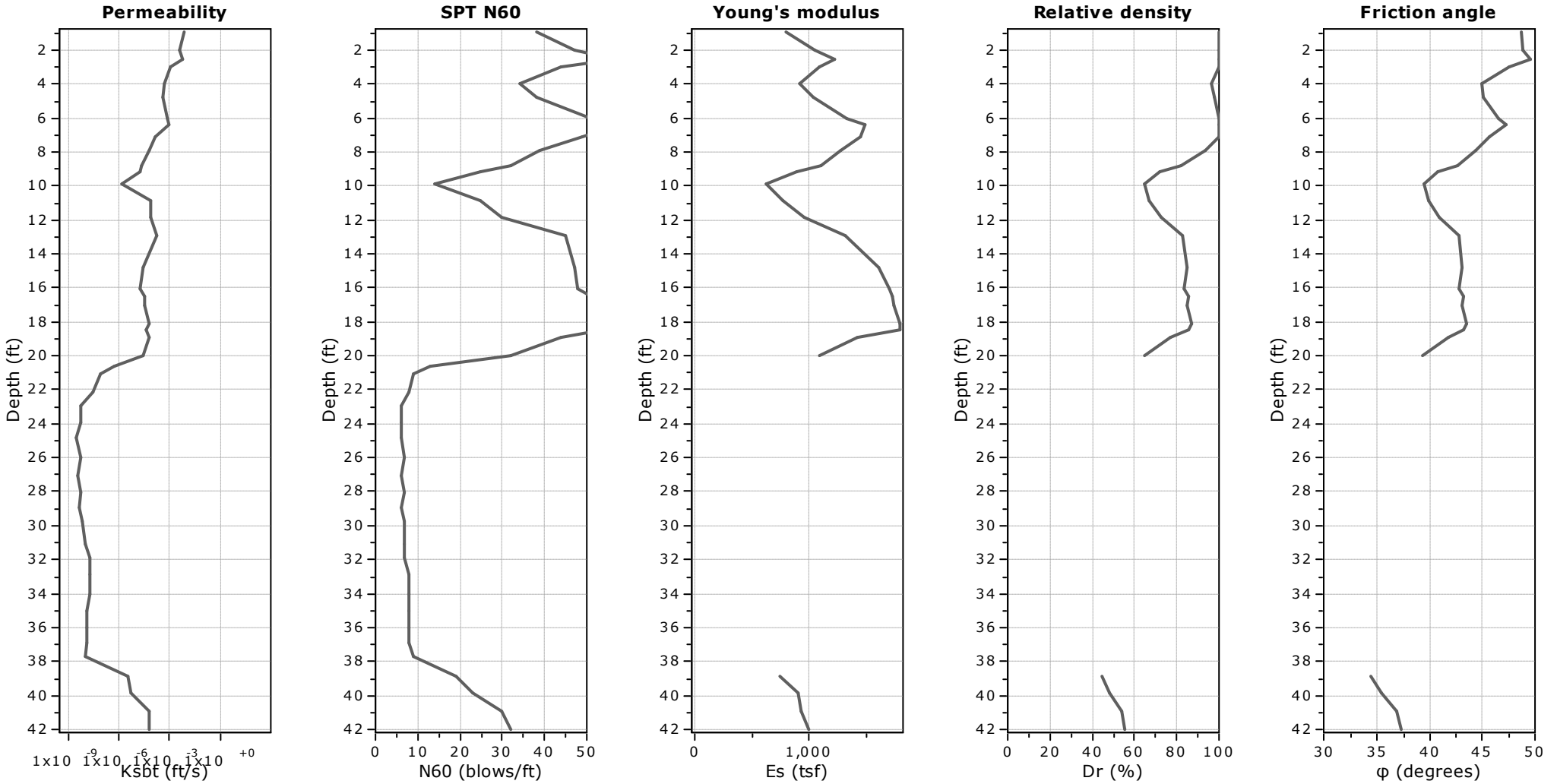
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL



Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)

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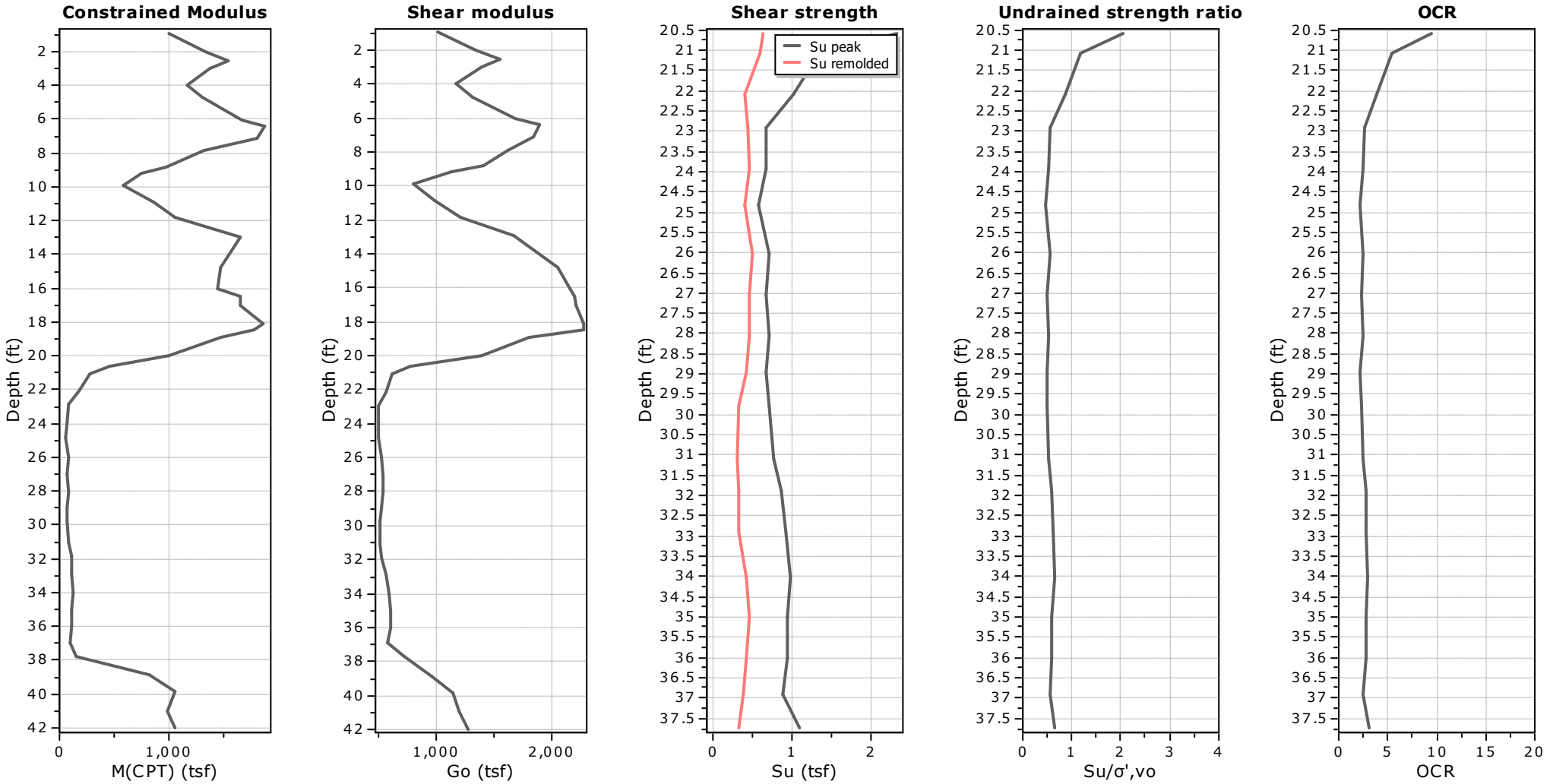

Calculation parameters

Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14
OCR factor for clays, N_{kt}: 0.33
Flat Dilatometer Test data

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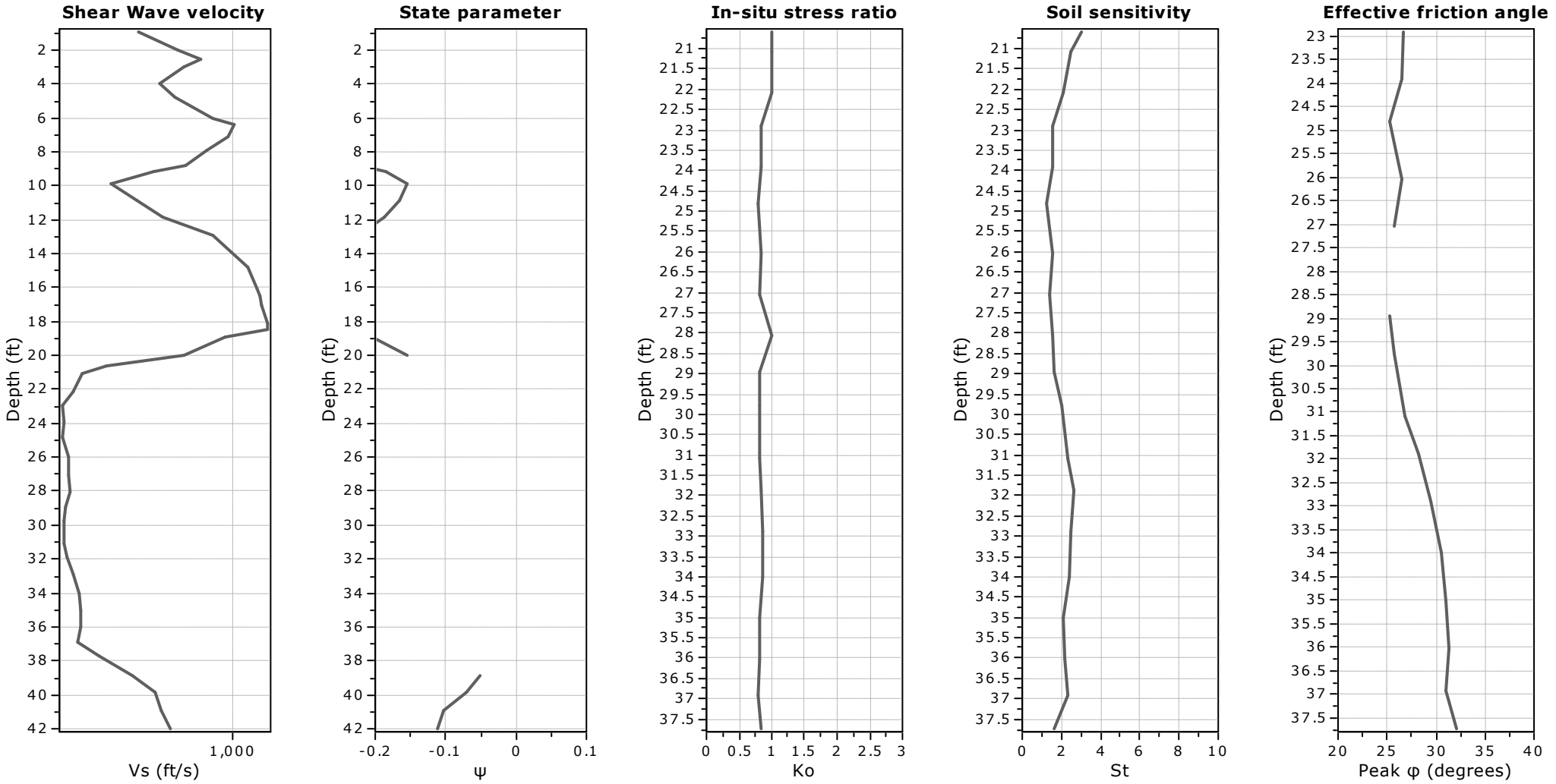
Location: Hennepin Powr Station, Hennepin, IL



Calculation parameters

Soil Sensitivity factor, N_S: 7.00

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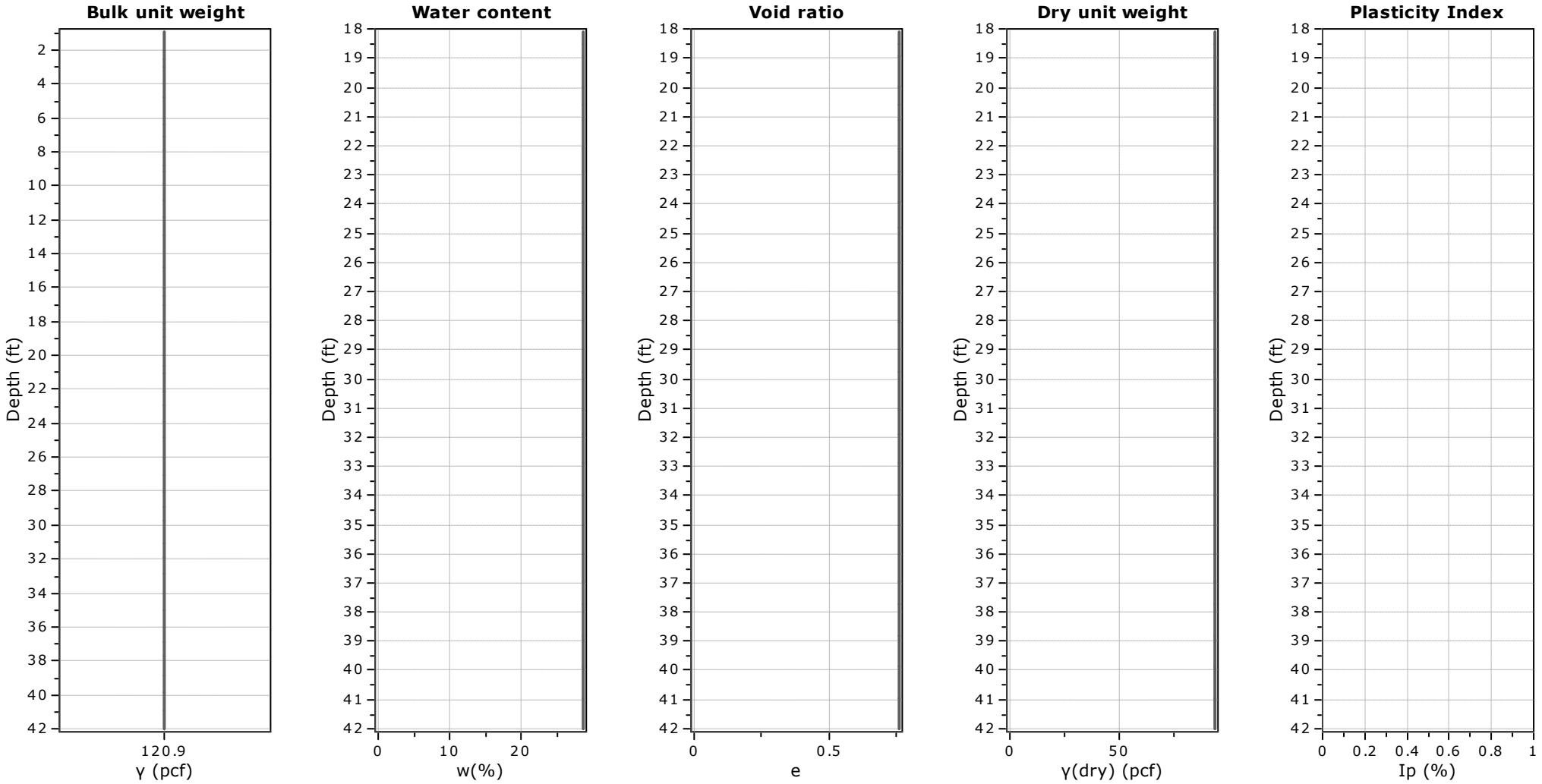
Location: Hennepin Powr Station, Hennepin, IL



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Coords: UTM Zone 16N
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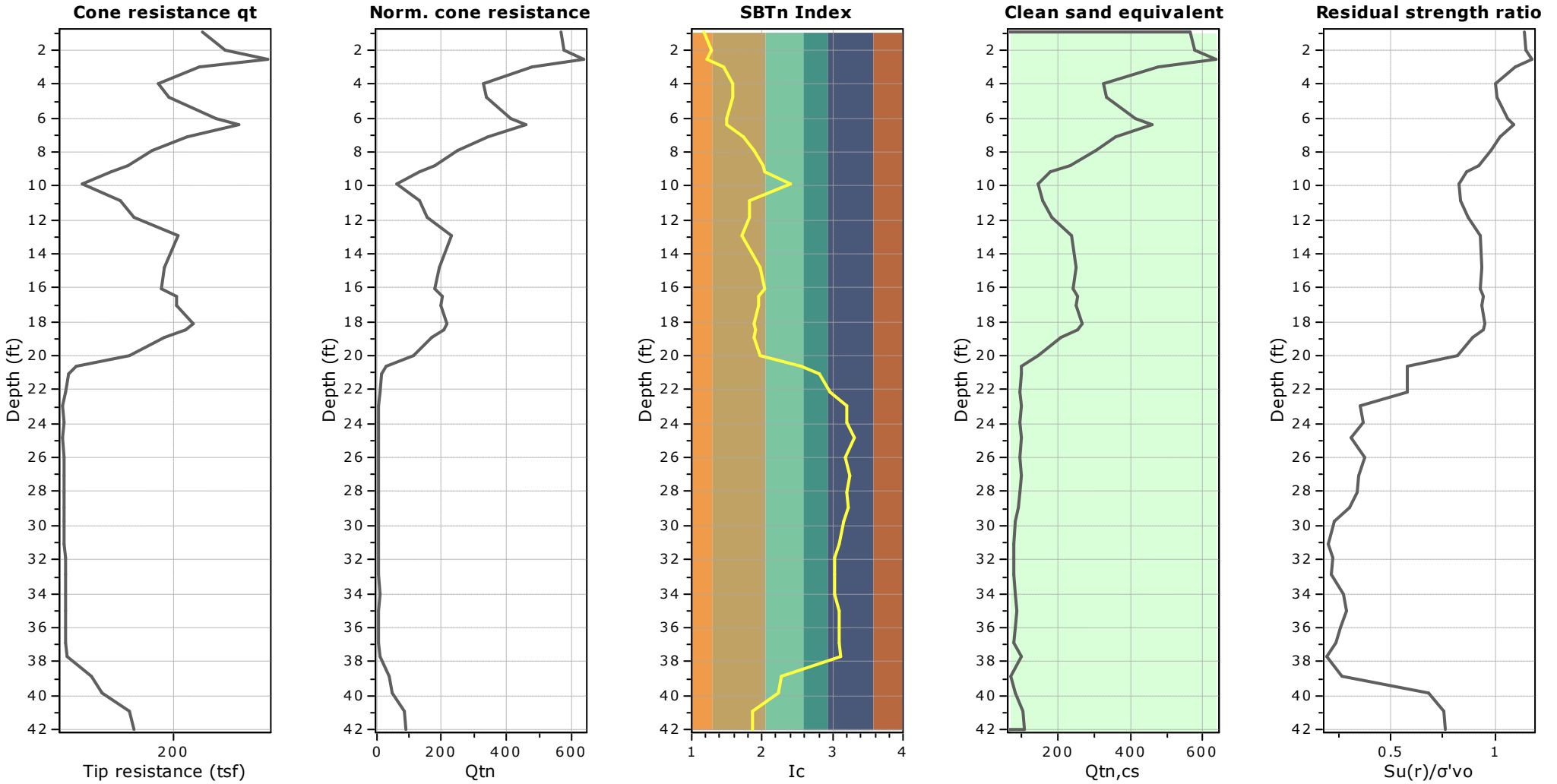
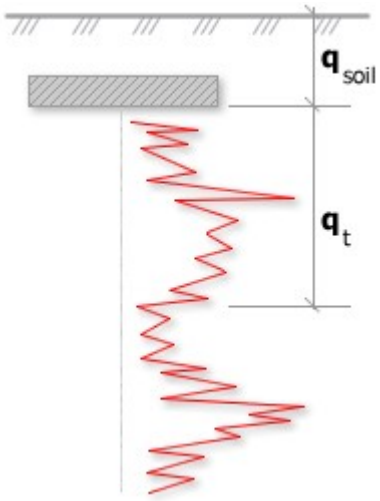
Location: Hennepin Powr Station, Hennepin, IL

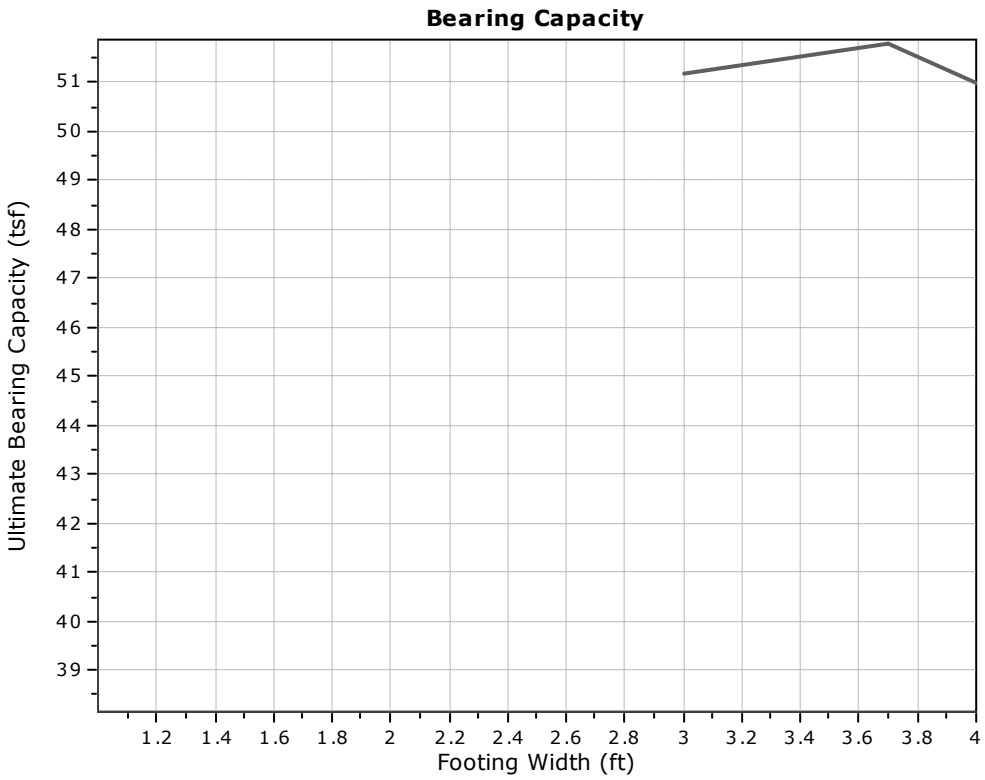




Bearing Capacity calculation is perfromed based on the formula:

$$Q_{ult} = R_k \times q_t + q_{soil}$$

where:
R_k: Bearing capacity factor
q_t: Average corrected cone resistance over calculation depth
q_{soil}: Pressure applied by soil above footing



:: Tabular results ::

No	B (ft)	Start Depth (ft)	End Depth (ft)	Ave. q_t (tsf)	R_k	Soil Press. (tsf)	Ult. bearing cap. (tsf)
1	3.00	1.60	6.10	255.32	0.20	0.10	51.16
2	3.70	1.60	7.15	258.40	0.20	0.10	51.78
3	4.40	1.60	8.20	249.01	0.20	0.10	49.90
4	5.10	1.60	9.25	225.36	0.20	0.10	45.17
5	5.80	1.60	10.30	211.28	0.20	0.10	42.35
6	6.50	1.60	11.35	203.89	0.20	0.10	40.87
7	7.20	1.60	12.40	199.04	0.20	0.10	39.90
8	7.90	1.60	13.45	199.58	0.20	0.10	40.01
9	8.60	1.60	14.50	199.58	0.20	0.10	40.01
10	9.30	1.60	15.55	198.65	0.20	0.10	39.83
11	10.00	1.60	16.60	198.05	0.20	0.10	39.71
12	10.70	1.60	17.65	198.45	0.20	0.10	39.79
13	11.40	1.60	18.70	201.12	0.20	0.10	40.32
14	12.10	1.60	19.75	200.38	0.20	0.10	40.17
15	12.80	1.60	20.80	190.73	0.20	0.10	38.24

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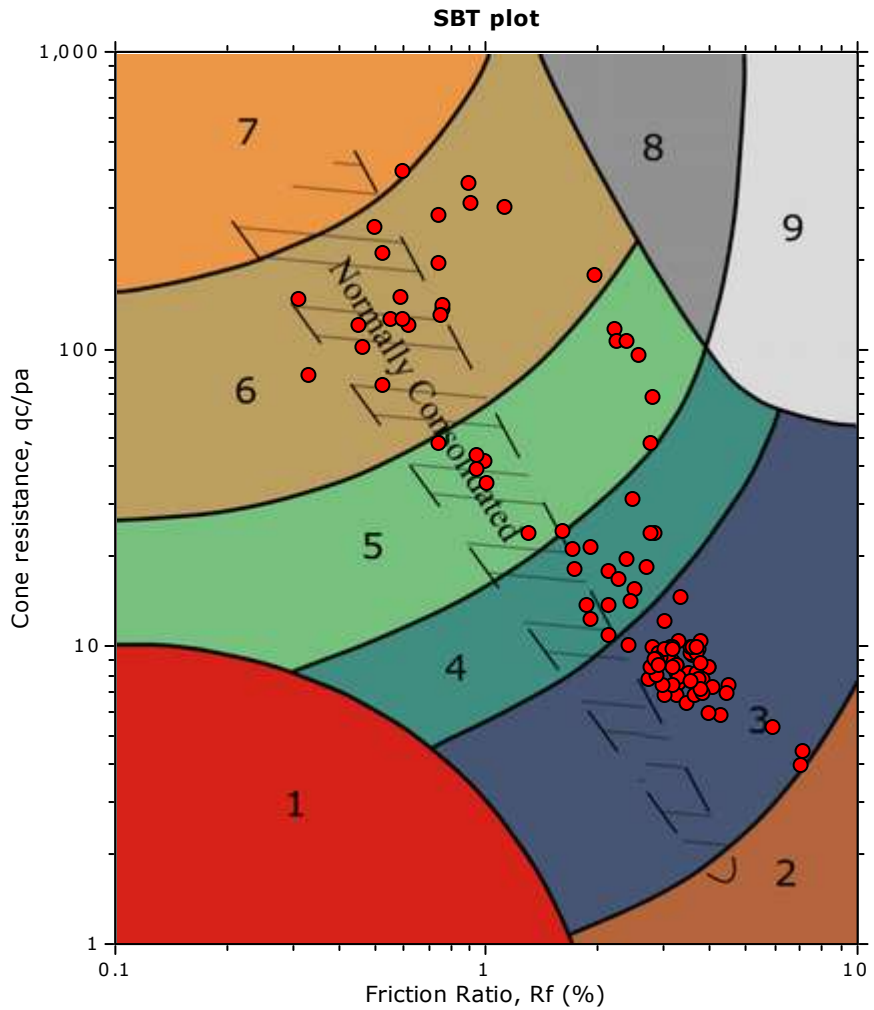
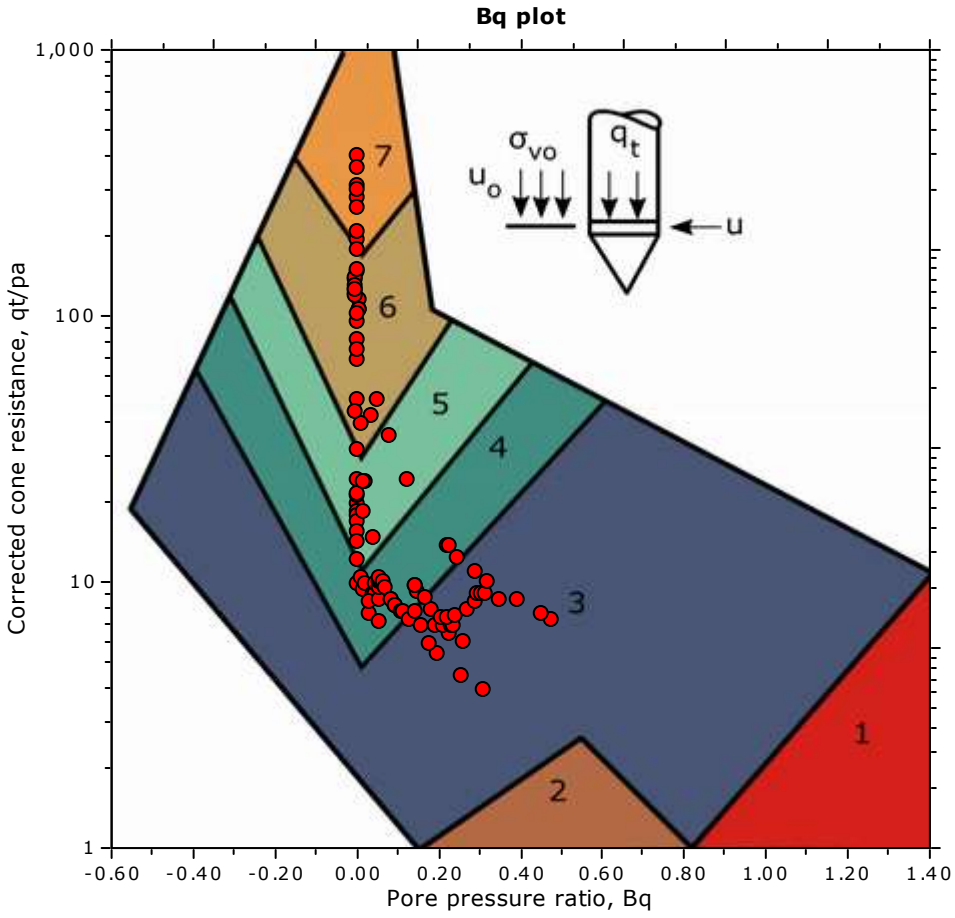
CPT: Sheet1
Total depth: 55.22 ft, Date: 3/17/2025
Surface Elevation: 0.00 ft
Coords: UTM Zone 16N
4574662mE
305168m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL

SBT - Bq plots





SBT legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

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CPT: Sheet1
Total depth: 55.22 ft, Date: 3/17/2025
Surface Elevation: 0.00 ft
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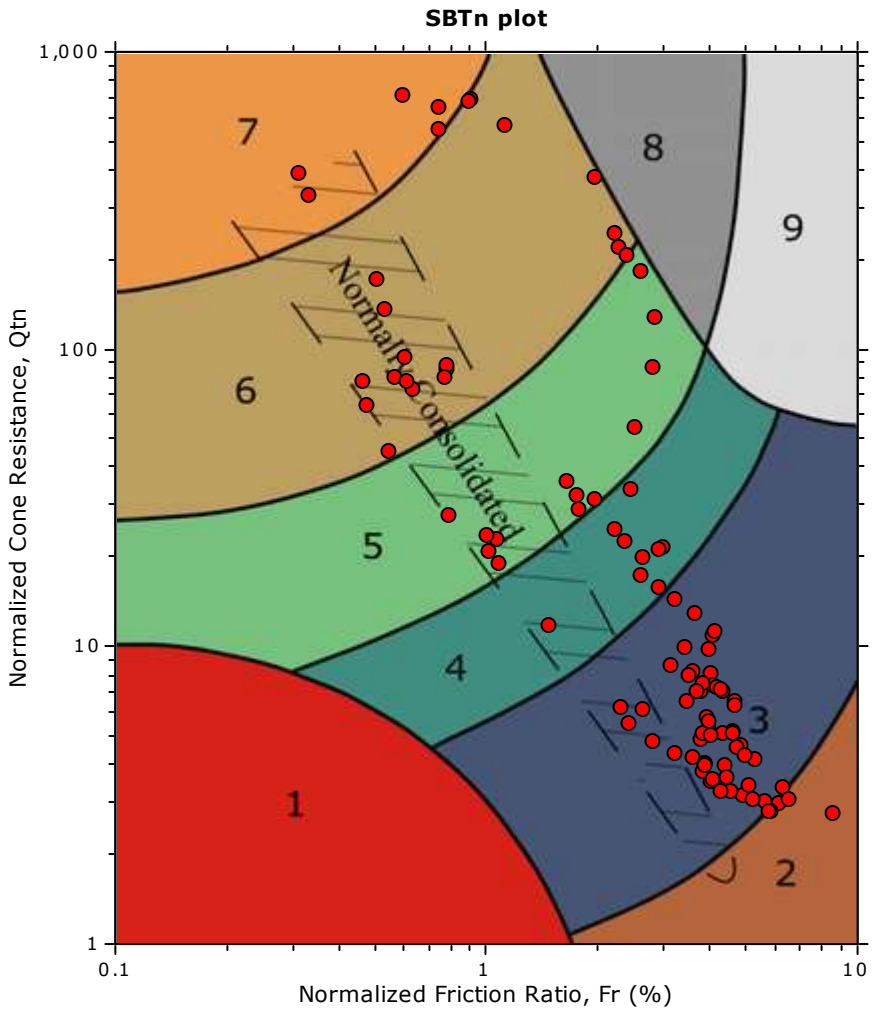
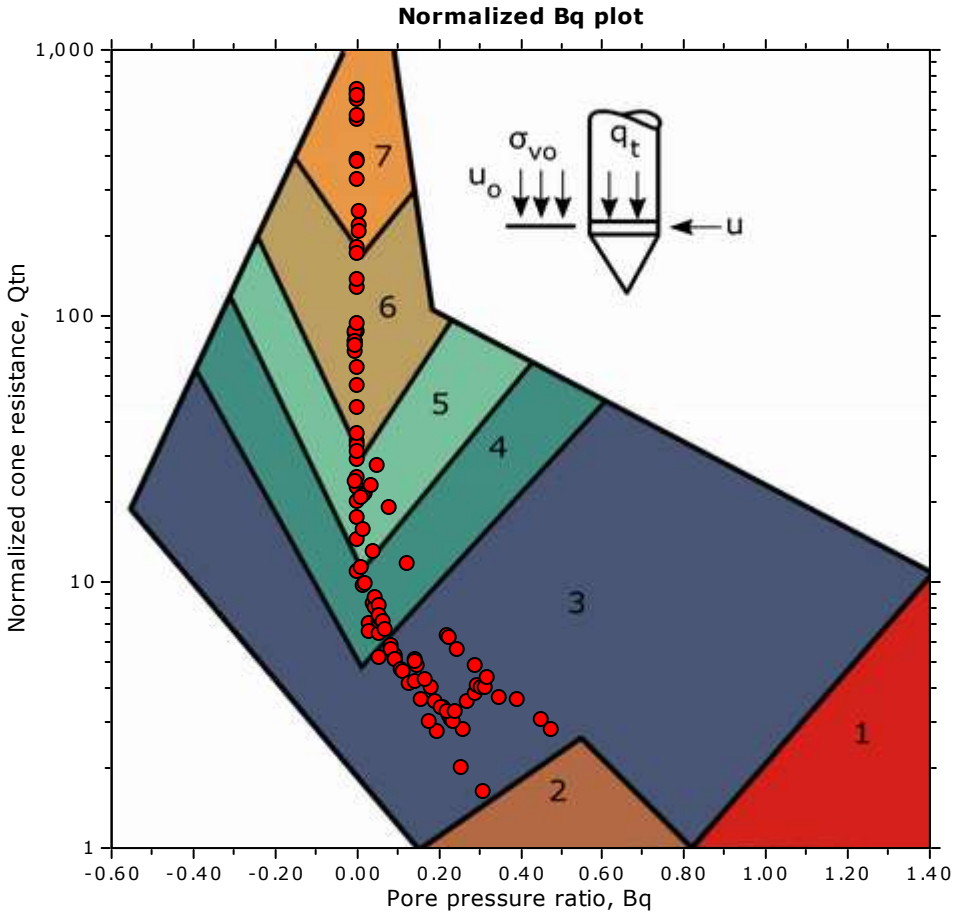
4574662mE
305168m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL

SBT - Bq plots (normalized)





SBTn legend

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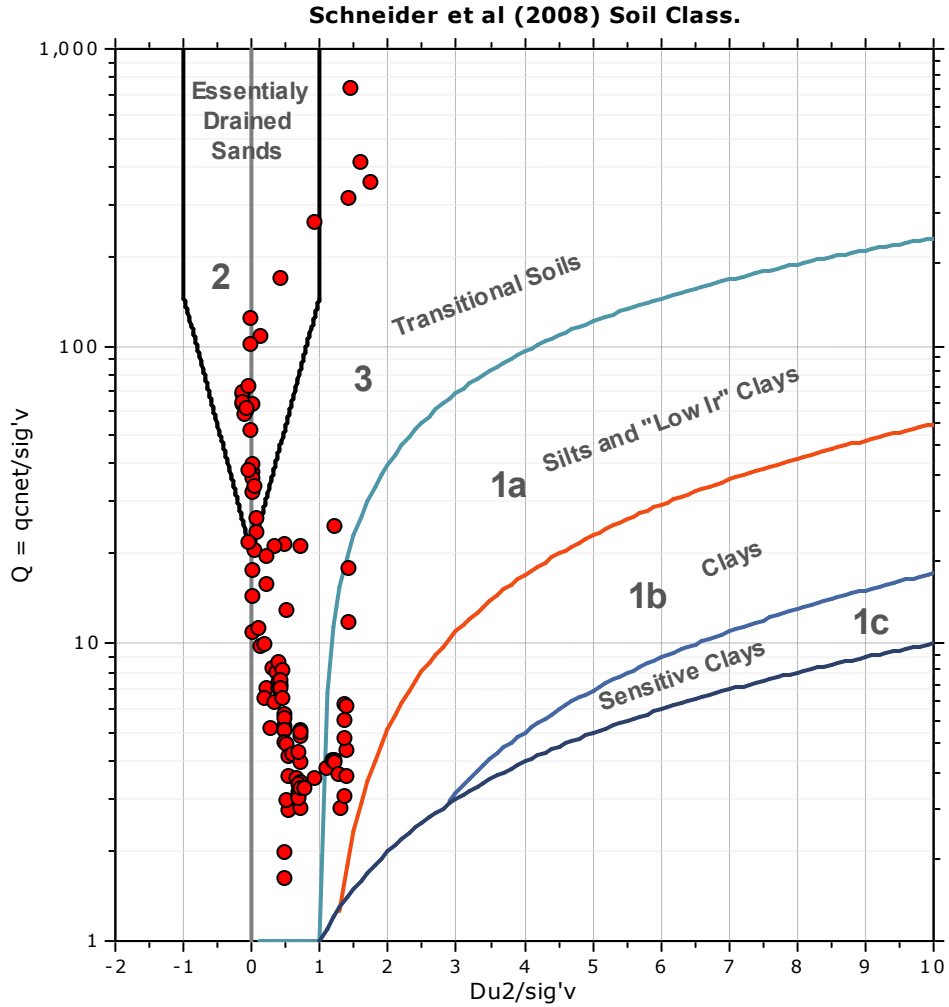
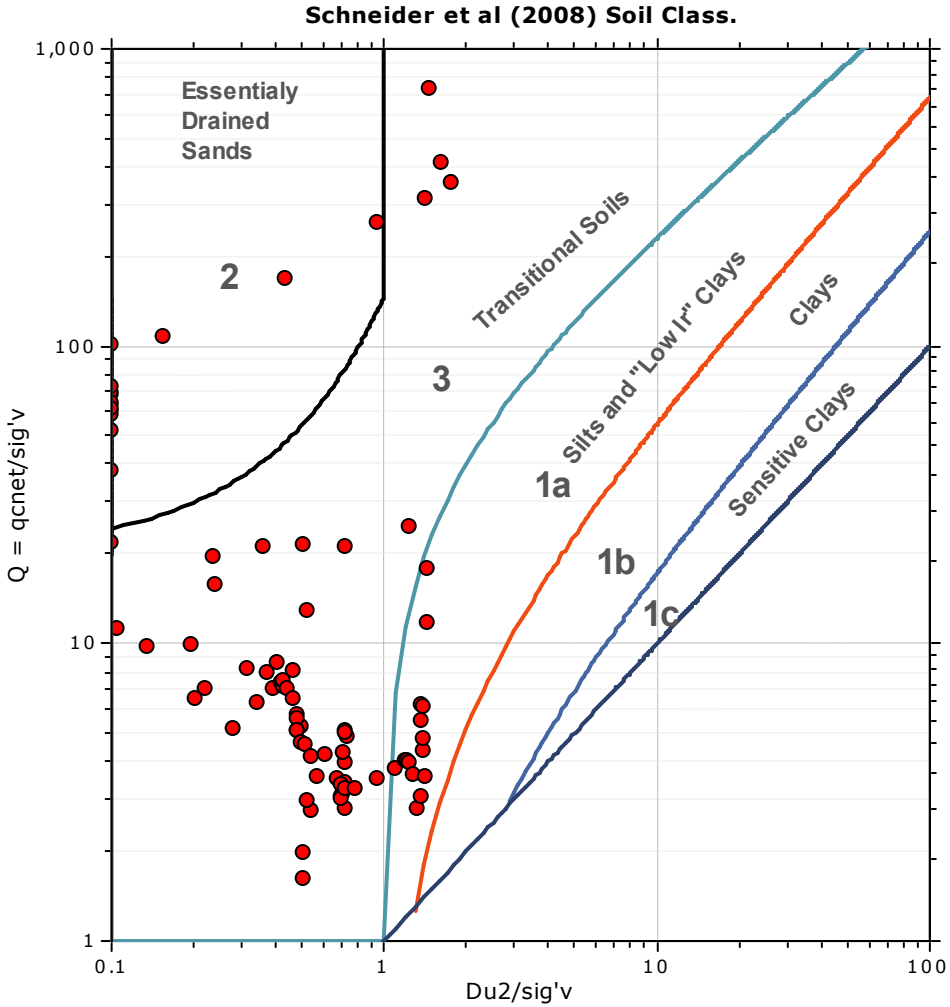
Bq plots (Schneider)





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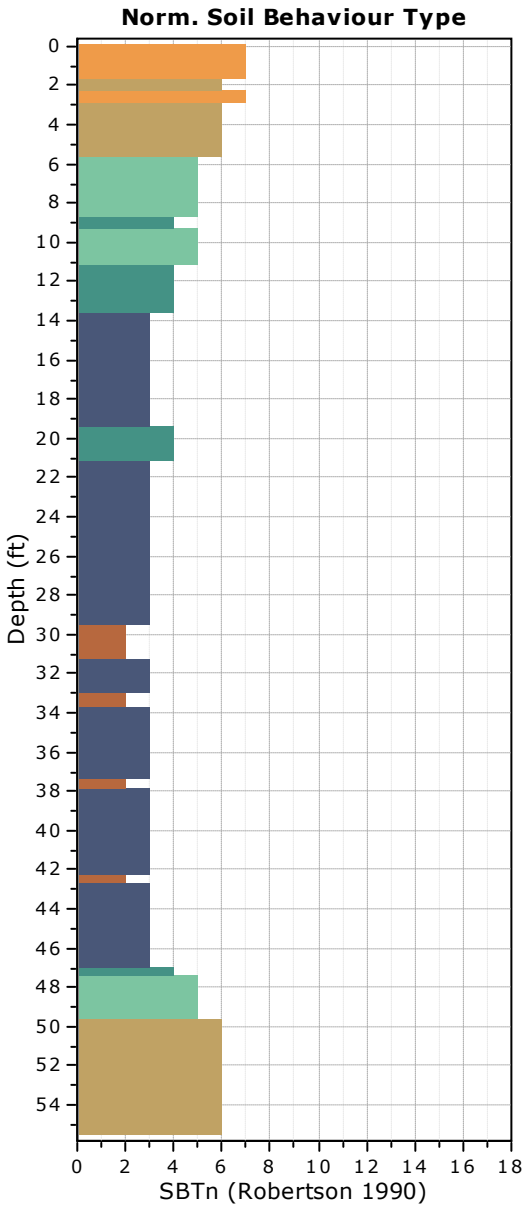

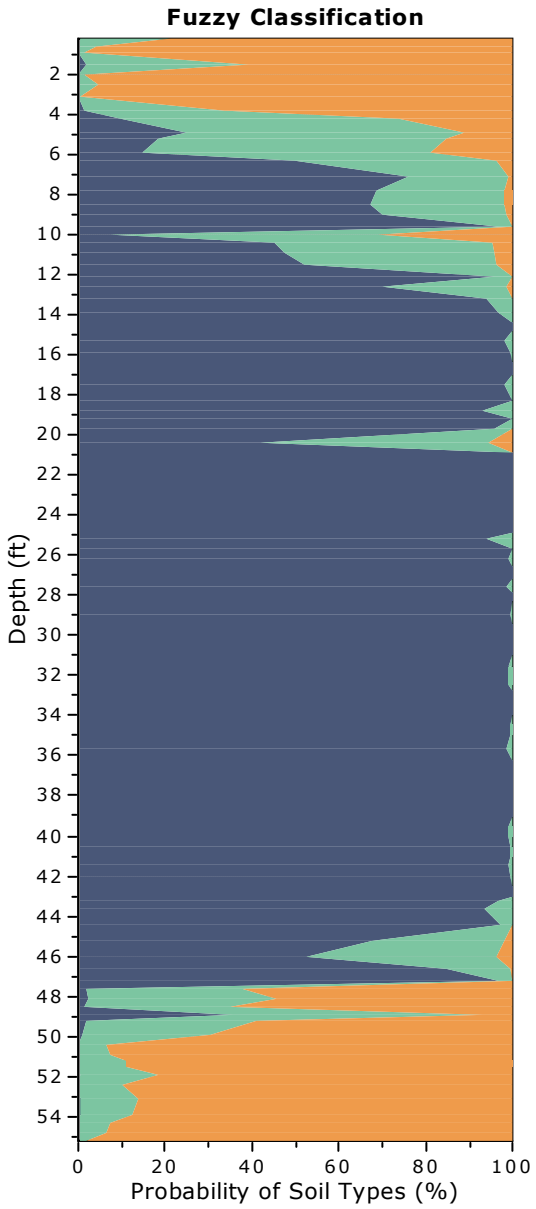

Fuzzy classifiaction legend
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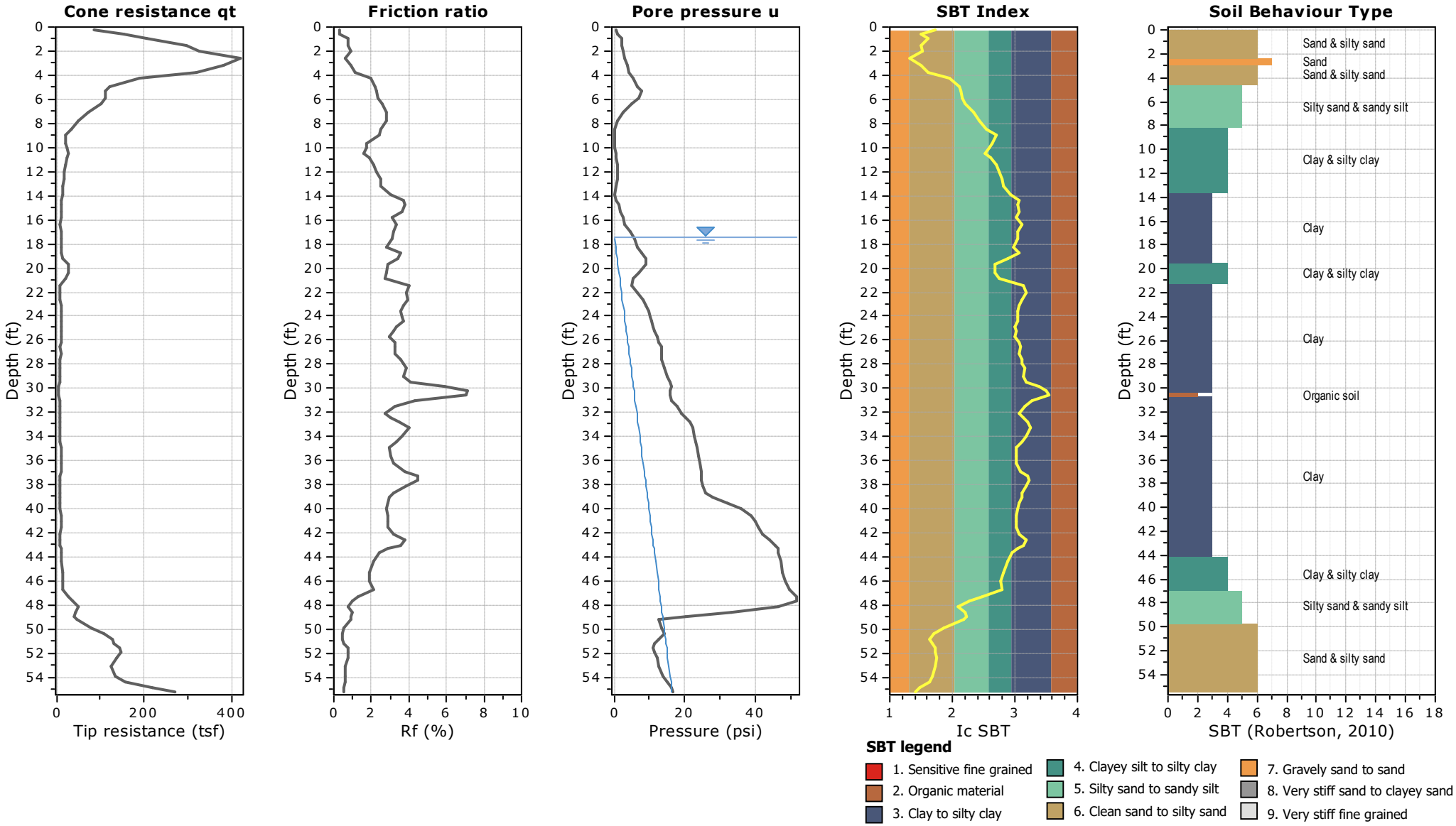

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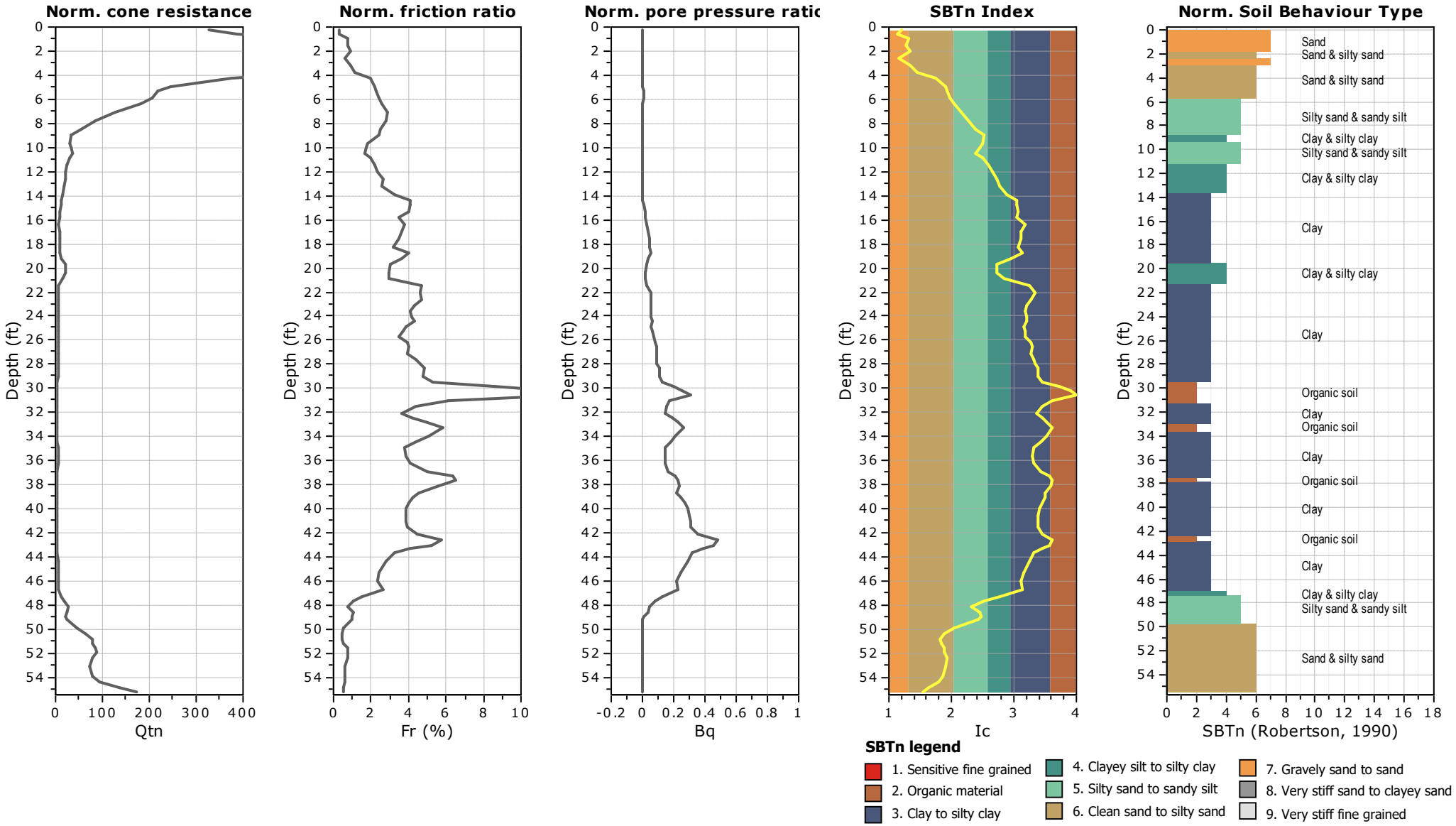

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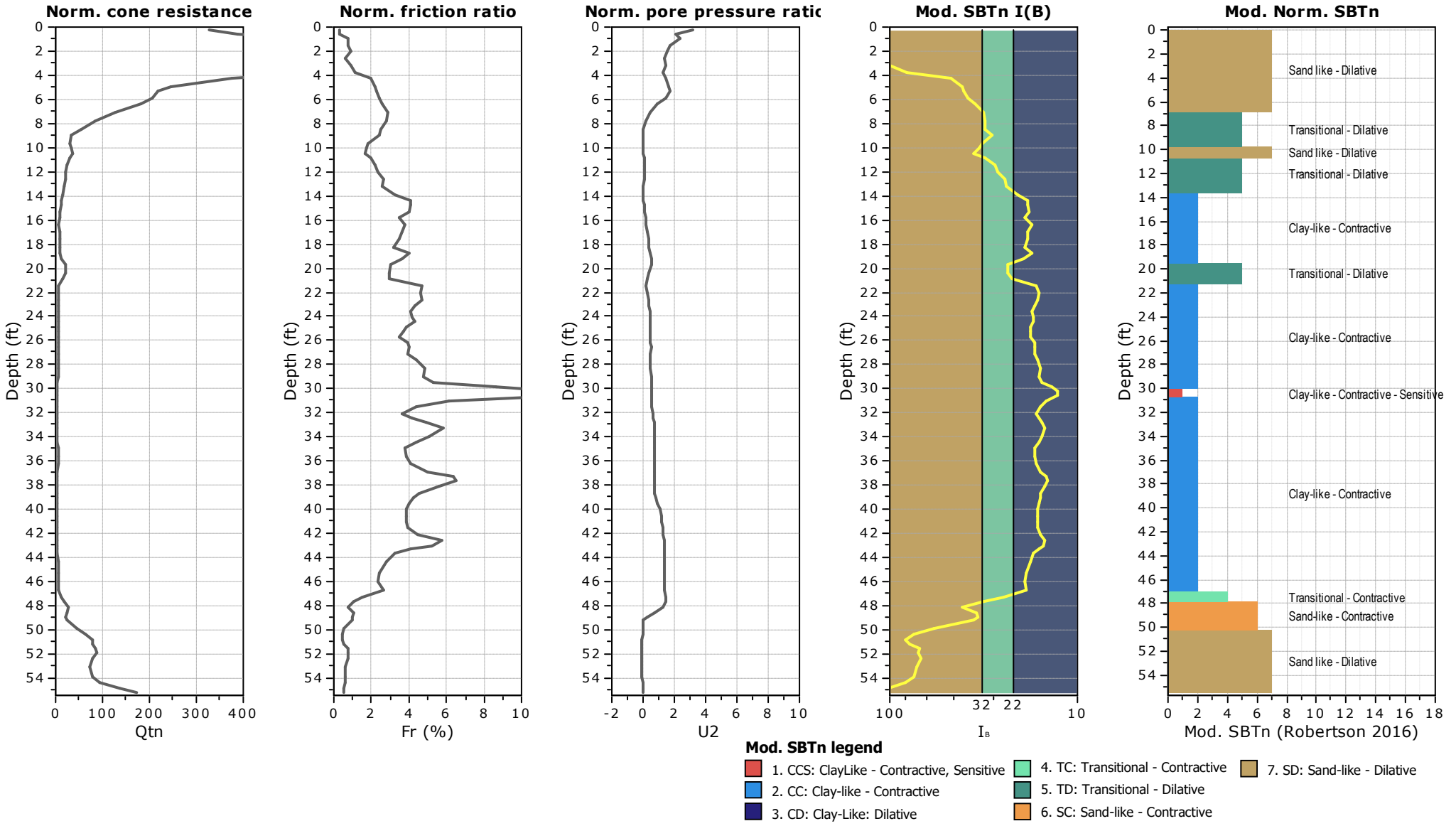
305168m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL

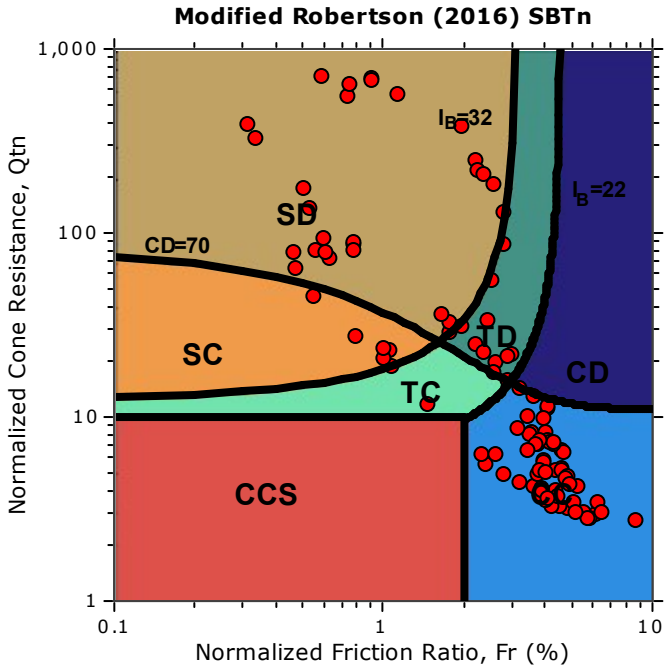


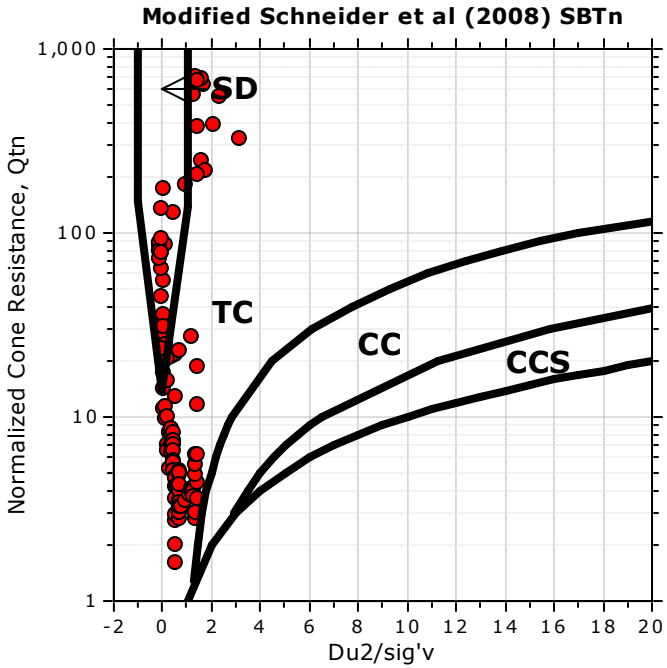
GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

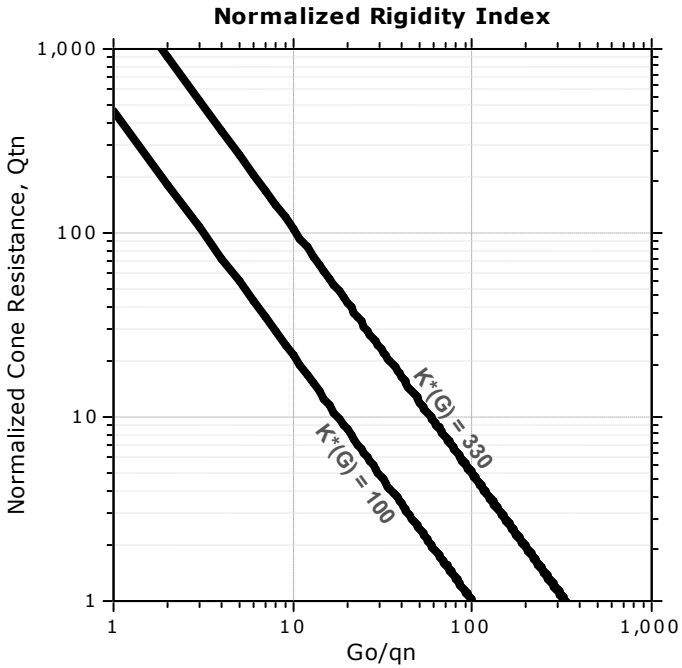
CPT: Sheet1
Total depth: 55.22 ft, Date: 3/17/2025
Surface Elevation: 0.00 ft
Coords: UTM Zone 16N
4574662mE
305168m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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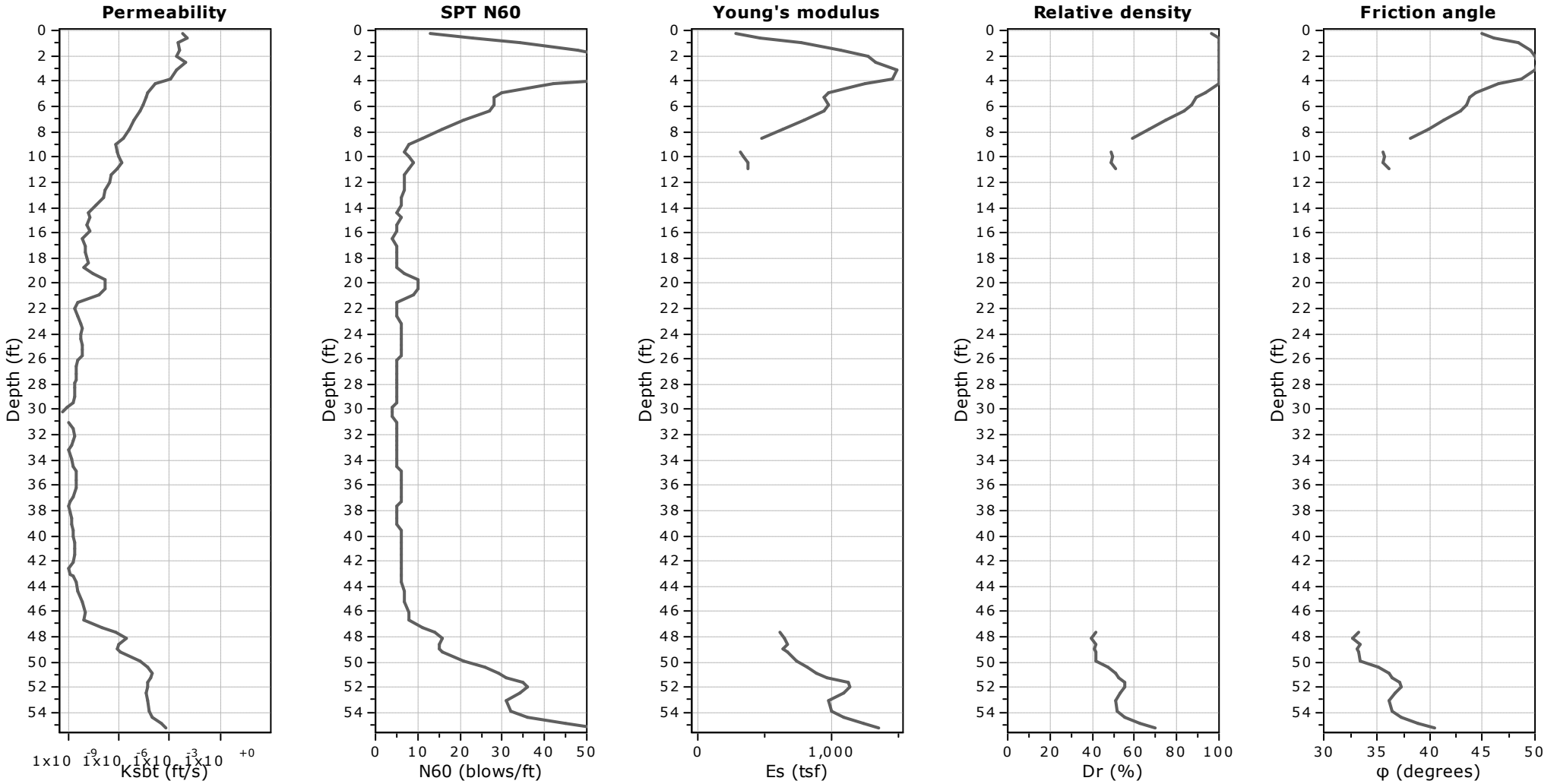
CPT: Sheet1
Total depth: 55.22 ft, Date: 3/17/2025
Surface Elevation: 0.00 ft
Coords: UTM Zone 16N
4574662mE
305168m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL



Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)

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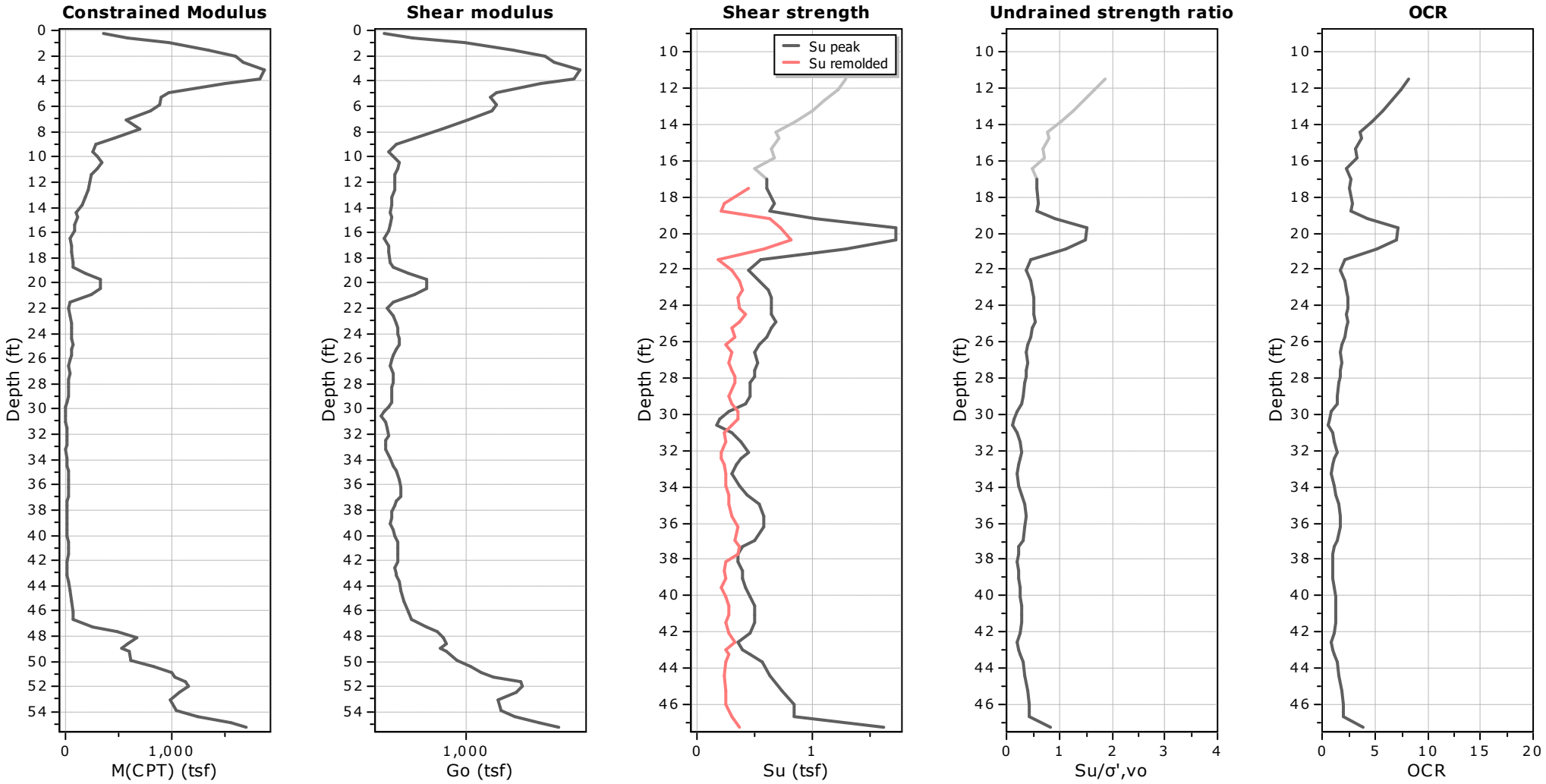
CPT: Sheet1
Total depth: 55.22 ft, Date: 3/17/2025
Surface Elevation: 0.00 ft
Coords: UTM Zone 16N
4574662mE
305168m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL



Calculation parameters

Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14
OCR factor for clays, N_{kt}: 0.33
Flat Dilatometer Test data

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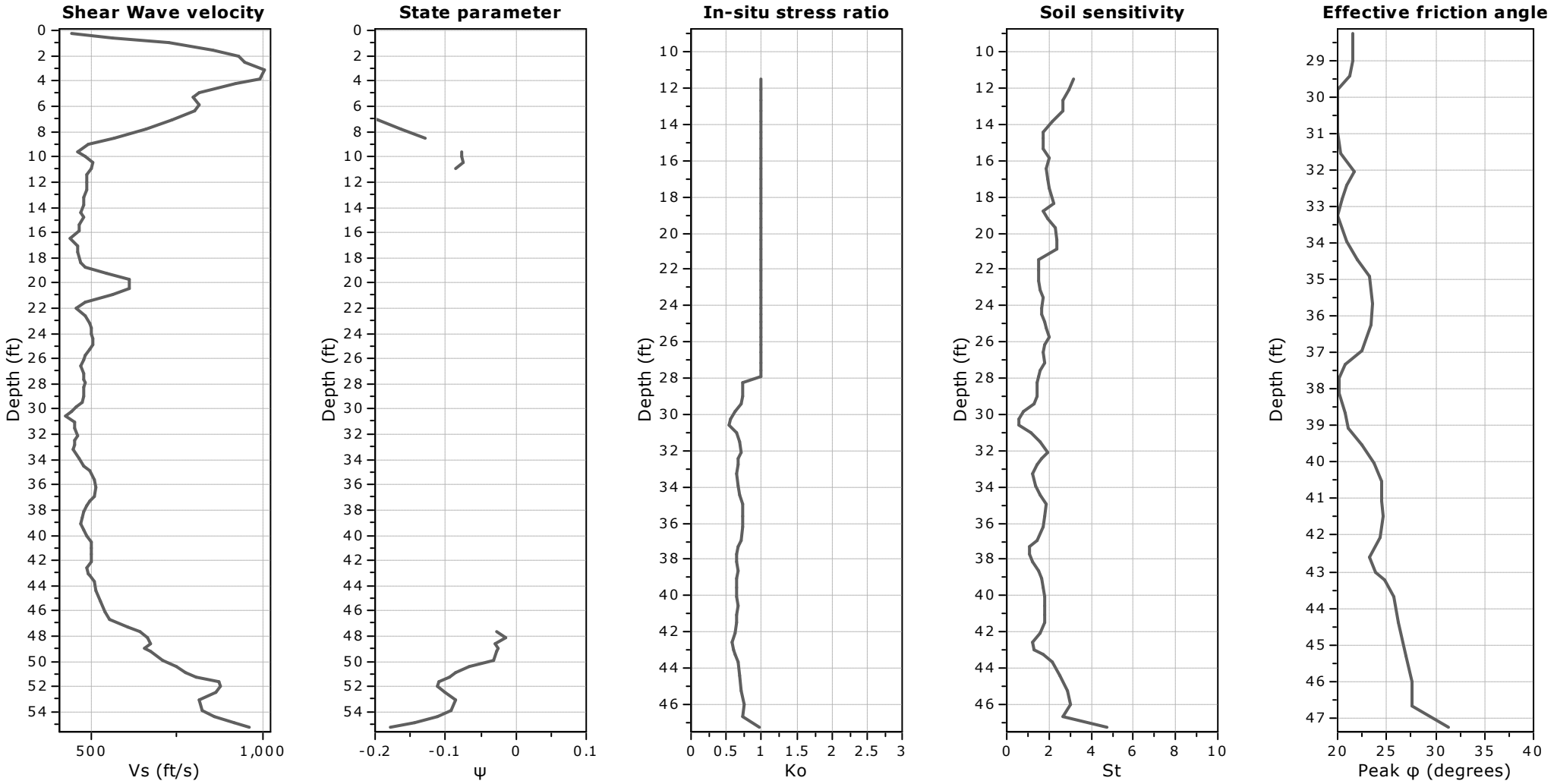
CPT: Sheet1
Total depth: 55.22 ft, Date: 3/17/2025
Surface Elevation: 0.00 ft
Coords: UTM Zone 16N
4574662mE
305168m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL



Calculation parameters

Soil Sensitivity factor, N_S: 7.00

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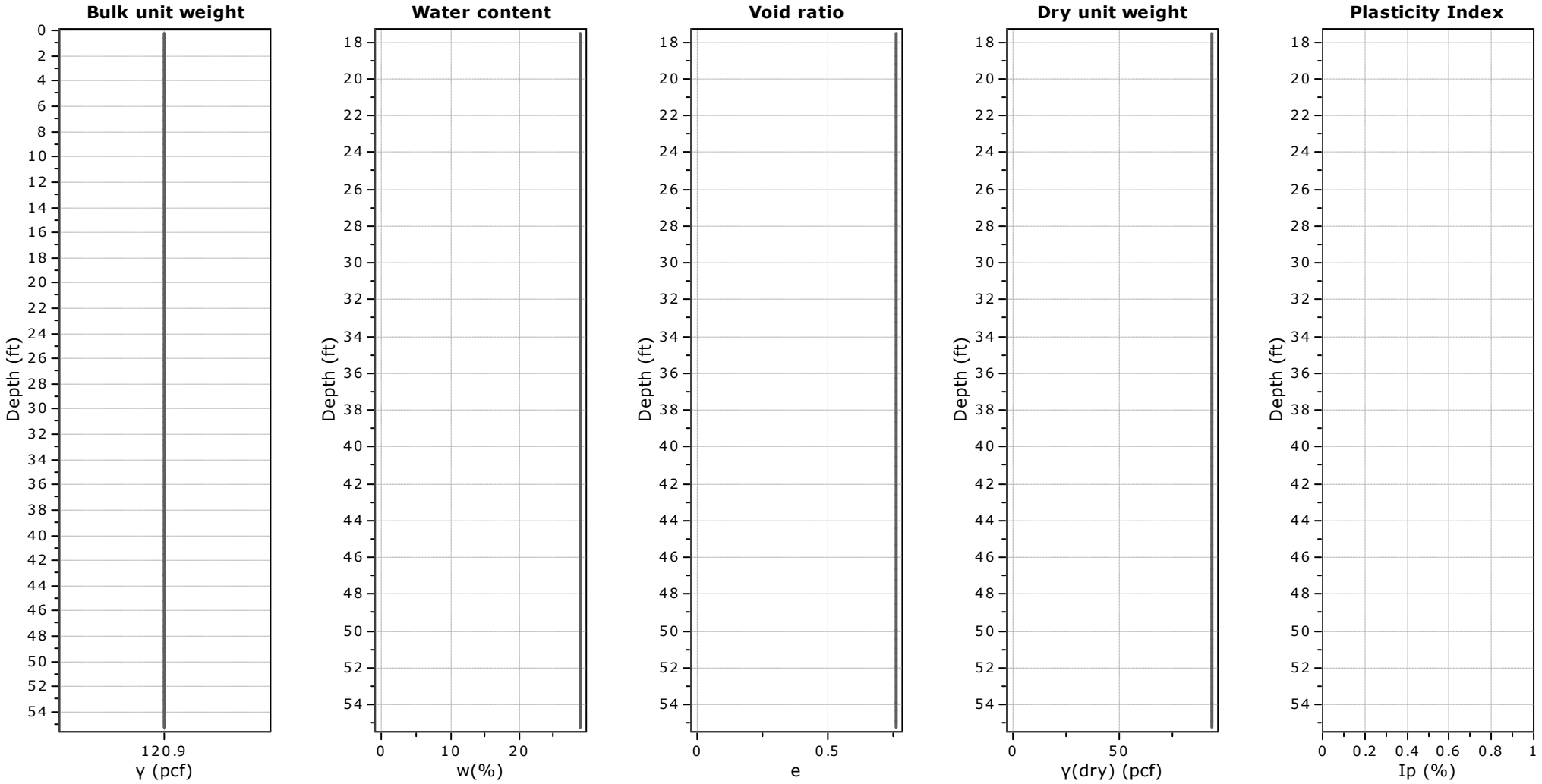
CPT: Sheet1
Total depth: 55.22 ft, Date: 3/17/2025
Surface Elevation: 0.00 ft
Coords: UTM Zone 16N
4574662mE
305168m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL



GeoLogismiki
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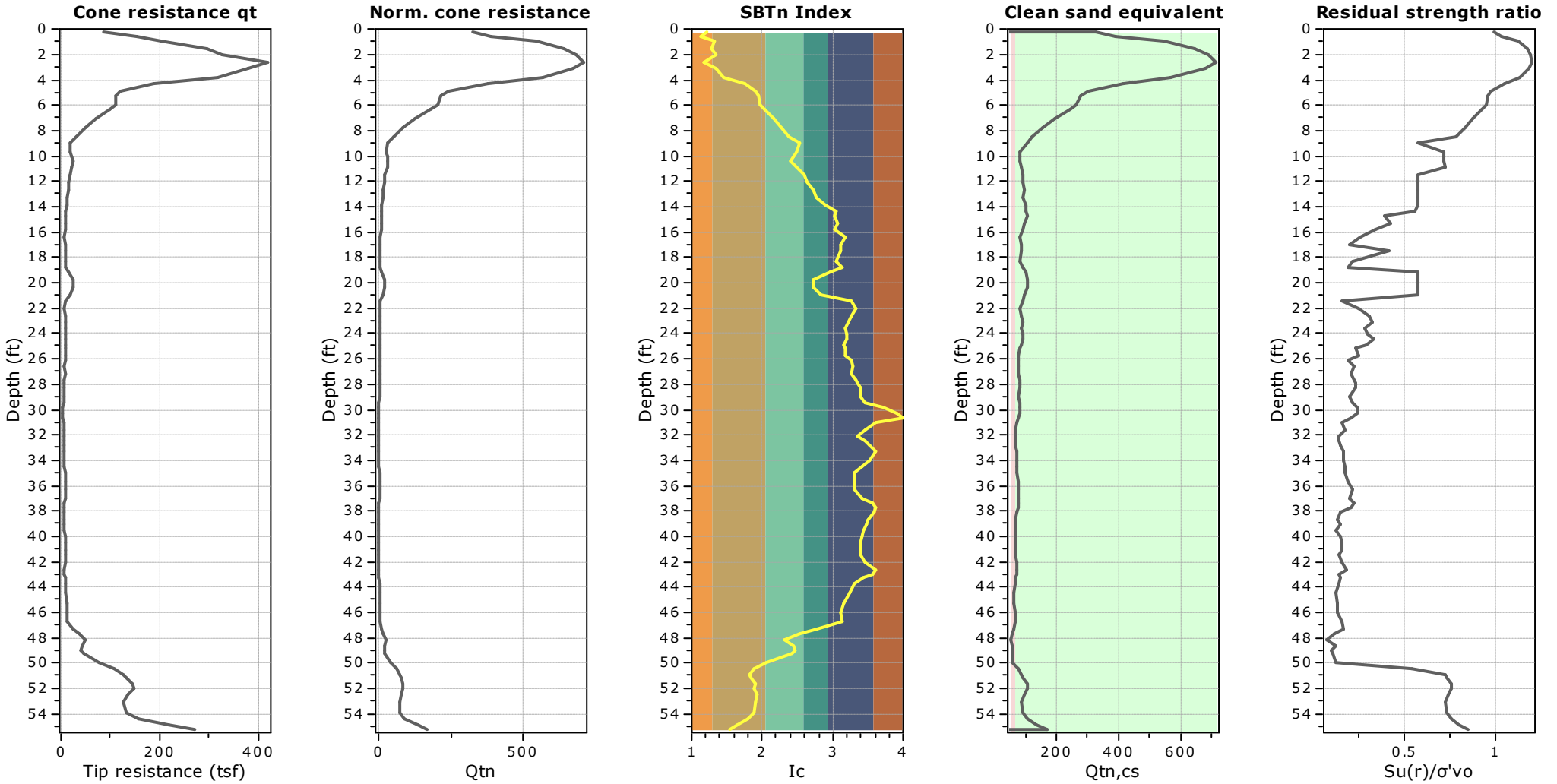
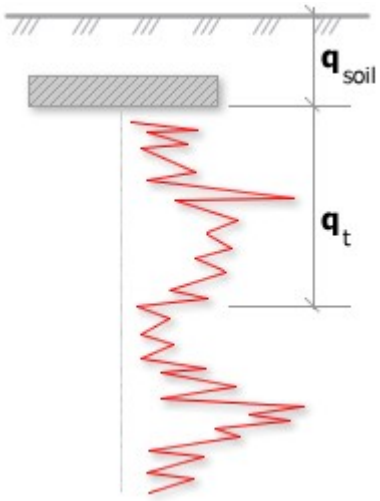
Merarhias 56
http://www.geologismiki.gr

CPT: Sheet1
Total depth: 55.22 ft, Date: 3/17/2025
Surface Elevation: 0.00 ft
Coords: UTM Zone 16N
4574662mE
305168m
Cone Operator:

Project: HEN WAPS CPTu Soundings - HENC002
Location: Hennepin Powr Station, Hennepin, IL

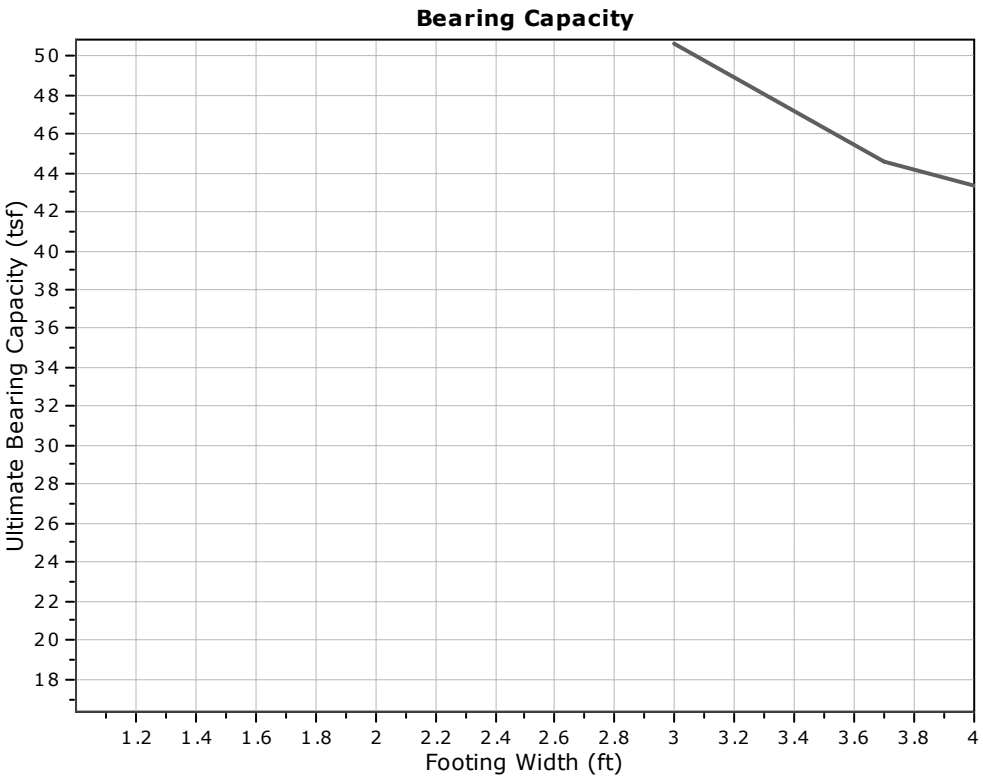




Bearing Capacity calculation is perfromed based on the formula:

$$Q_{ult} = R_k \times q_t + q_{soil}$$

where:
R_k: Bearing capacity factor
q_t: Average corrected cone resistance over calculation depth
q_{soil}: Pressure applied by soil above footing



:: Tabular results ::

No	B (ft)	Start Depth (ft)	End Depth (ft)	Ave. q_t (tsf)	R_k	Soil Press. (tsf)	Ult. bearing cap. (tsf)
1	3.00	1.60	6.10	252.68	0.20	0.10	50.63
2	3.70	1.60	7.15	222.48	0.20	0.10	44.59
3	4.40	1.60	8.20	208.19	0.20	0.10	41.73
4	5.10	1.60	9.25	182.30	0.20	0.10	36.56
5	5.80	1.60	10.30	162.11	0.20	0.10	32.52
6	6.50	1.60	11.35	146.79	0.20	0.10	29.45
7	7.20	1.60	12.40	133.94	0.20	0.10	26.88
8	7.90	1.60	13.45	123.18	0.20	0.10	24.73
9	8.60	1.60	14.50	113.88	0.20	0.10	22.87
10	9.30	1.60	15.55	105.93	0.20	0.10	21.28
11	10.00	1.60	16.60	99.02	0.20	0.10	19.90
12	10.70	1.60	17.65	93.05	0.20	0.10	18.71
13	11.40	1.60	18.70	90.38	0.20	0.10	18.17
14	12.10	1.60	19.75	83.90	0.20	0.10	16.88
15	12.80	1.60	20.80	82.23	0.20	0.10	16.54

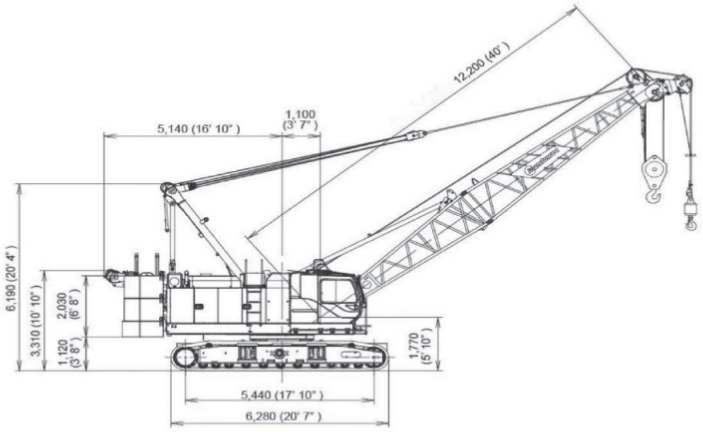
Attachment B

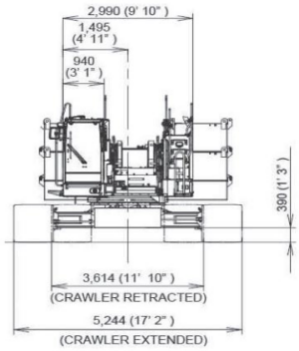
Crane Loading Calculations

Manitowoc 11000 - 110 Ton Surcharge Function Calculations
Vistra-Hennepin Old West Ash Pond System

Cross-Section:
Prepared by: Nguyet Nguyen Date: 10/23/2024
Checked By: Date:

working weight (lb)	Wall Installation Equipment	Crane Footprint Length (ft)	Crane Footprint Width (ft)	Crane Area Footprint (ft^2)	Crane Mat Dimensions (ft)	C-C' Surcharge Load in Slope/W	
						Surcharge load (pcf) (1ft high)	Surcharge area (ftxft)
198500	30000	30.00	30.00	900.00	+ 5	253.89	30 x 30





Manitowoc Crawler Crane Spec

Working weight

Approximately 90,000 kg (198,500 lb) including upperworks and lowerworks, full upper counterweights, full carbody counterweights, and 12,2 m (40') basic boom.

Attachment C

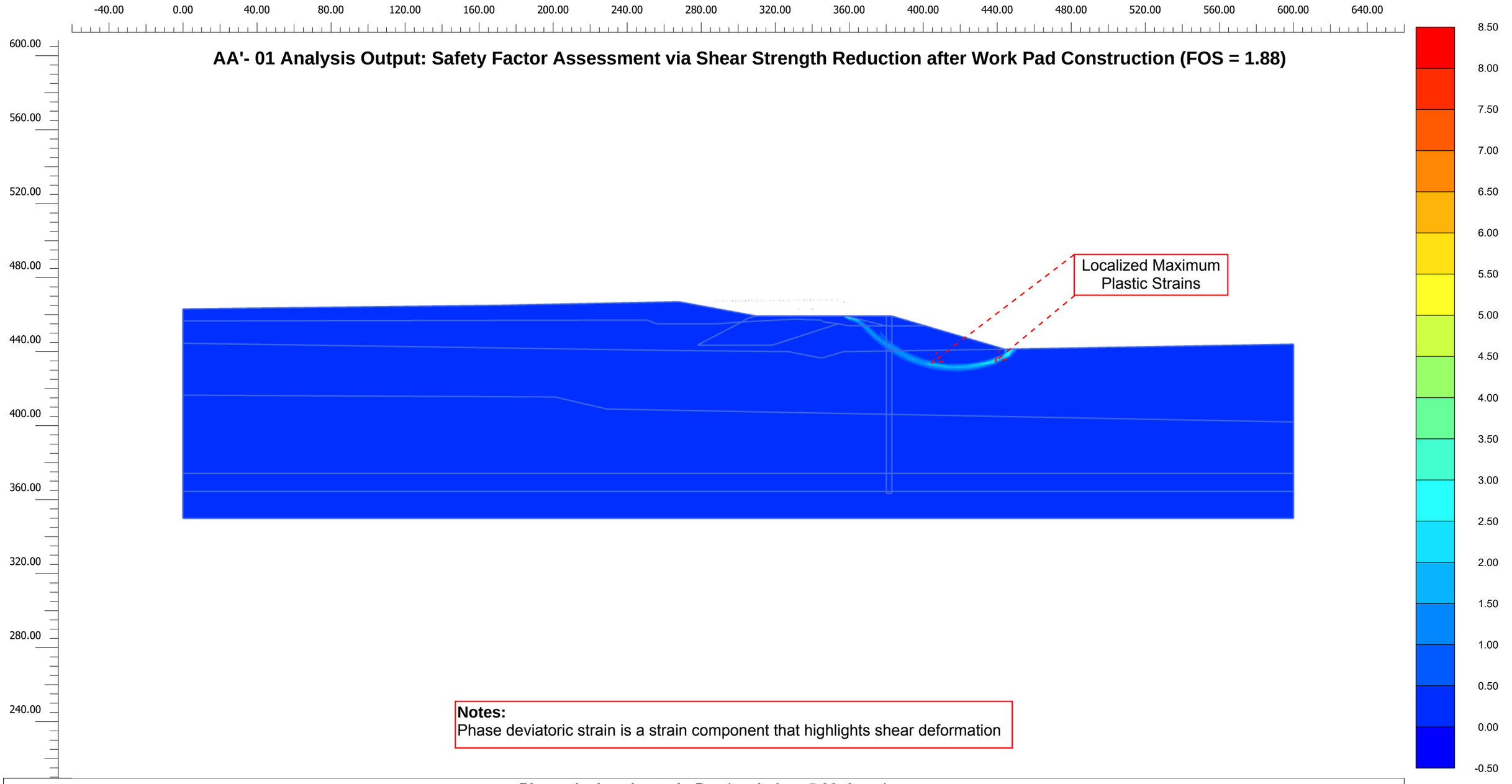
Results

Table 8. Summary of Plaxis Results Outputs

Cross-Section	Phase	New Analysis ID	New Description
A-A'	Work Pad Construction Phase	AA-01	Safety Factor Assessment via Shear Strength Reduction after Work Pad Construction (FOS = 1.88)
	Trench Excavation Phase	AA-02	Safety Factor Assessment via Shear Strength Reduction after Trench Excavation (FOS = 1.33)
		AA-03	Estimated Deviatoric Strain after Trench Excavation
		AA-04	Estimated Horizontal Displacements after Trench Excavation
		AA-05	Estimated Vertical Displacements after Trench Excavation
F-F'	Work Pad Construction Phase	FF-01	Safety Factor Assessment via Shear Strength Reduction after Work Pad Construction (FOS = 1.77)
	Trench Excavation Phase	FF-02	Safety Factor Assessment via Shear Strength Reduction after Trench Excavation (FOS = 1.30)
		FF-03	Estimated Deviatoric Strain after Trench Excavation
		FF-04	Estimated Horizontal Displacements after Trench Excavation
		FF-05	Estimated Vertical Displacements after Trench Excavation

Output Version 21.1.0.479

AA'- 01 Analysis Output: Safety Factor Assessment via Shear Strength Reduction after Work Pad Construction (FOS = 1.88)



Notes:
Phase deviatoric strain is a strain component that highlights shear deformation

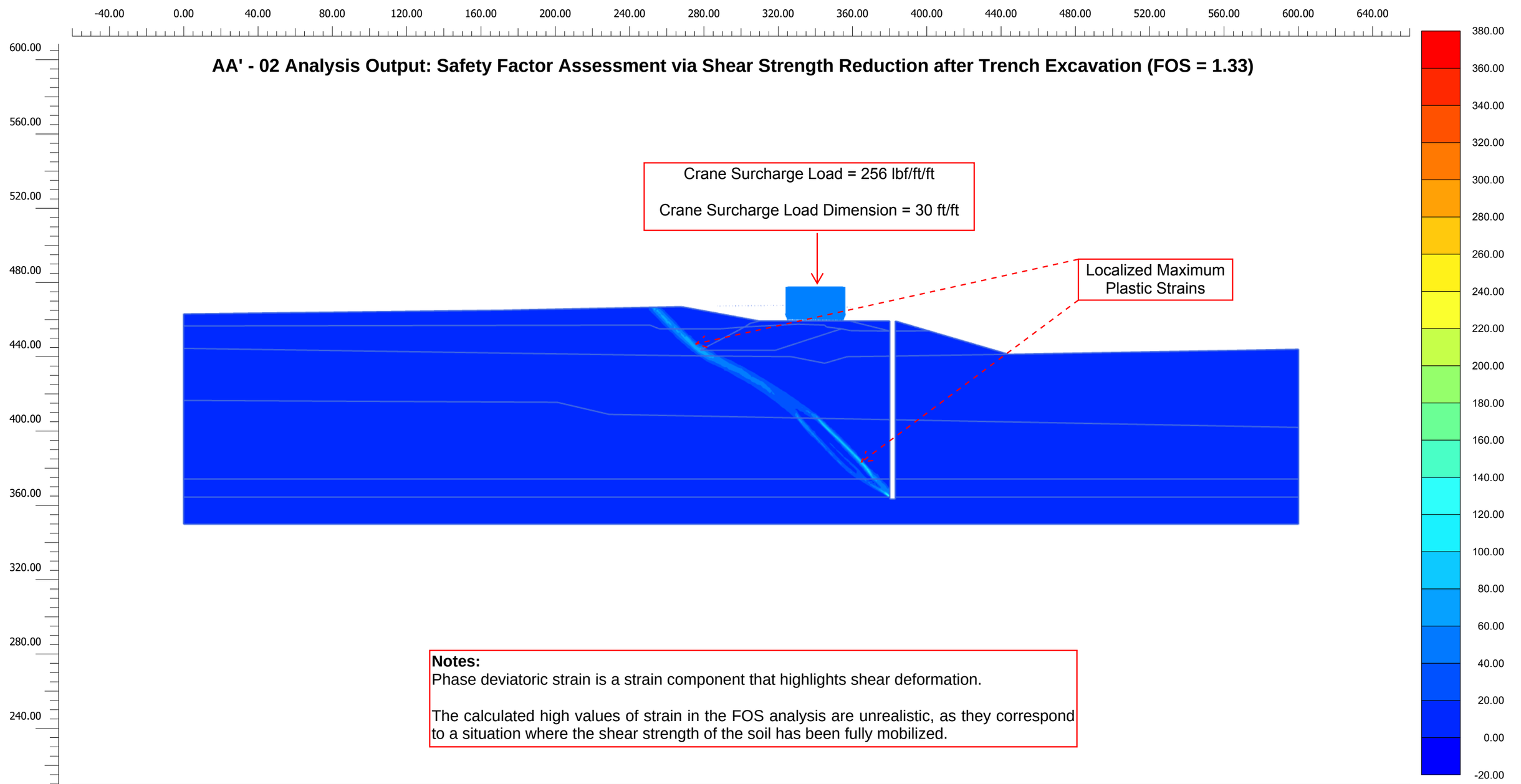
Phase deviatoric strain $P\gamma_s$ (scaled up 5.00 times)

Maximum value = 8.148 (Element 344 at Node 9429)

Minimum value = $0.7139*10^{-9}$ (Element 3114 at Node 26258)

RAMBOLL	*Project description* Hennepin West Ash Pond System Deep Cutoff Wall		*Date* 4/11/2025
	Project filename Cross Section A-A'	*Step* 462	*Company* Ramboll Americas Engineering Solutions

AA' - 02 Analysis Output: Safety Factor Assessment via Shear Strength Reduction after Trench Excavation (FOS = 1.33)



Notes:
Phase deviatoric strain is a strain component that highlights shear deformation.

The calculated high values of strain in the FOS analysis are unrealistic, as they correspond to a situation where the shear strength of the soil has been fully mobilized.

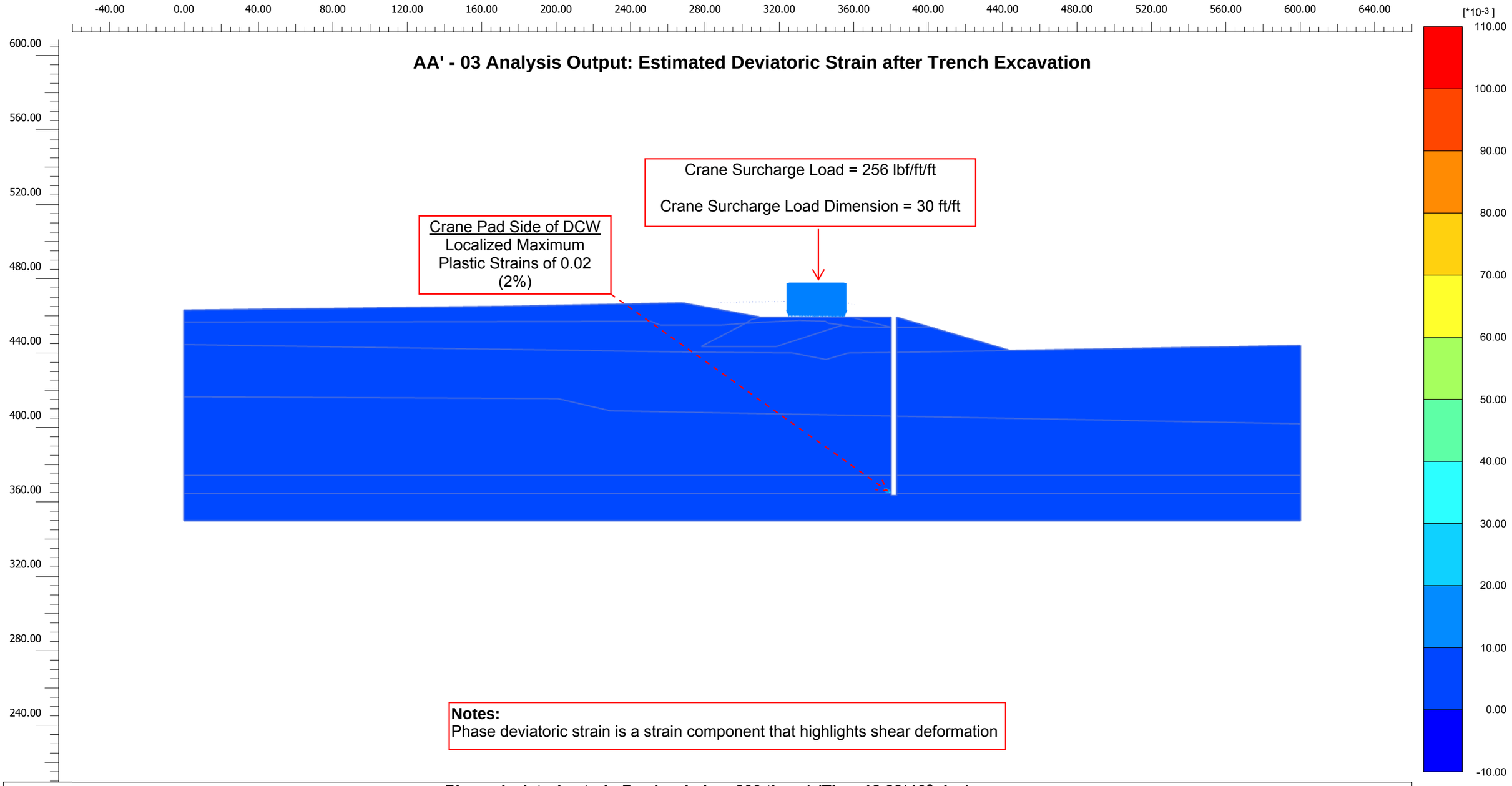
Phase deviatoric strain $P\gamma_s$ (scaled up 0.0500 times)

Maximum value = 361.0 (Element 2907 at Node 13817)

Minimum value = $1.381*10^{-9}$ (Element 304 at Node 6196)

RAMBOLL	*Project description* Hennepin West Ash Pond System Deep Cutoff Wall		*Date* 4/11/2025
	Project filename Cross Section A-A'	*Step* 362	*Company* Ramboll Americas Engineering Solutions

AA' - 03 Analysis Output: Estimated Deviatoric Strain after Trench Excavation



Notes:
Phase deviatoric strain is a strain component that highlights shear deformation

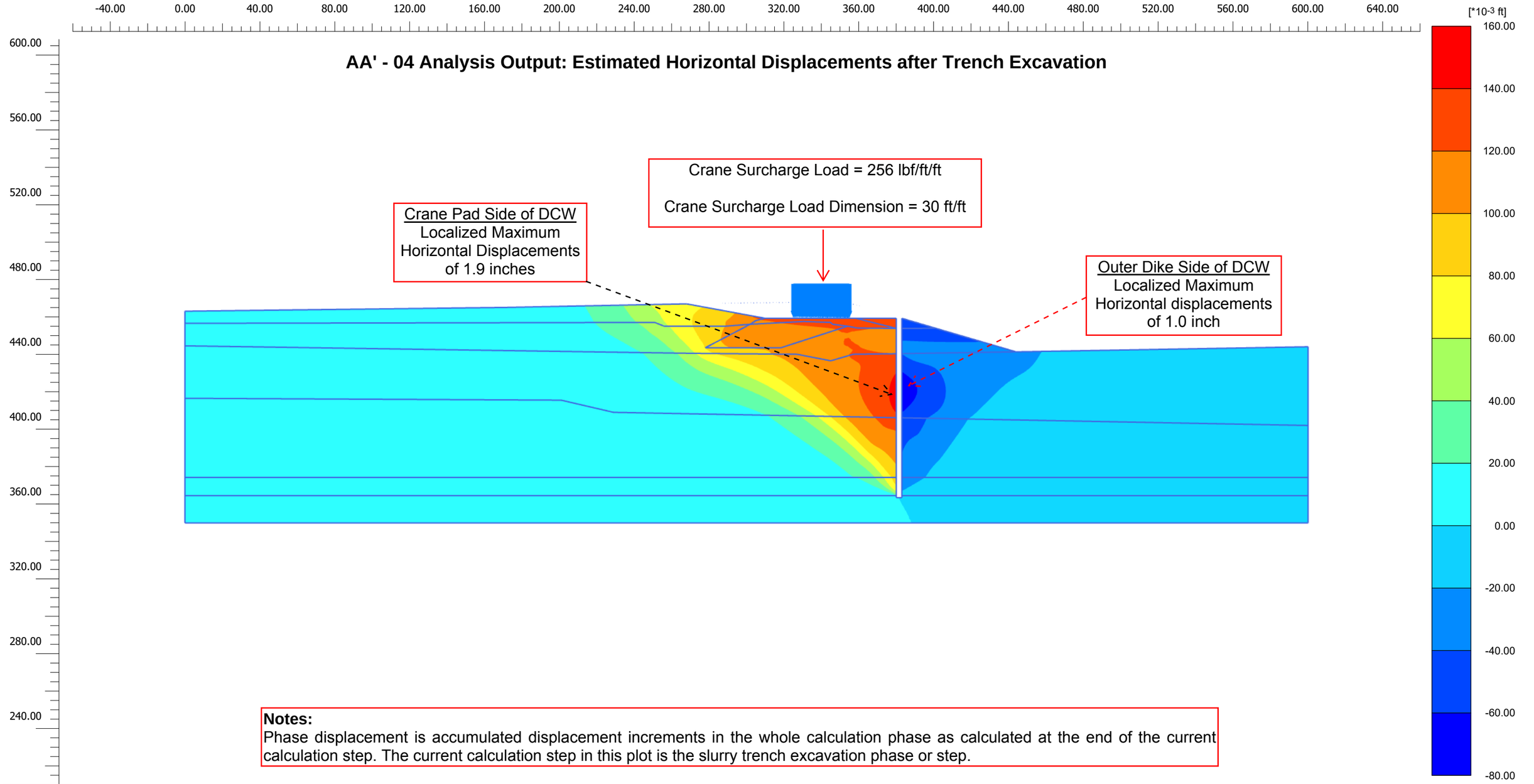
Phase deviatoric strain $P\gamma_s$ (scaled up 200 times) (Time $18.28*10^3$ day)

Maximum value = 0.1021 (Element 2907 at Node 13817)

Minimum value = $4.816*10^{-9}$ (Element 3143 at Node 26287)

RAMBOLL	*Project description* Hennepin West Ash Pond System Deep Cutoff Wall		*Date* 4/11/2025
	Project filename Cross Section A-A'	*Step* 262	*Company* Ramboll Americas Engineering Solutions

AA' - 04 Analysis Output: Estimated Horizontal Displacements after Trench Excavation



Notes:
Phase displacement is accumulated displacement increments in the whole calculation phase as calculated at the end of the current calculation step. The current calculation step in this plot is the slurry trench excavation phase or step.

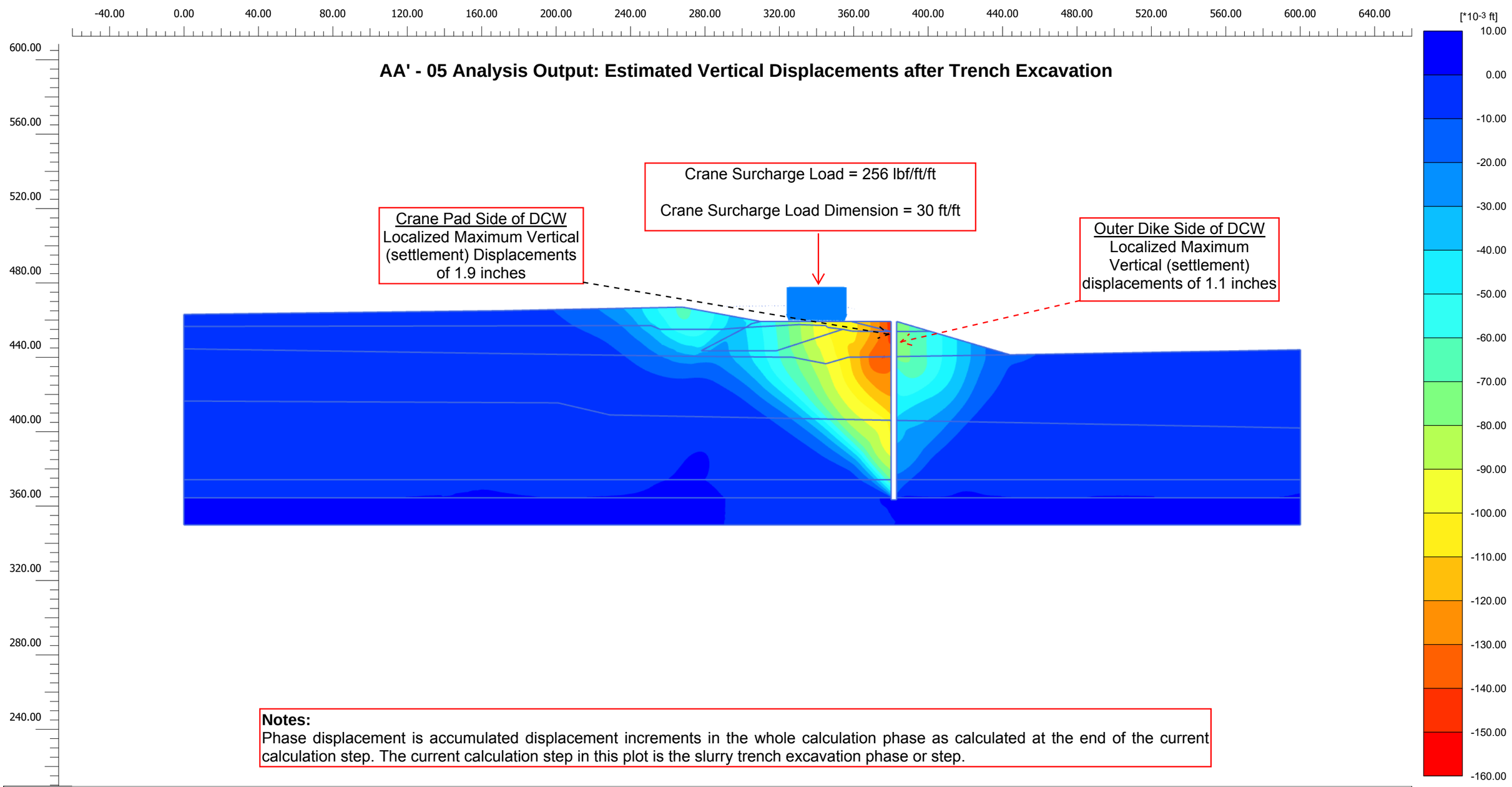
Phase displacements Pu_x (scaled up 50.0 times) (Time $18.28*10^3$ day)

Maximum value = 0.1441 ft (Element 1161 at Node 7830)

Minimum value = -0.06727 ft (Element 1543 at Node 7285)

RAMBOLL	*Project description* Hennepin West Ash Pond System Deep Cutoff Wall		*Date* 4/11/2025
	Project filename Cross Section A-A'	*Step* 262	*Company* Ramboll Americas Engineering Solutions

AA' - 05 Analysis Output: Estimated Vertical Displacements after Trench Excavation



Notes:
Phase displacement is accumulated displacement increments in the whole calculation phase as calculated at the end of the current calculation step. The current calculation step in this plot is the slurry trench excavation phase or step.

Phase displacements Pu_y (scaled up 100 times) (Time $18.28*10^3$ day)

Maximum value = $0.08934*10^{-3}$ ft (Element 2687 at Node 19856)

Minimum value = -0.1513 ft (Element 684 at Node 7017)

RAMBOLL	*Project description* Hennepin West Ash Pond System Deep Cutoff Wall		*Date* 4/11/2025
	Project filename Cross Section A-A'	*Step* 262	*Company* Ramboll Americas Engineering Solutions

Output Version 21.1.0.479

FF' - 01 Analysis Output: Safety Factor Assessment via Shear Strength Reduction after Work Pad Construction (FOS) = 1.77

Notes:
Phase deviatoric strain is a strain component that highlights shear deformation

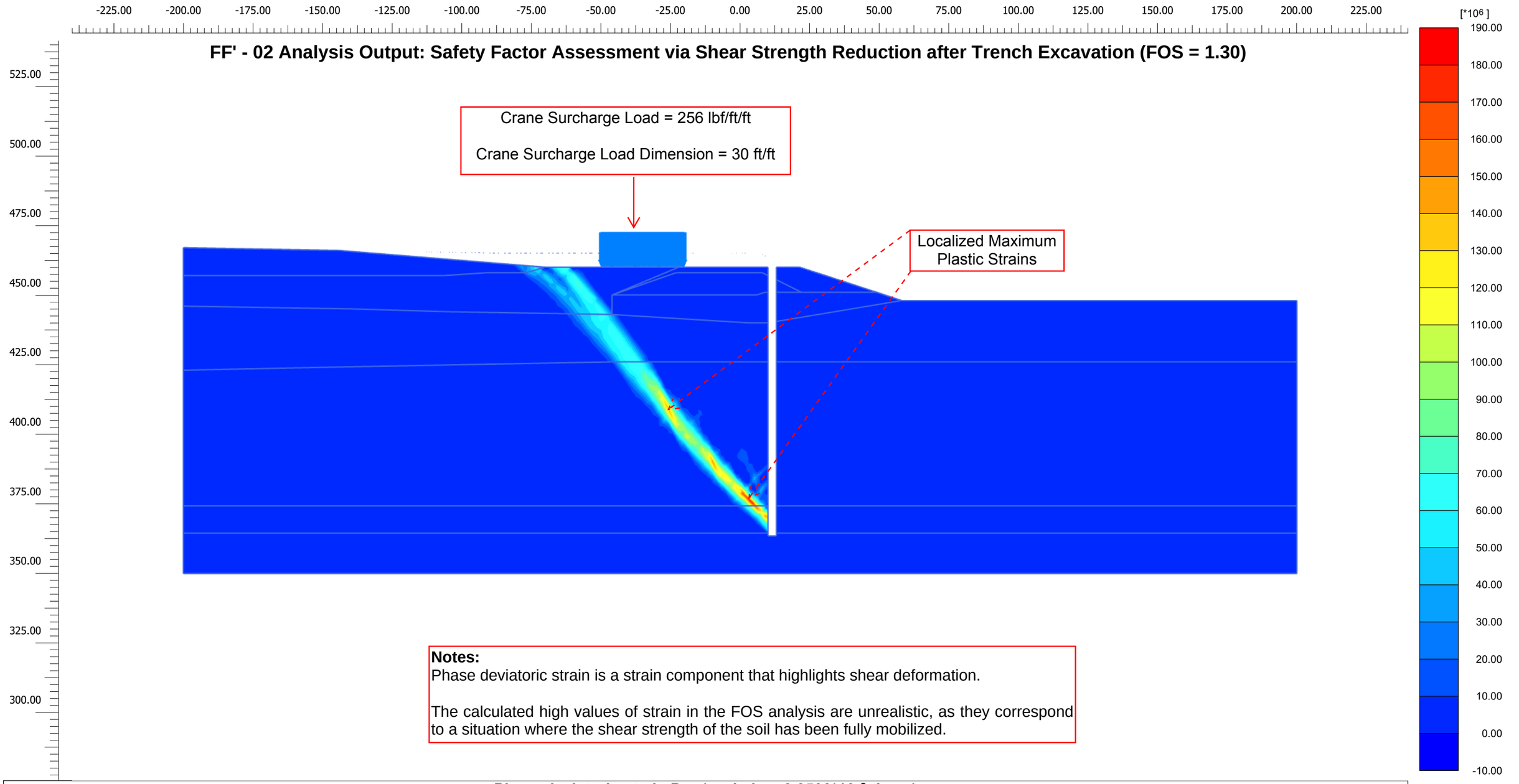
Phase deviatoric strain $P\gamma_s$ (scaled up $0.500*10^{-9}$ times)

Maximum value = $32.58*10^{9}$ (Element 723 at Node 5399)

Minimum value = $0.03550*10^{-6}$ (Element 2292 at Node 19603)

RAMBOLL	*Project description* Hennepin West Ash Pond System Deep Cutoff Wall		*Date* 4/11/2025
	Project filename Cross Section F-F'	*Step* 2199	*Company* Ramboll Americas Engineering Solutions

FF' - 02 Analysis Output: Safety Factor Assessment via Shear Strength Reduction after Trench Excavation (FOS = 1.30)



Notes:
Phase deviatoric strain is a strain component that highlights shear deformation.

The calculated high values of strain in the FOS analysis are unrealistic, as they correspond to a situation where the shear strength of the soil has been fully mobilized.

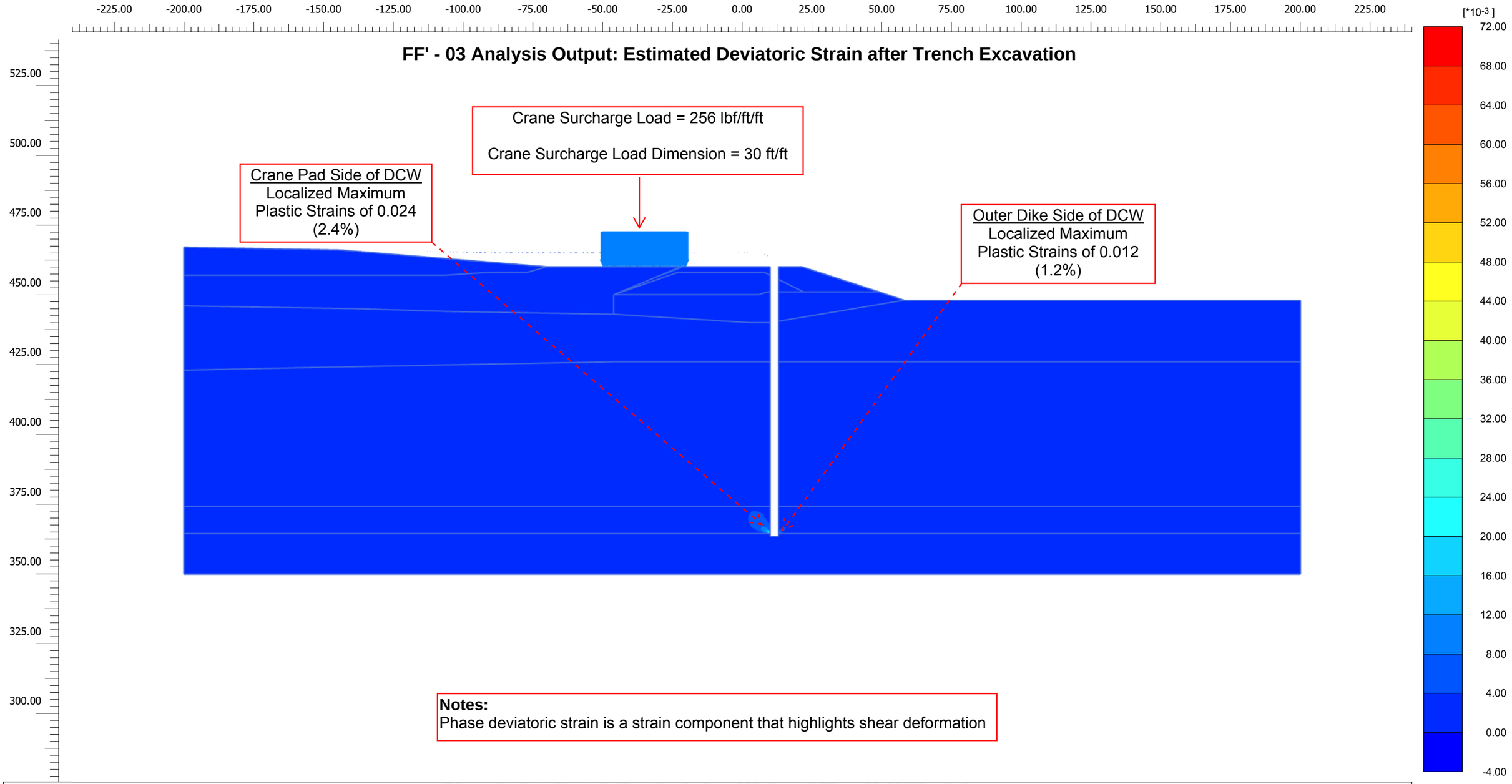
Phase deviatoric strain $P\gamma_s$ (scaled up $0.0500*10^{-6}$ times)

Maximum value = $180.1*10^{6}$ (Element 2026 at Node 13151)

Minimum value = $2.093*10^{-9}$ (Element 2292 at Node 19612)

RAMBOLL	*Project description* Hennepin West Ash Pond System Deep Cutoff Wall		*Date* 4/11/2025
	Project filename Cross Section F-F'	*Step* 1199	*Company* Ramboll Americas Engineering Solutions

FF' - 03 Analysis Output: Estimated Deviatoric Strain after Trench Excavation



Notes:
Phase deviatoric strain is a strain component that highlights shear deformation

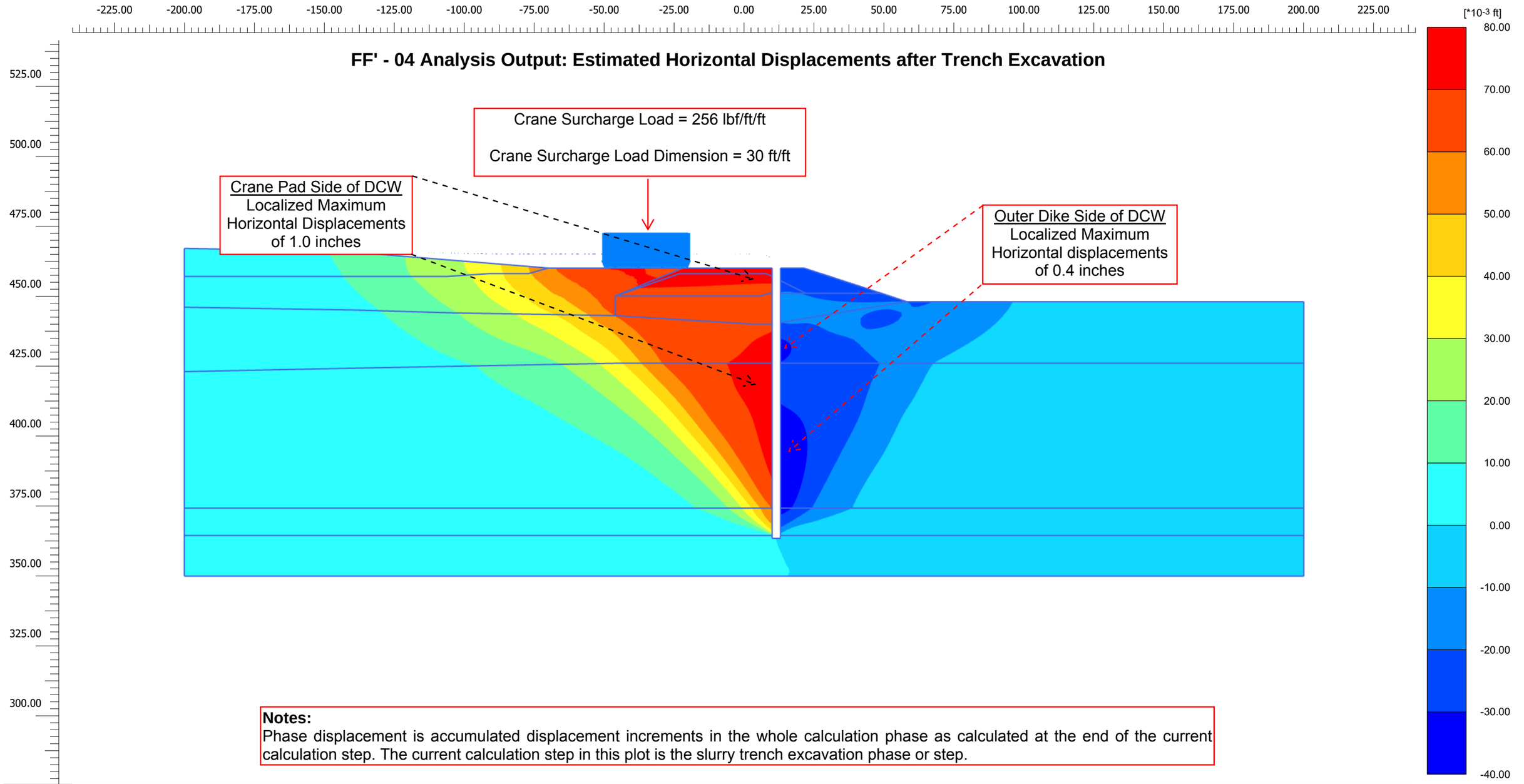
Phase deviatoric strain $P\gamma_s$ (scaled up 200 times) (Time $18.29*10^3$ day)

Maximum value = 0.06842 (Element 2162 at Node 15067)

Minimum value = $0.02442*10^{-6}$ (Element 2292 at Node 19603)

RAMBOLL	*Project description* Hennepin West Ash Pond System Deep Cutoff Wall		*Date* 4/11/2025
	Project filename Cross Section F-F'	*Step* 199	*Company* Ramboll Americas Engineering Solutions

FF' - 04 Analysis Output: Estimated Horizontal Displacements after Trench Excavation



Notes:
Phase displacement is accumulated displacement increments in the whole calculation phase as calculated at the end of the current calculation step. The current calculation step in this plot is the slurry trench excavation phase or step.

Phase displacements Pu_x (scaled up 100 times) (Time 18.29*10^3 day)

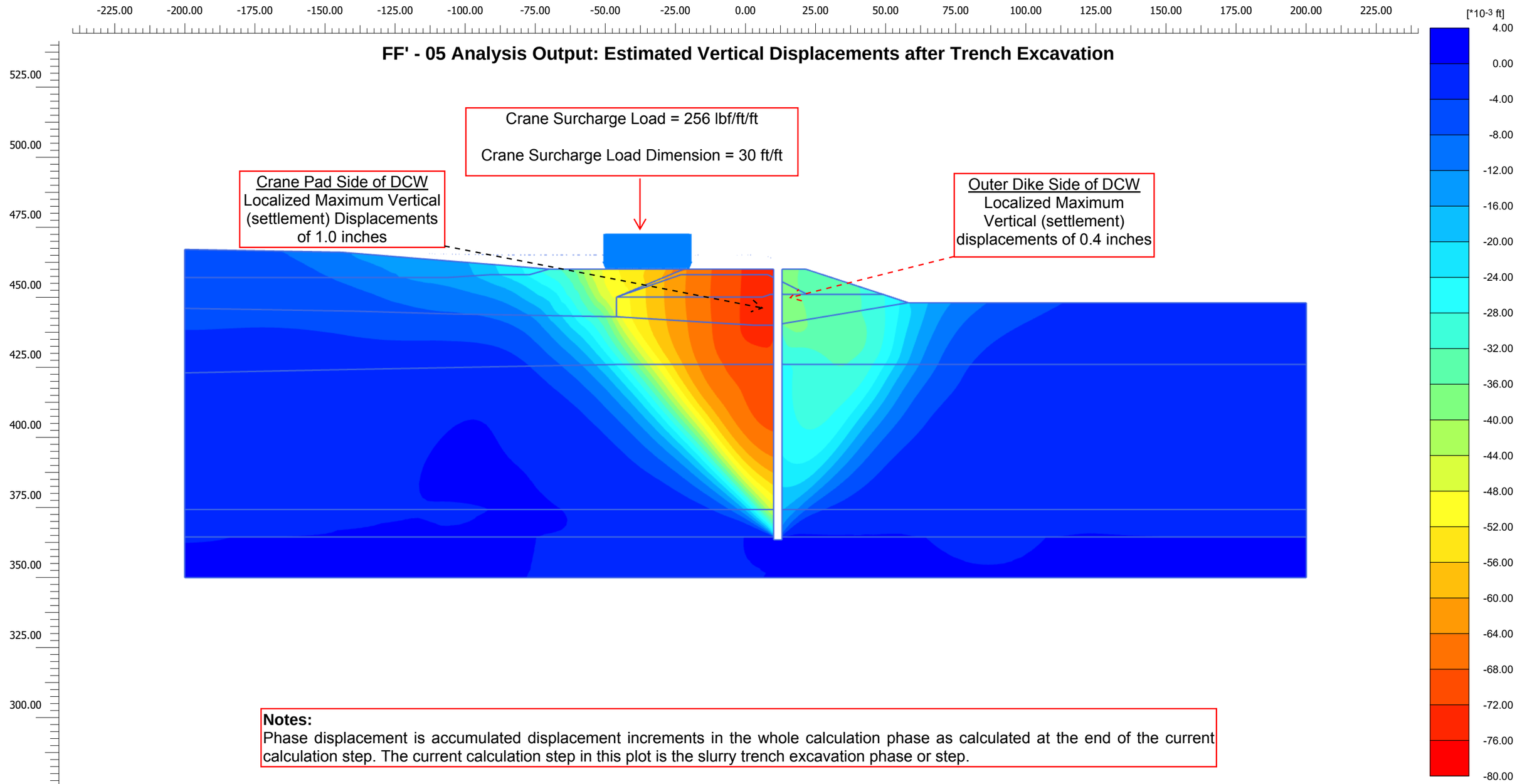
Maximum value = 0.07450 ft (Element 1472 at Node 13405)

Minimum value = -0.03589 ft (Element 1779 at Node 13603)

RAMBOLL	*Project description* Hennepin West Ash Pond System Deep Cutoff Wall		*Date* 4/11/2025
	Project filename Cross Section F-F'	*Step* 199	*Company* Ramboll Americas Engineering Solutions

Output Version 21.1.0.479

FF' - 05 Analysis Output: Estimated Vertical Displacements after Trench Excavation



Notes:
Phase displacement is accumulated displacement increments in the whole calculation phase as calculated at the end of the current calculation step. The current calculation step in this plot is the slurry trench excavation phase or step.

Phase displacements Pu_y (scaled up 200 times) (Time $18.29*10^3$ day)

Maximum value = $0.1721*10^{-3}$ ft (Element 1876 at Node 8536)

Minimum value = -0.07622 ft (Element 748 at Node 10745)

RAMBOLL	*Project description*: Hennepin West Ash Pond System Deep Cutoff Wall		*Date*: 4/11/2025
	Project filename: Cross Section F-F'	*Step*: 199	*Company*: Ramboll Americas Engineering Solutions

APPENDIX H.2
GEOTECHNICAL SITE PLAN

PROJECT: 1940110241-006 | DATED: 4/17/2025 | DESIGNER: ATABARES

- Pre-Closure Borings
- Pre-Closure Cone Penetration Test (CPT) Soundings
- Existing Monitoring Well
- Existing Piezometer
- 2024 Ramboll Bedrock Borings
- Geotechnical Analysis Cross-Section
- Existing Conditions Topography Contours
- Limits of Final Cover

0 250 500 Feet

Notes

1. All information is shown approximately and is for informational purposes.
2. Existing exploration, piezometers, and monitoring well locations are taken from reports prepared by AECOM, CEC, Geosyntec, NRT, and Ramboll from 2016-2025. These reports are included as attachments to the Corrective Action Plan.
3. Pre-closure borings and CPTs were advanced prior to the construction of the final closure of the WAPS. These explorations were advanced from ground surface elevations and through subsurface materials that may have been significantly altered as part of closure construction.
4. Existing conditions topography and the limits of the final cover system were taken from the permit-level remedial design drawings attached to this corrective action plan. Additional reference information for this information is included within those drawings.

GEOTECHNICAL SITE PLAN
HENNEPIN - WEST ASH POND SYSTEM

Vistra
Hennepin Power Station
Hennepin, Illinois

FIGURE 01

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

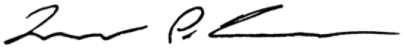
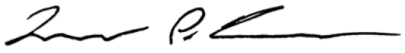
APPENDIX H.3
2020 GEOSYNTEC CLOSURE GEOTECHNICAL CALCULATIONS

Geosyntec
consultants

COMPUTATION COVER SHEET

Client: **Dynegy** Project: **Hennepin WAPS Final Design** Project No.: **CHE8356B**
Task No.: **B/02**

Title of Computations: **Geotechnical Calculations for Closure Design**

Computations by:	Signature		8-3-2020
	Printed Name	Dan Chambers	Date
	Title	Senior Staff Engineer	
Assumptions and Procedures Checked by: (peer reviewer)	Signature		8-3-2020
	Printed Name	Lucas P. Carr, P.E.	Date
	Title	Senior Engineer	
Computations Checked by:	Signature		8-3-2020
	Printed Name	Lucas P. Carr, P.E.	Date
	Title	Senior Engineer	
Computations backchecked by: (originator)	Signature		8-3-2020
	Printed Name	Dan Chambers	Date
	Title	Senior Staff Engineer	
Approved by: (pm or designate)	Signature		8-3-2020
	Printed Name	Lucas P. Carr, P.E.	Date
	Title	Engineer of Record	

Approval notes: Updated for cover raise

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No.	Sheet	Date	By	Checked by	Approval
1	-	9/16/2019	LPC	AS	JPS
2	-	8/03/2020	DC	LPC	LPC

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Client:	Dynegy	Project:	Hennepin Final Design	Project No.:	CHE8356B	Task No.:	B-02

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1. PURPOSE

This calculation package presents geotechnical calculations performed to support the development of the final closure design for the Old West Ash Pond (OWAP) and Old West Polishing Pond (OWPP) at the Hennepin Power Station (the Site). The analyses provided in this calculation package include:

(i) a summary of subsurface conditions and development of geotechnical design parameters and seismic inputs;

(ii) liquefaction screening analyses;

(iii) global slope stability analyses for static, pseudo-static, and post-earthquake conditions;

(iv) sheet pile wall design for temporary excavation support of the splitter dike between the OWAP and OWPP (Splitter Dike);

(v) seepage analyses to estimate inflows into the OWPP during excavation,

(vi) cover system veneer stability analyses, and

(vii) closure-induced settlement analyses.

2. SUMMARY OF SUBSURFACE INVESTIGATIONS

Subsurface investigation data for the Site is available from the following sources.

AECOM Investigation, 2015 – West Ash Complex

A subsurface investigation was performed by AECOM at the OWAP and OWPP and consisted of field exploration and laboratory testing between October and December of 2015 (AECOM, 2016). The field exploration included 18 hollow-stem auger and mud rotary borings, installation of 3 geotechnical piezometers to monitor groundwater levels, and 14 cone penetration test (CPT) soundings. Geotechnical explorations were located at the dike crest, dike toe, and within the ponds. Two borings were performed at the toe of the dike immediately north of the OWAP and OWPP, from barges within the Illinois River.

Boring depths ranged from 21.5 to 76.5 feet below ground surface (bgs). Soil samples were collected from each of the borings for laboratory testing. Disturbed soil samples were obtained with a split-spoon sampler during Standard Penetration Testing (SPT) and relatively undisturbed samples were collected using three-inch diameter steel Shelby tubes.

CPT soundings were performed with shear wave velocity measurements and pore pressure dissipation testing. CPT depths ranged from 5.7 to 88.9 feet bgs.

The laboratory testing program included the following tests:

Index Tests:

- Moisture content (ASTM D2216);
- Dry unit weight;
- Atterberg limits (ASTM D4318); and
- Grain size analyses (ASTM D422).

Strength Tests:

- Unconfined compressive strength (UCS) (ASTM D2166);
- Isotropically Consolidated-Undrained (CIU) (ASTM D4767);
- Drained direct shear (ASTM D3080);

Permeability Tests:

- Hydraulic Conductivity Testing (ASTM D5084).

Corrosion Tests:

- Soil Corrosivity Indication Series Testing (ASTM G51 / ASTM G57 / DIPRA)

CEC Investigation, 2016 – Old West Polishing Pond

Civil and Environmental Consultants (CEC) performed an investigation of the thickness of CCR within the OWPP in March of 2016 (CEC, 2016). The investigation consisted of nine hand-advanced Piston sampler borings, which were collected from a pontoon boat within the OWPP. Boring depths ranged from 6.2 to 8.5 feet. Each boring was advanced through CCR and into the underlying native soils. No laboratory testing was performed.

CEC Investigation, 2017 – Old West Ash Pond

CEC performed a subsurface investigation in March 2017 at the OWAP and Splitter Dike (CEC, 2017). The investigation was performed to evaluate the thickness and extents of CCR within the OWAP. The investigation consisted of 20 hollow-stem auger borings with SPT and split-spoon and Shelby tube sampling. Piezometers were installed in six of the borings. Boring depths ranged from 13 to 30 feet bgs. Each boring was advanced through CCR and into the underlying native soils. No laboratory testing was performed.

Geosyntec Investigation, 2017 – Old West Ash Pond and Old West Polishing Pond

Geosyntec performed a subsurface investigation in December 2017 at the OWAP, OWPP, and splitter dike (Geosyntec, 2018). The investigation was performed to: (i) evaluate the need for dewatering of CCR during closure construction, (ii) gather data on the compressibility of CCR and alluvial foundation soils for settlement analyses, (iii) evaluate geotechnical conditions along the approximate alignment of the proposed sheet pile wall, and (iv) collect information on the depth to and type of bedrock at the site. The investigation consisted of eight piezometers, nine test pits, and two borings on the OWAP; two piezometers along the OWPP perimeter dikes; and four borings along the proposed sheet pile wall alignment. Samples of soil and CCR were collected from select borings and piezometers for laboratory testing. Borings and piezometers were advanced to depths between 10.1 and 55.5 feet; test pits were advanced to depths between 5.0 and 10.5 feet.

The laboratory testing program included the following tests:

Index Tests:

- Moisture content (ASTM D2216);
- Dry unit weight;
- Atterberg limits (ASTM D4318);
- Grain size analyses (ASTM D422); and
- Specific gravity (ASTM D854).

Strength Tests:

- Unconsolidated-undrained triaxial (UU) (ASTM D2850);

Permeability Tests:

- Flexible wall hydraulic Conductivity Testing (ASTM D5084)

Compressibility Tests:

- Incremental one-dimensional consolidation (ASTM D2435)

3. SUMMARY OF SUBSURFACE CONDITIONS

In general, the soils encountered at the OWAP and OWPP included;

(i) CCR (predominantly fly ash with some bottom ash) within the ponds;
(ii) Sand and Gravel Dike Fill, comprising the upper-most portions of the perimeter dikes (typically 10 to 15 ft thick, but variable across the site);
(iii) Silt and Clay Dike Fill, comprising the lower portions of the perimeter dikes,
(iv) Silt and Clay Alluvium, beneath the dikes and CCR;
(v) Sand and Gravel Alluvium, beneath the Silt and Clay Alluvium in most areas, although sometimes directly under the CCR and perimeter dikes where the Silt and Clay Alluvium is not present.
(vi) Organic Sediments were also present in the Illinois River riverbed, directly overlying the Silt and Clay Alluvium soils.

Each subsurface material is discussed in the following sub-sections.

CCR

CCR at the OWAP and OWPP predominantly consisted of wet-sluiced material within the interior of the pond. The material size was generally classified as silt, sandy silt, or silty sand; this indicates that the material is predominantly fly ash but also contains zones of bottom ash. The consistency of the material, based on uncorrected field SPT blowcounts, ranged from very loose to dense within the interior of the pond. CCR was found to underlie the splitter dike between the Old West Ash Pond and Old West Polishing Pond; this indicates that the dike was constructed over sluiced CCR as stated in historic construction documents (AECOM, 2016b).

A limited amount of CCR intermingled with Silt and Clay Dike Fill was encountered in 2015 AECOM boring HEN-B012 (AECOM, 2016), drilled in the southwest dike crest of the Old West Ash Pond. The material was encountered between 15 and 25 feet in depth

and was described as a hard, sandy silt with ash, and had an SPT N-value of 47. This indicates that the material was likely placed as structural dike fill and means that it is unlikely that the material is comprised of sluiced CCR. CCR was not encountered within the perimeter dikes of the Old West Ash Pond in any other borings reviewed by Geosyntec (AECOM, 2015; CEC, 2017; and Geosyntec, 2018).

Sand and Gravel Dike Fill [SGDF]

The SGDF at the OWAP and OWPP consisted of compacted granular fill. The fill is present above the Silt and Clay Dike Fill around the entire perimeter of the OWAP and OWPP, and at the splitter dike, and was placed circa 1988-1989 to raise the crest of the dike from approximately El. 460 ft to El. 465 ft (AECOM, 2016b). The SGDF was generally classified as clayey gravel or clayey sand. The consistency of the material, based on uncorrected field SPT blow counts, was typically medium dense to very dense.

Silt and Clay Dike Fill [SCDF]

The SCDF at the OWAP and OWPP consisted of compacted cohesive dike fill and underlies the SCDF around the entire perimeter embankment, and at the splitter dike. The material constitutes the original OWAP and OWPP embankment constructed in 1951 and 1952 and the splitter dike between the OWPP and OWAP constructed in 1988 to 1989 (AECOM, 2016b). The 1951-1952 and 1988-1989 materials were found to have essentially the same geotechnical characteristics. The SCDF was generally classified as a lean clay, clayey silt, or silt, although some pockets of granular material were also present. The consistency of the material, based on uncorrected field SPT blow counts, was typically medium stiff to stiff.

Silt and Clay Alluvium [SCA]

The SCA at the OWAP and OWPP consisted of native, normally-consolidated alluvial deposits and underlie the dike materials and most of the pond. The SCA is not present at the northeast corner of the OWAP, where the CCR lies directly on top of the Sand and Gravel Alluvium. The Silt and Clay Alluvium was generally classified as a lean clay, clayey silt, or silt, although some pockets of granular material were also present. The consistency of the materials, based on uncorrected field SPT blow counts, was typically medium stiff.

Sand and Gravel Alluvium [SGA]

The SGA at the OWAP and OWPP consisted of native alluvial and glacial outwash deposits and underlaid the entirety of the Site. The material was generally classified as a silty gravel, clayey gravel, well-graded gravel, or a silty sand, although some pockets of cohesive material were also present. The consistency of the SGA, based on uncorrected field SPT blow counts, was typically medium dense to dense.

Organic Sediments

Organic sediments were encountered overlying the alluvial materials in barge-based borings drilled within the Illinois River, and consisted of recent, normally-consolidated river sediments. The material was generally classified as an organic clay with some pockets of silty sand. The consistency of the material, based on uncorrected field SPT blow counts, was typically very soft.

4. DESIGN GEOTECHNICAL STRENGTH AND UNIT WEIGHT PARAMETERS

Design geotechnical strength and unit weight parameters for each subsurface material were selected using available laboratory data, CPT sounding information, published correlations, and engineering judgment. Design geotechnical parameters are summarized in Table 1, and the process used to select the design geotechnical parameters is described in the following sub-sections. Design hydraulic parameters are discussed in Section 8.

Written by: **DC** Date: **08-03-20** (DD MM YY) Reviewed by: **LPC** Date: **08-03-20** (DD MM YY)

Client: **Dynegy** Project: **Hennepin Final Design** Project No.: **CHE8356B** Task No.: **B-02**

Table 1. Design Geotechnical Parameters

Soil Unit	Total Unit Weight, γ_t (pcf)	Drained Strength		Peak Undrained Strength		Post-Earthquake Strength	
		Friction Angle, ϕ' (deg.)	Cohesion, c' (psf)	Undrained Shear Strength[1], Su (psf)	$\frac{\tau_{ff}}{\sigma'_{fc}}$	Undrained Shear Strength, Su (psf)	$\frac{\tau_{ff}}{\sigma'_{fc}}$
CCR	102	33	0	--	0.42	--	0.42 *(under splitter dike)*[2] 0.045 *(inside ash pond)*[3]
Silt and Clay Dike Fill	115	CIU: 30 DS: 25	75	1,000	--	--	--
Sand and Gravel Dike Fill	120	38	0	--	--	--	--
Silt and Clay Alluvium	110	CIU: 30 DS: 25	75	0 ft ≤ z ≤ 8.5 ft: 260 z > 8.5 ft: 260 + 15.5 * (z - 8.5)	--	--	--
Sand and Gravel Alluvium	z < 20 ft: 115 z ≥ 20 ft: 125	38	0	--	--	--	--
Organic Sediments	107	24	0	0 ft ≤ z ≤ 5 ft: 250 z > 5 ft: 250 + 110 * (z - 5)	--	0 ft ≤ z ≤ 5 ft: 190 z > 5 ft: 190 + 120 * (z - 5)	--
Buttress	125	34	75	900	--	--	--

CCR

The design total unit weight of CCR was selected as 99 pcf based on laboratory measurements (Figure 1). It should be noted that some of the CCR specimens that were subjected to unit weight and CIU triaxial tests were observed to be mixed CCR and soil. These specimens are indicated using a different symbol on Figures 1, 2, and 3.

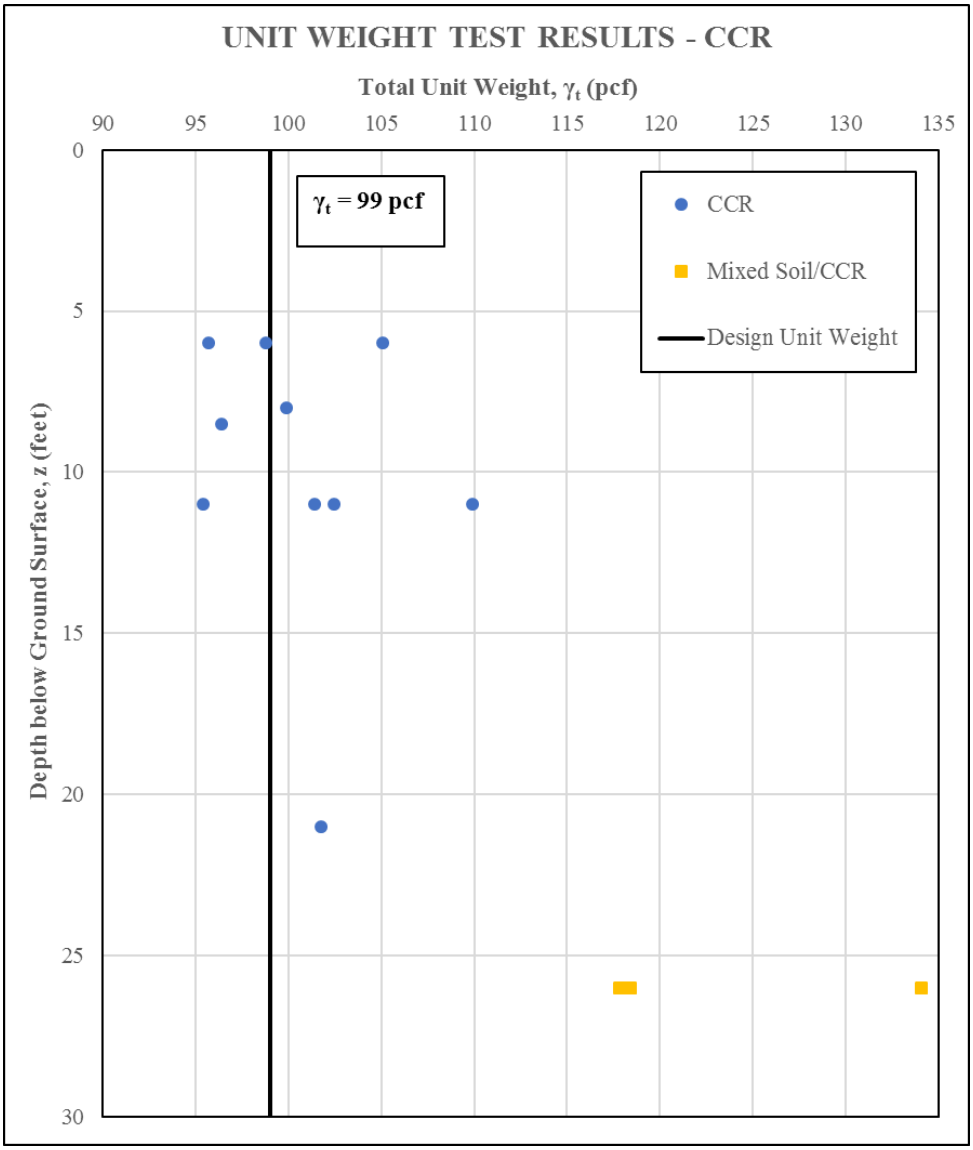

Figure 1. Design Unit Weight of the CCR

The design drained strength of the CCR material was selected as a friction angle of 33 degrees with no cohesion based on results of CIU triaxial tests (Figure 2). Triaxial test specimen failure was defined as peak obliquity, limited to 10% maximum axial strain.

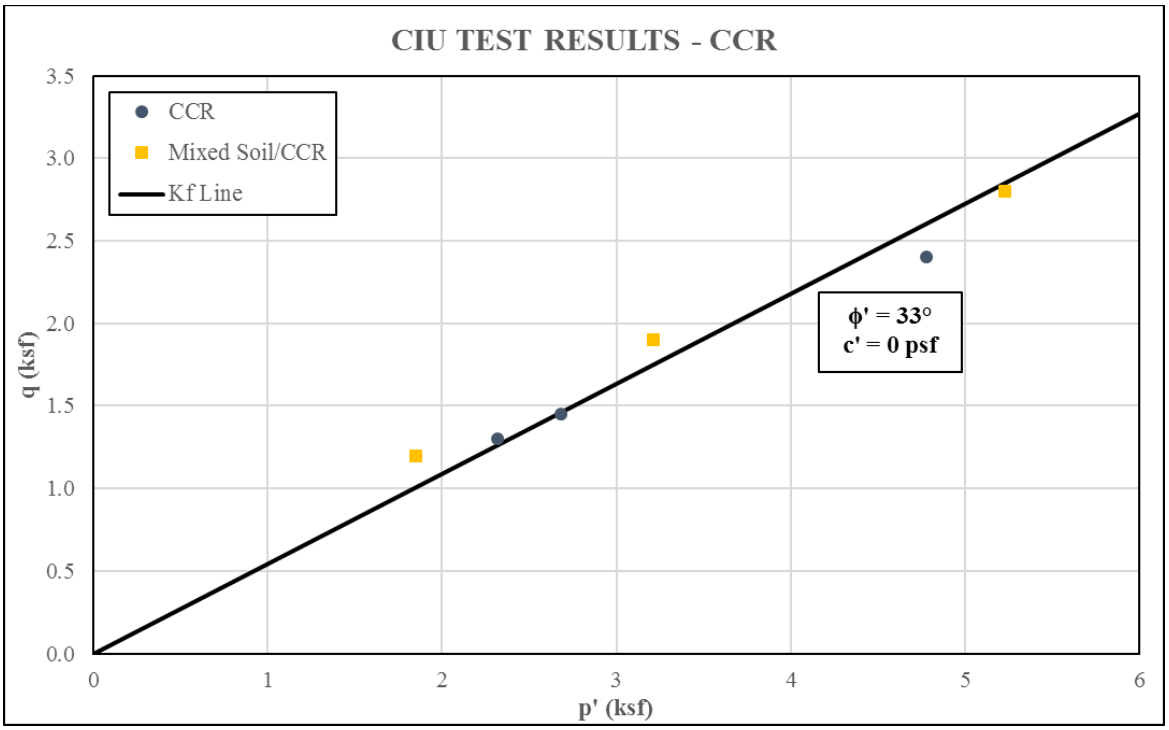

Figure 2. Design Drained Strength of the CCR

The peak undrained strength of the CCR materials was modeled using a ratio of undrained shear strength on the failure plane at failure to vertical consolidation stress on the failure plane prior to shear (i.e., $\frac{\tau_{ff}}{\sigma'_{fc}}$ or a c/p' ratio). A lower-bound ratio of 0.42 was selected based on CIU triaxial test measurements (Figure 3). Failure of CIU specimens was again defined as peak obliquity, limited to 10% strain. *In-situ* vertical effective stress ranges for CCR within the OWAP range from 0 to 2.5 ksf, and the selected ratio of 0.42 represents a lower-bound shear strength within this range of stresses.

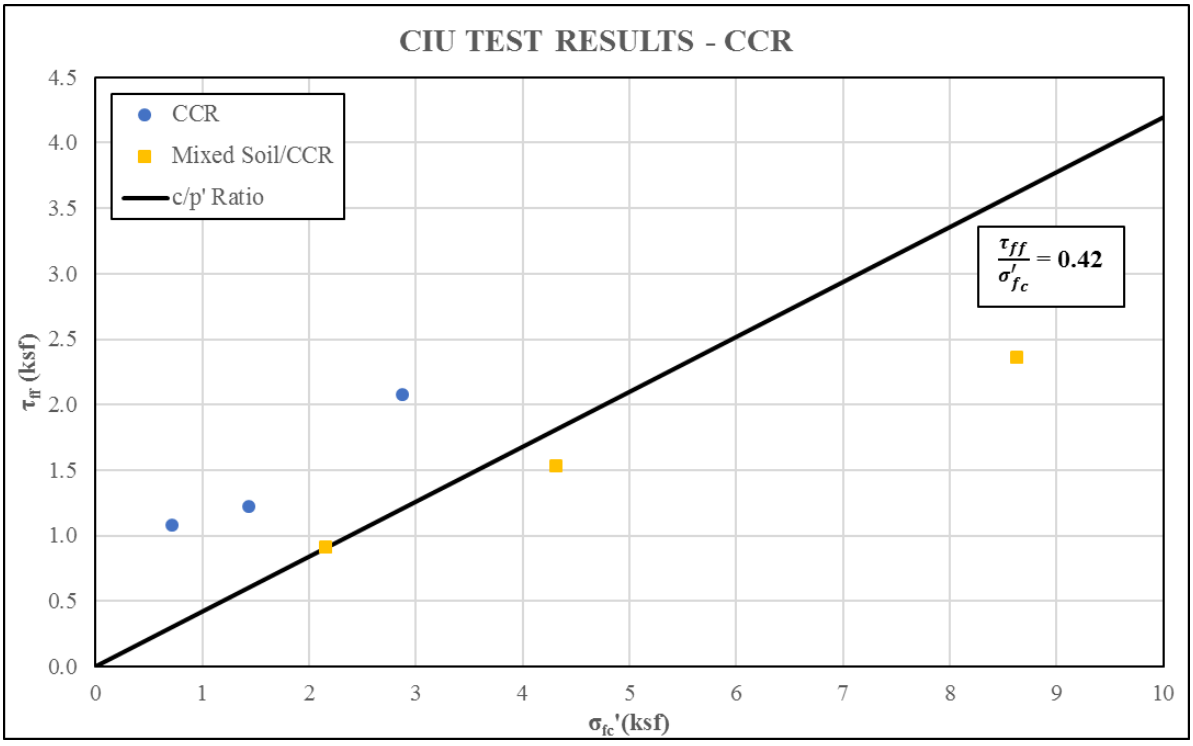

Figure 3. Design Undrained Strength of the CCR

Silt and Clay Alluvium

The design total unit weight of the Silt and Clay Alluvium was selected as 111 pcf based on laboratory measurements (Figure 4). This corresponds to a mean unit weight for the entire site.

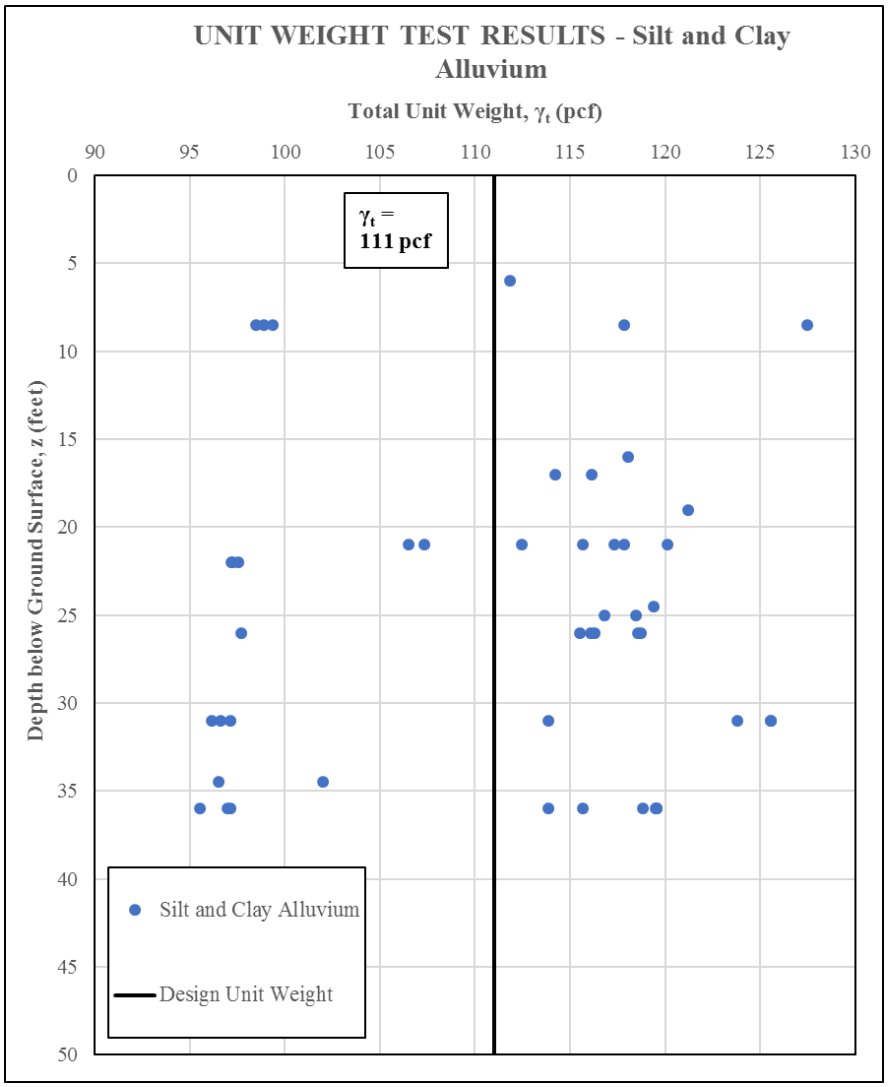

Figure 4. Design Unit Weight of the Silt and Clay Alluvium

The drained shear strength of the Silt and Clay Alluvium was selected based on CIU triaxial and direct shear tests. Failure for CIU specimens was defined as peak obliquity, limited to 10% axial strain, while failure for direct shear specimens was defined as peak shear stress, limited to 10% shear strain. From the CIU triaxial data and direct shear data, design friction angles of 30 degrees and 25 degrees were selected, respectively, as shown

in Figures 5 and 6. From both the CIU and direct shear data a cohesion of 75 psf was selected for design. Based on these test results it is assumed that there is strength anisotropy, which is common in fine-grained alluvial deposits. The strength anisotropy was modeled within the slope stability analysis using an anisotropic strength function, which varies the friction angle as a function of the slip surface base angle. Slip surface angles of 1 to 90 degrees (e.g. triaxial compression) were assigned a friction angle of 30 degrees while slip surface angles of 0 to -90 degrees (e.g. direct shear and triaxial extension) were assigned a friction angle of 25 degrees. A constant cohesion of 75 psf was assumed for all slip surface base angles.

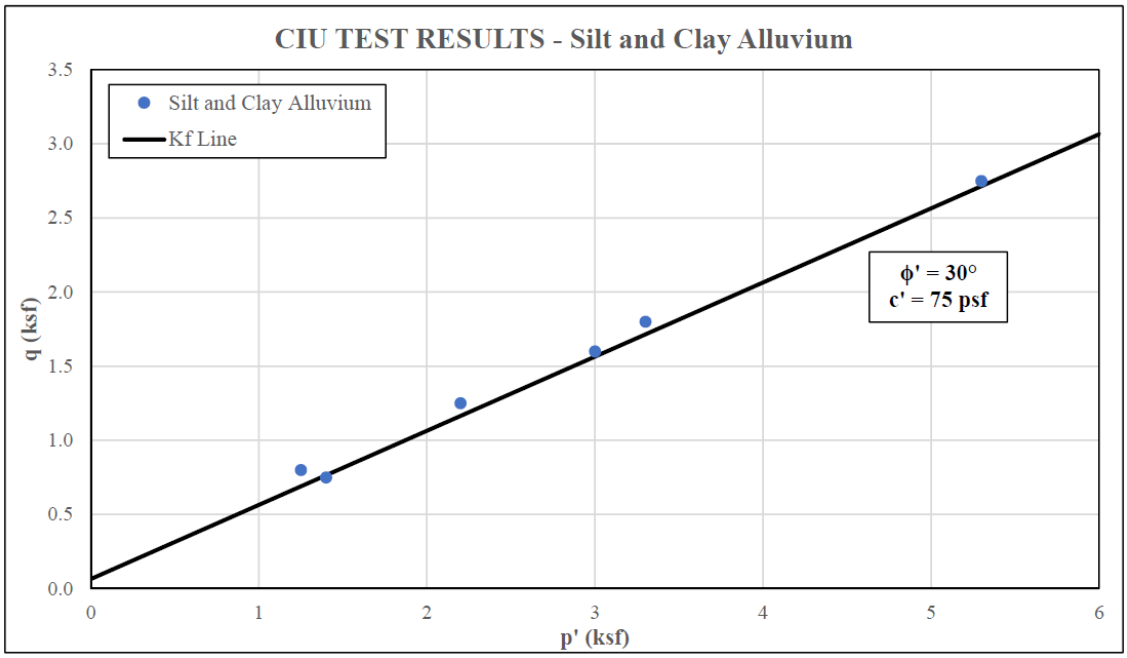

Figure 5. CIU Triaxial Design Drained Strength of the Silt and Clay Alluvium

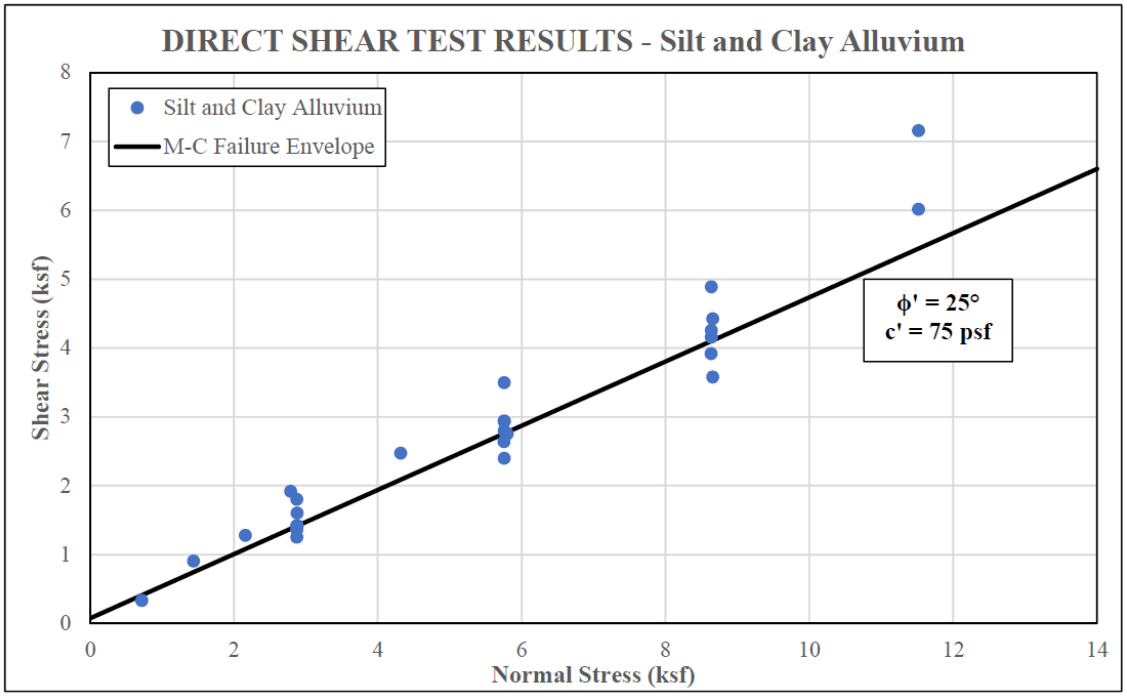

Figure 6. Direct Shear Design Drained Strength of the Silt and Clay Alluvium

The design undrained shear strength of the Silt and Clay Alluvium was selected using a function of undrained shear strength vs. depth below grade, as shown in Table 1 and Figure 7. The strength data were found to correlate better with depth below existing grade rather than with sample elevation and were therefore plotted as such. Undrained shear strength data were taken from unconfined compressive strength (UCS) and unconsolidated-undrained triaxial tests (AECOM, 2016 and Geosyntec, 2018) and correlation with CPT data. The CPT correlation follows NCHRP (2007) and used a N_{kT} value of 17 which provided a reasonable agreement with the UCS data. The design undrained shear strengths are indicative of a normally-consolidated alluvial clay, as the shear strength was found to increase with depth and approximately follows a c/p' ratio of 0.3.

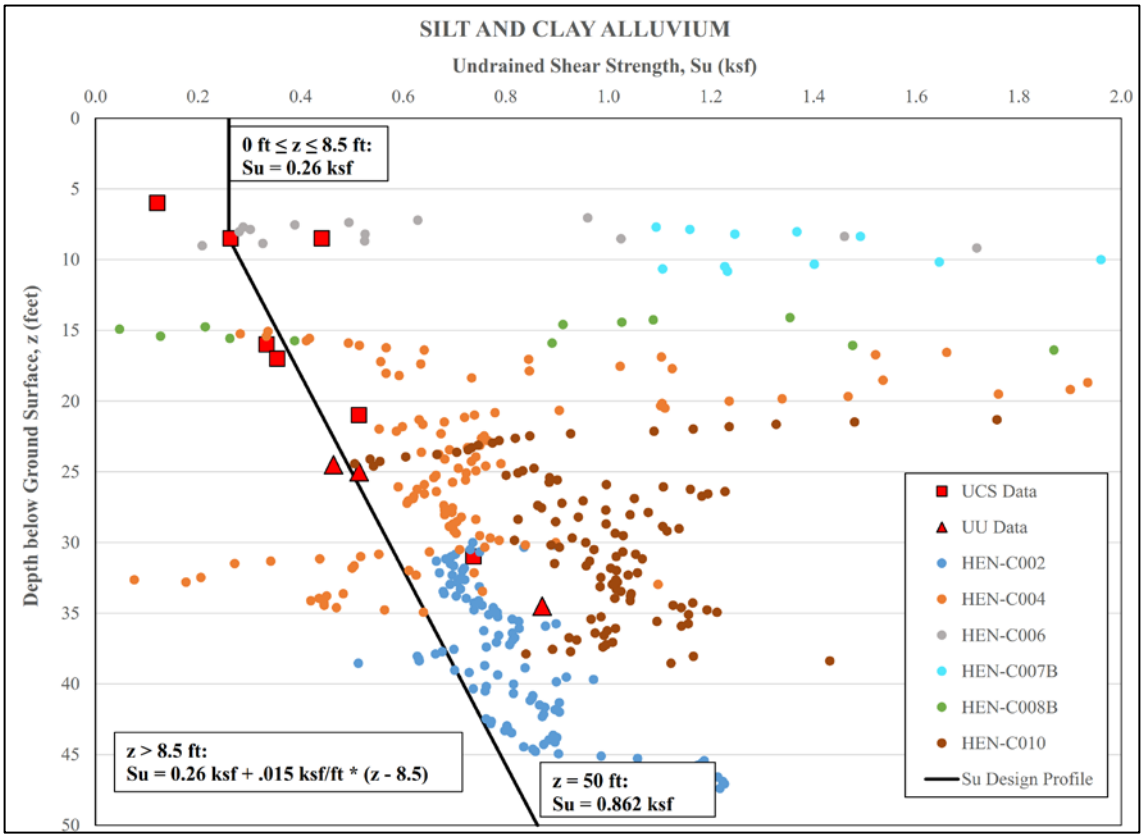

Figure 8. Design Undrained Strength of the Silt and Clay Alluvium

Silt and Clay Dike Fill

The Silt and Clay Dike Fill was assigned the same design unit weight and drained strength parameters as the Silt and Clay Alluvium, as drained shear strength test data is not available for this material, and it is likely comprised of Silt and Clay Alluvium that was excavated from the footprint of the ponds and compacted to form the dikes. The undrained strength of the Silt and Clay Dike Fill was estimated to be a constant value of 1,000 psf based on unconfined compressive strength tests and CPT data (Figure 9), following the same methodology used for the Silt and Clay Alluvium. The apparent scatter in the CPT data in Figure 9 is primarily due to the presence of gravel win the Silt and Clay Dike Fill; these high correlated undrained shear strengths were therefore not used for design.

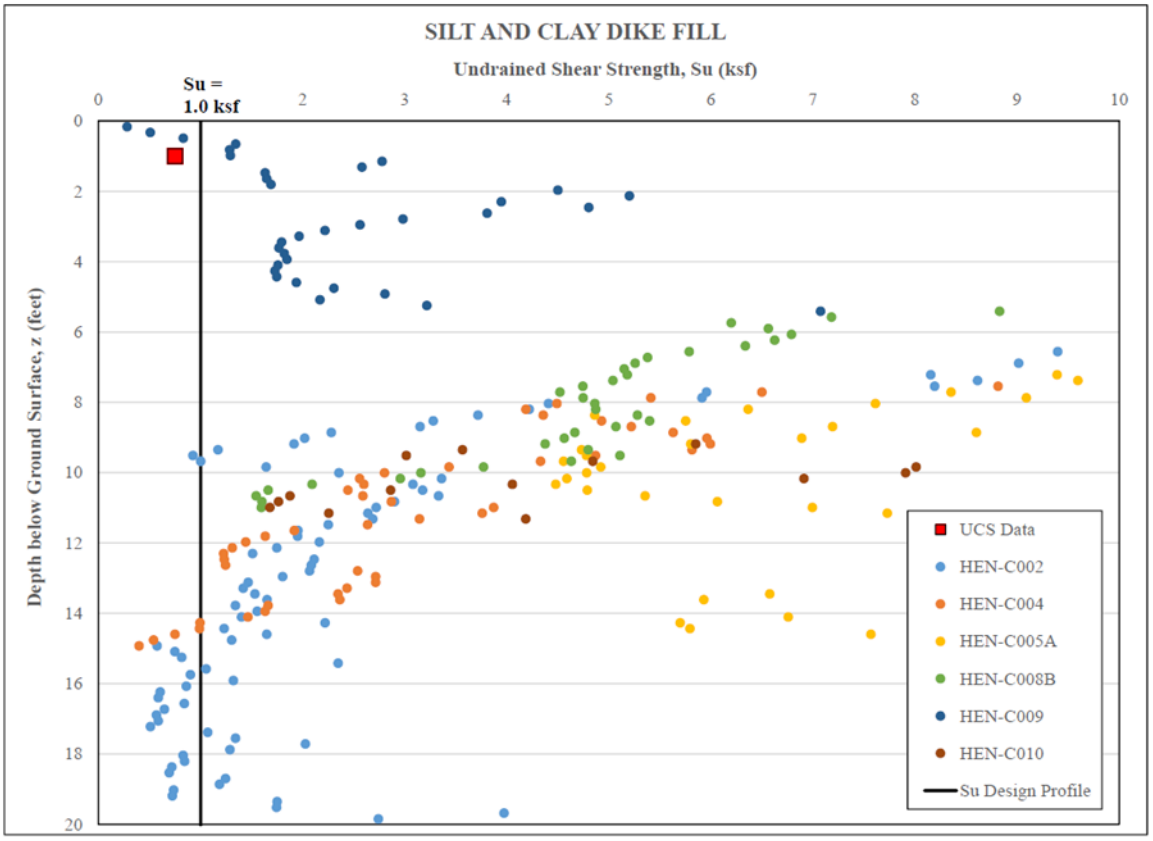

Figure 9. Design Undrained Strength of the Silt and Clay Dike Fill

Sand and Gravel Dike Fill

The Sand and Gravel Dike Fill was assigned a unit weight of 120 pcf (Figure 10) based on correlation with CPT data following NCHRP (2007).

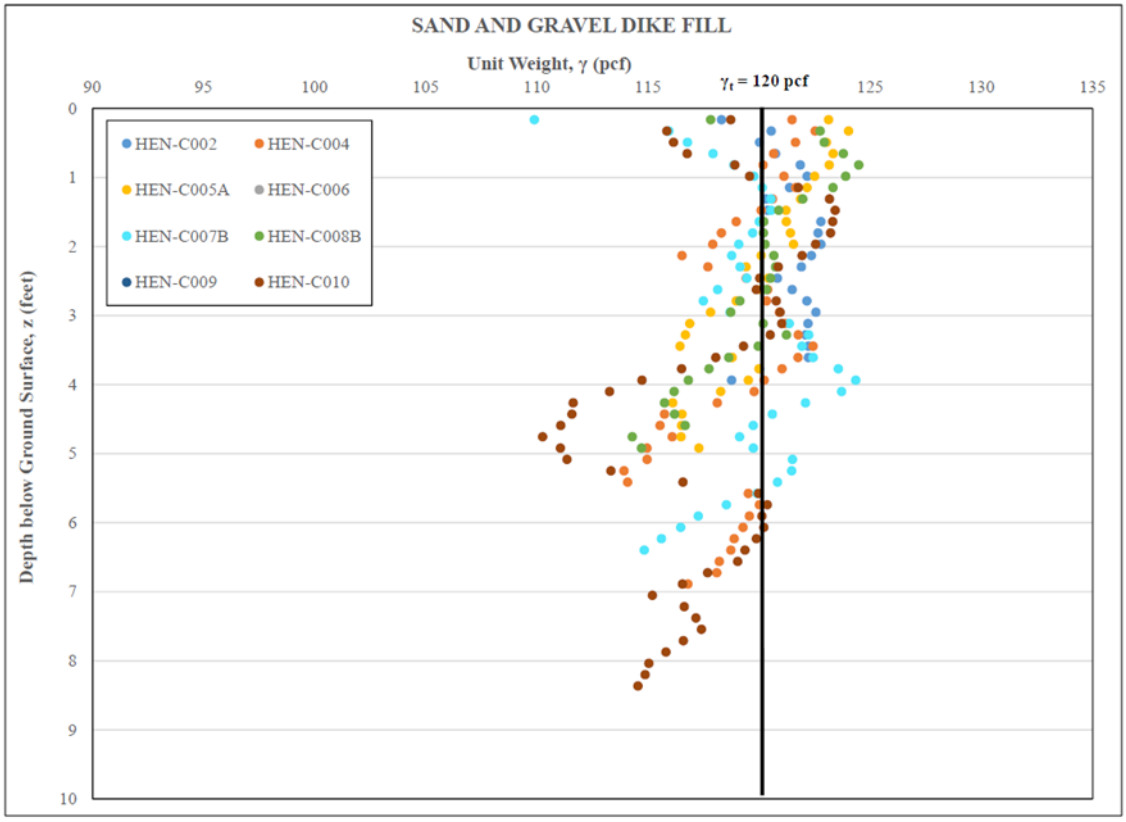

Figure 10. Design Unit Weight of the Sand and Gravel Dike Fill

The Sand and Gravel Dike Fill was assigned a 38-degree friction angle with no cohesion (Figure 11) based on correlation with CPT data following Kulhawy and Mayne (1990). Although the CPT correlations indicated friction angles above 38 degrees, the design friction angle was limited to 38 degrees based on engineering judgment. The material is assumed to be free-draining and respond in a drained manner to both static and seismic loading conditions.

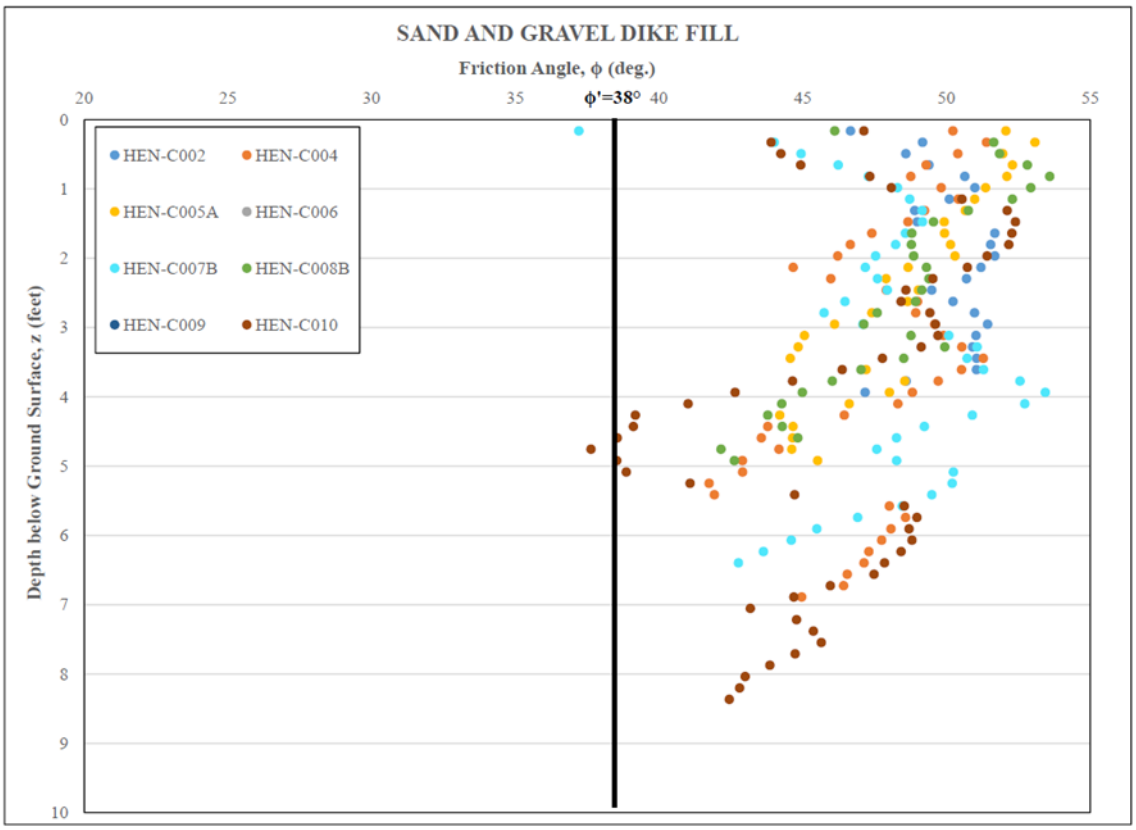

Figure 11. Design Drained Strength of the Sand and Gravel Dike Fill

Sand and Gravel Alluvium

The Sand and Gravel Alluvium was assigned an unsaturated unit weight of 115 pcf above a depth of 20 feet bgs and a saturated unit weight of 125 pcf at 20 feet bgs and deeper based on correlation with CPT data (Figure 12), following the same methodology used for the Sand and Gravel Dike Fill.

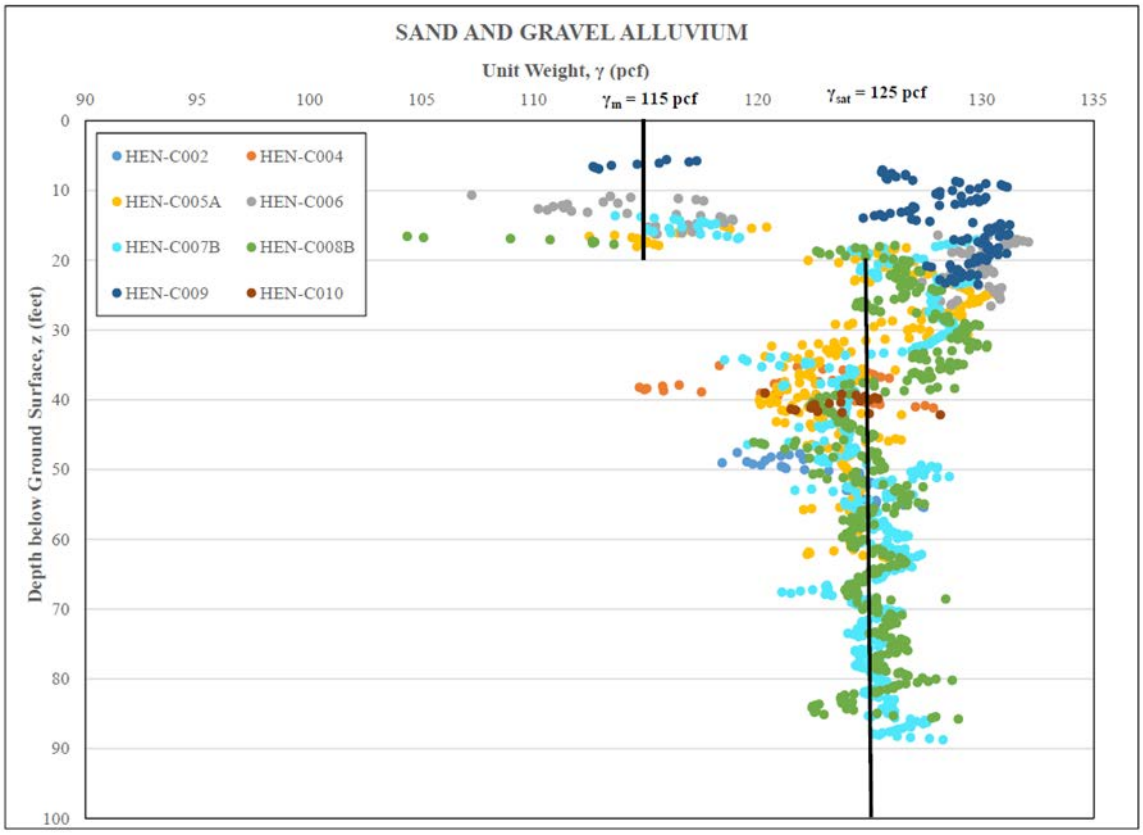

Figure 12. Design Unit Weight of the Sand and Gravel Alluvium

A friction angle of 38 degrees with no cohesion was assigned for the Sand and Gravel Alluvium material based on correlation with CPT data (Figure 13), following the same methodology as the Sand and Gravel Dike Fill. The material was assumed to be free draining and respond in a drained manner to both static and seismic loading conditions.

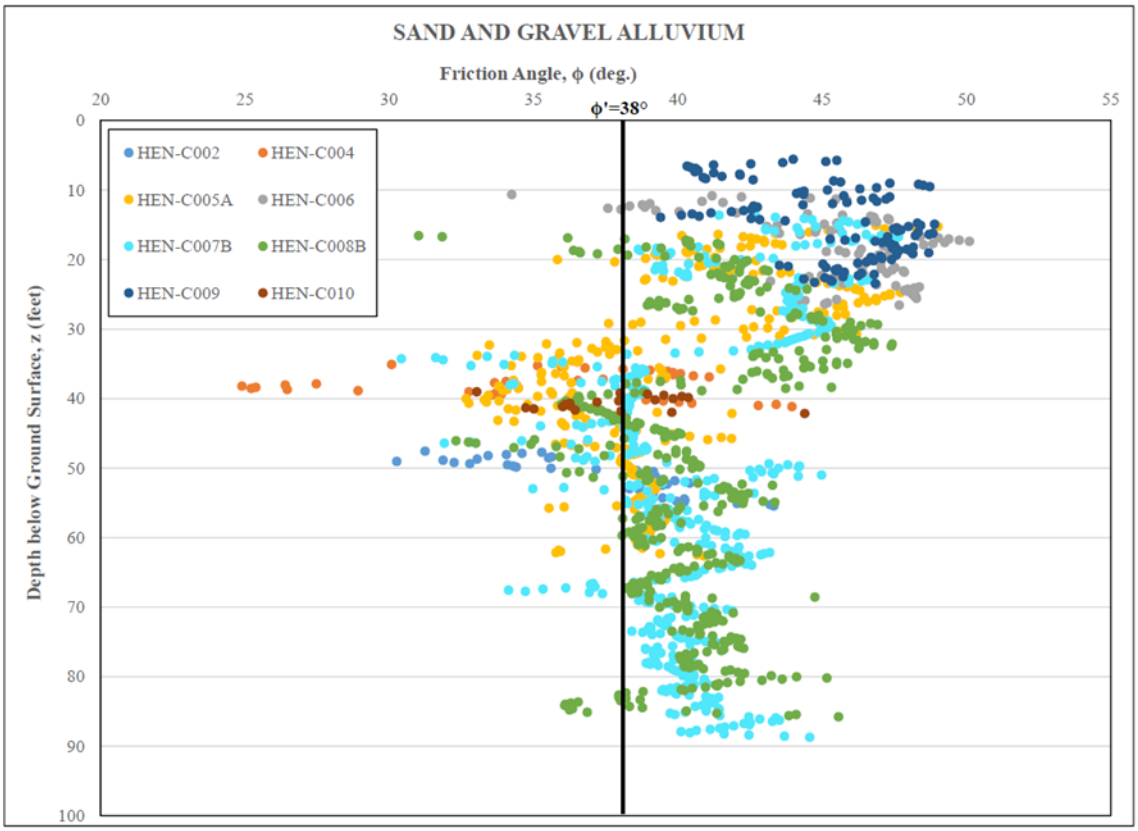

Figure 13. Design Drained Strength of the Sand and Gravel Alluvium

Organic Sediments

The Organic Sediments were assigned a design unit weight of 107 pcf based on the mean value of laboratory measurements (Figure 14).

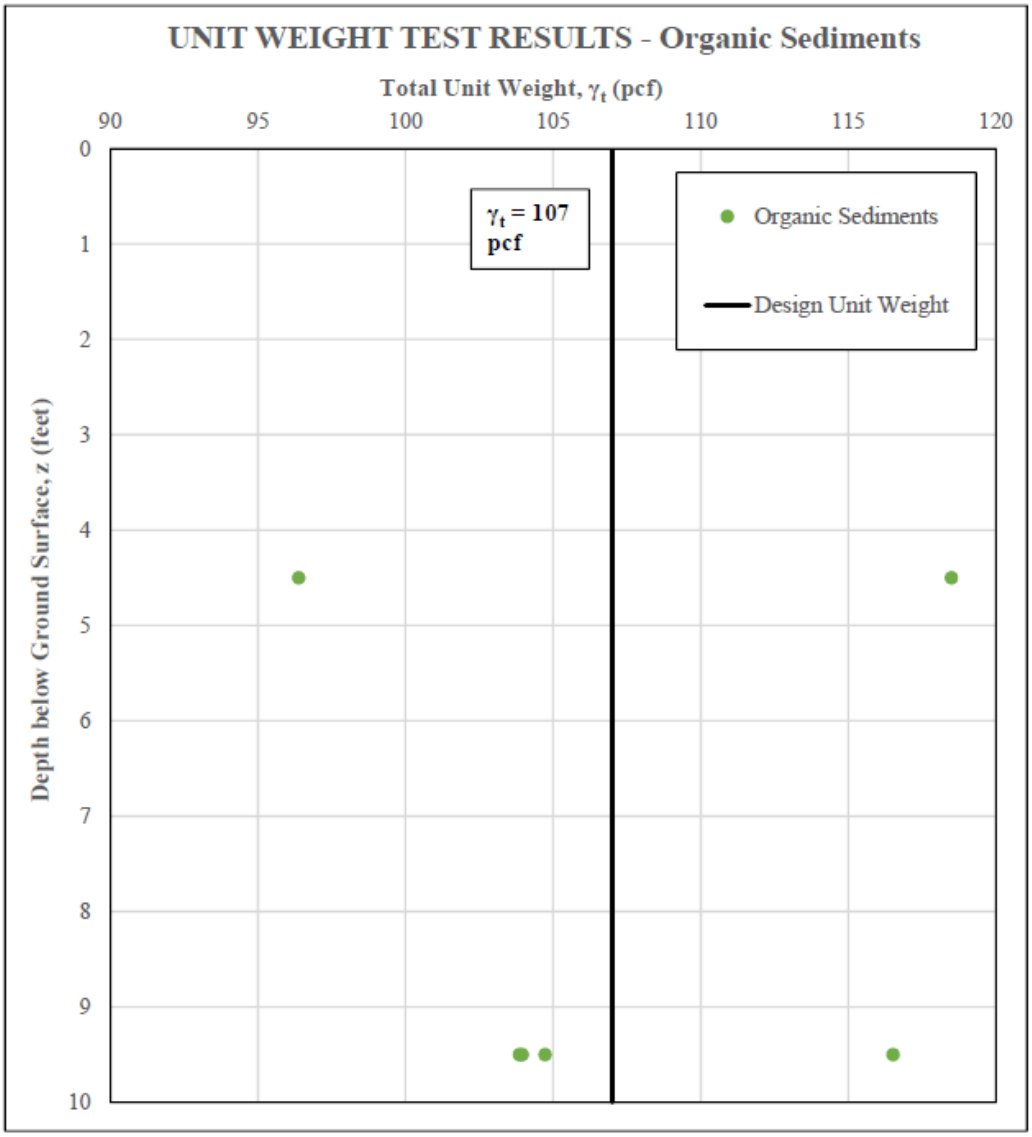

Figure 14. Unit Weight of the Organic Sediments

The design drained shear strength of the organic sediments was selected based on direct shear tests. Based on the direct shear data shown in Figure 15, a design friction angle of 24 degrees with no cohesion was selected for design.

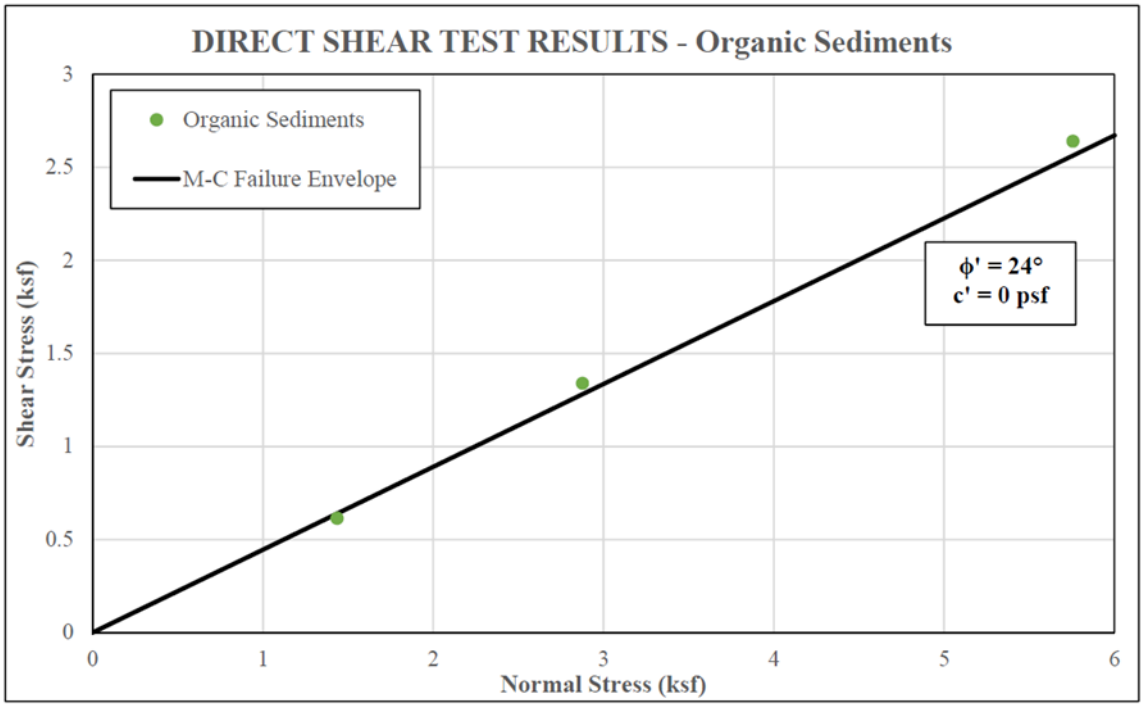

Figure 15. Drained Strength of the Organic Sediments

The design undrained shear strength of the Organic Sediments was selected using a function of undrained shear strength vs. depth below grade, as shown in Table 1 and Figure 16. Undrained shear strength data was taken from unconfined compressive strength tests.

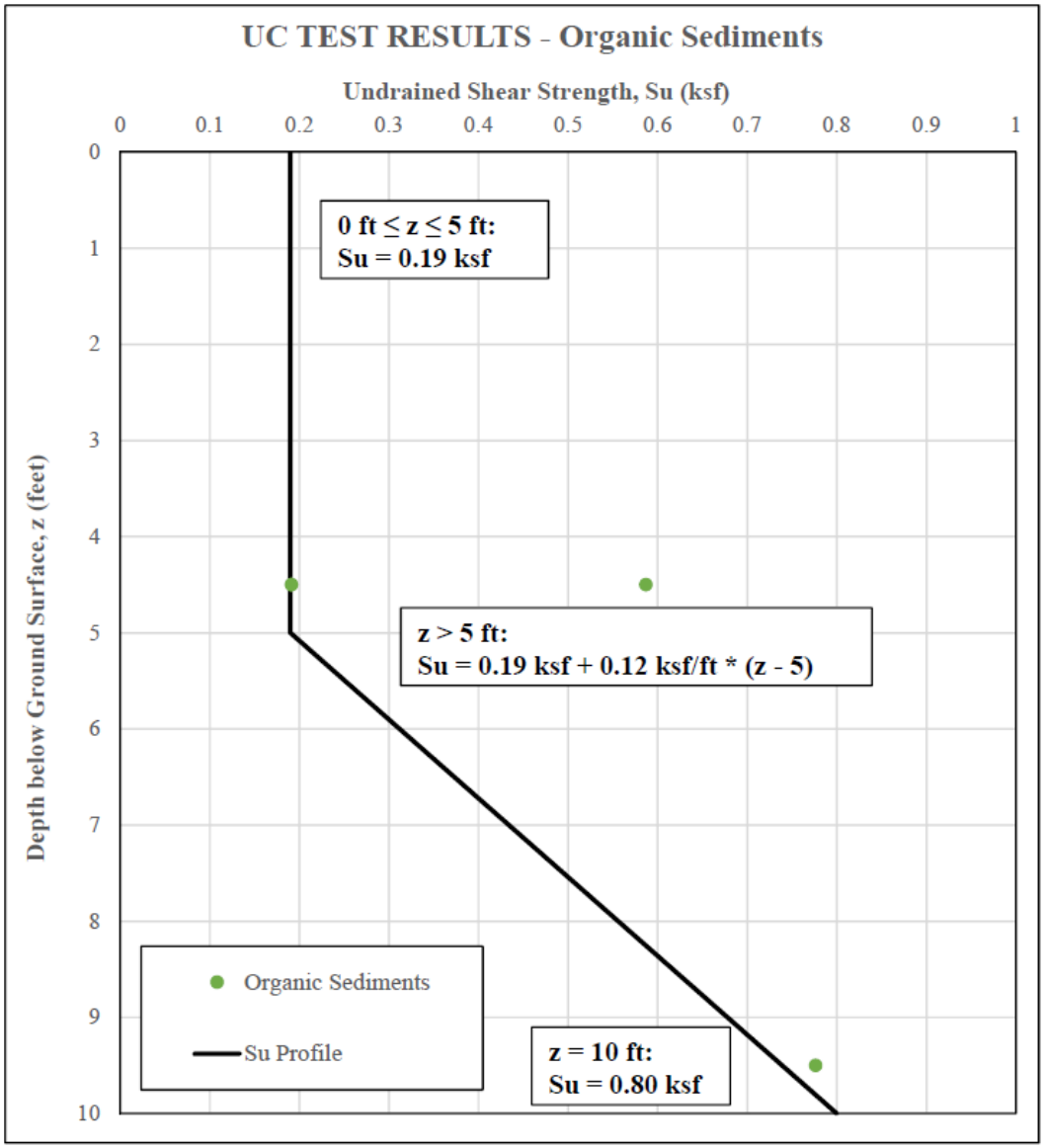

Figure 16. Undrained Strength of the Organic Sediments

Buttress

The Buttress is a design feature in the West Ash Pond system that consists of placed clay material. Buttress samples were collected and unconsolidated-undrained triaxial tests (4) and direct shear tests (3) were performed by Geotechnology, Inc. to during construction of the buttress, as part of Geosyntec's Construction Quality Assurance (CQA) services at the site. Geotechnical design perimeters for the placed buttress material were developed based on these tests.

The Buttress material was assigned a design unit weight of 125 pcf based on the mean value of laboratory measurements, as shown in Table 2.

Table 2. Summary of Laboratory Measured Clay Buttress Unit Weights

Boring ID	Lab Test	Total Unit Weight (pcf)
CB-01	Unconsolidated-undrained Triaxial Tests	124.4
CB-02		124.2
CB-02		124.0
CB-04		124.7
CB-01	Direct Shear Tests	124.3
CB-01		124.8
CB-01		124.9
CB-02		125.1
CB-02		124.7
CB-02		124.7
CB-04		128.9
CB-04		130.5
CB-04		129.0

The design undrained shear strength of 900 psf for the Buttress material was selected using the approximate lower third value from unconsolidated-undrained triaxial laboratory test results as seen in Figure 17.

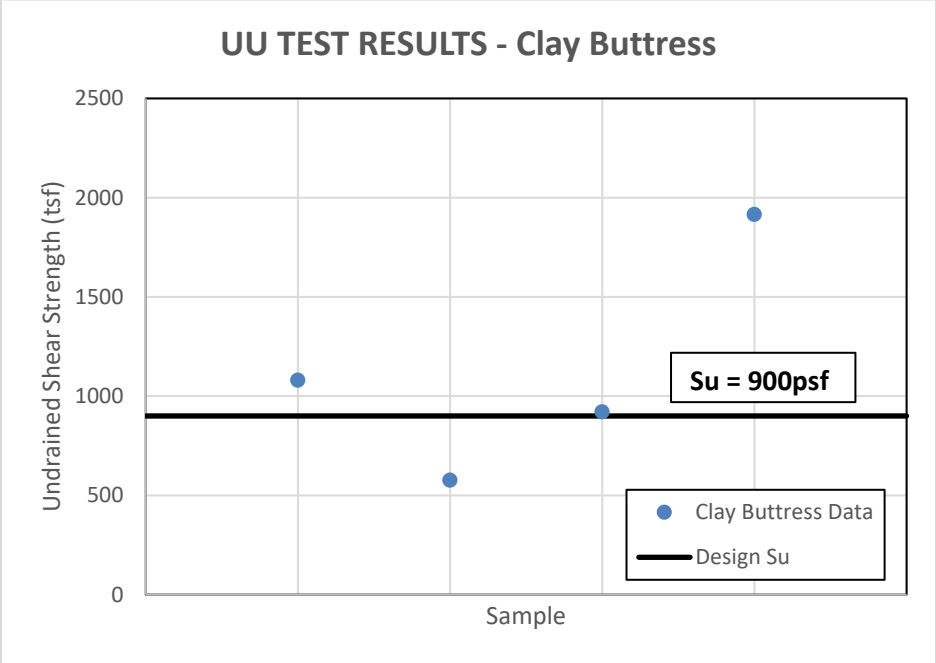

Figure 17. Undrained Strength of the Clay Buttress

The drained shear strength of the Buttress material was selected based on direct shear tests. Failure for direct shear specimens was defined as peak shear stress, limited to 10% shear strain. Based on the direct shear data shown in Figure 18, a design friction angles of 34 degrees and cohesion of 75 psf was selected.

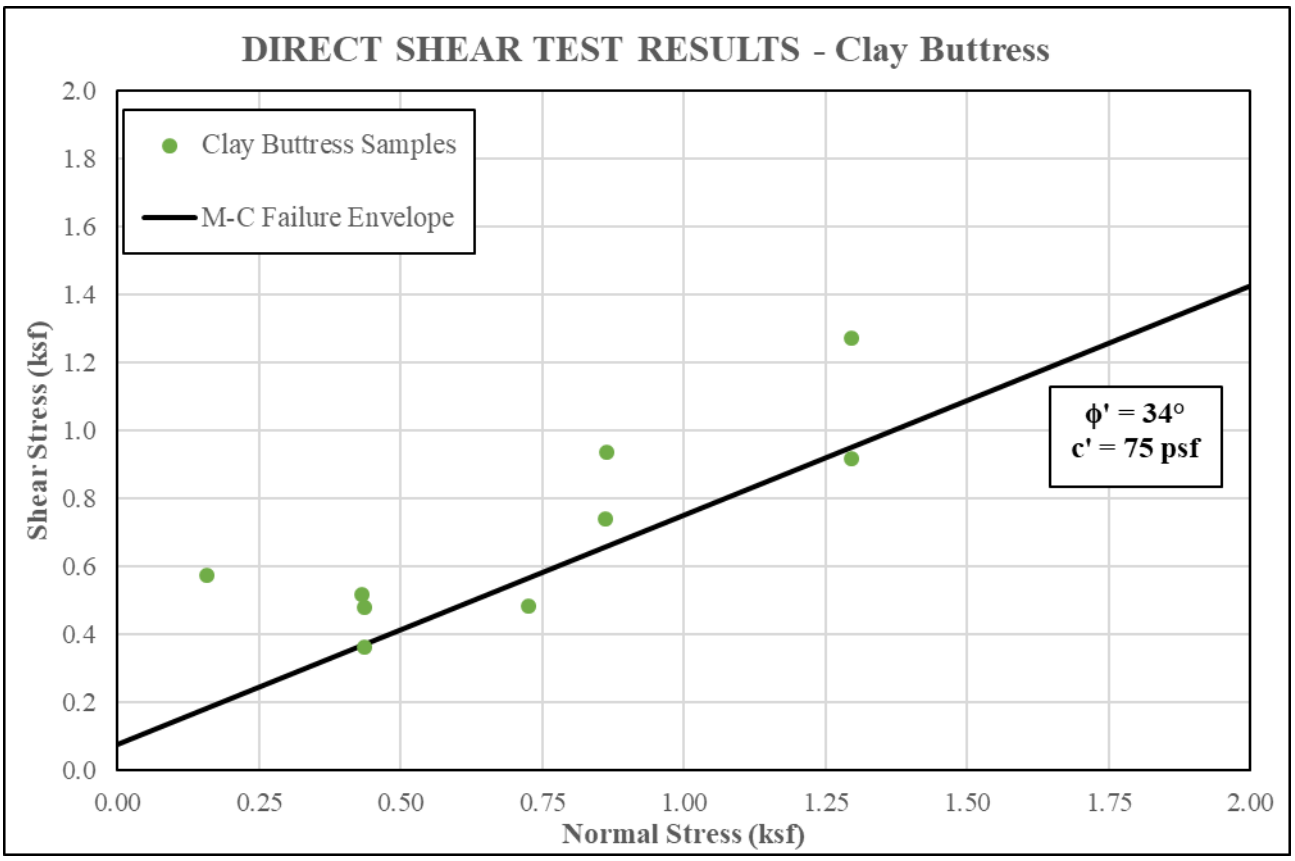

Figure 18. Drained Shear Strength of Clay Buttress

Groundwater Conditions

Groundwater conditions were estimated separately for long-term slope stability analyses, short-term slope stability analyses, and liquefaction screening analyses.

Groundwater conditions beneath the dike and impounded CCR for long-term slope stability analyses were selected to represent hydrostatic conditions that will develop within the CCR and foundation soils after the final cover system is installed. Natural Resource Technology (NRT) prepared a Hydrostatic Modeling Report for the Hennepin West Ash Pond System (NRT, 2017). The report found that total hydraulic head at the bottom of the CCR will reduce to near-zero within five years after cover construction is complete.

Therefore, the groundwater elevations for these analyses were assumed to be either equal to the CCR/foundation soil interface, or El. 447 feet (the approximate upper-most historic normal elevation of the adjacent Illinois River, as found from the LaSalle, IL gauging station [USACE, 2018]), whichever is higher. The CCR/foundation soil interface varies from approximately El. 450 to El. 440 ft across the site, but it generally similar to El. 447 ft. Groundwater conditions at and beyond the downstream toe of the dike were assumed to be equal to the ground surface or the upper-most historic normal Illinois River elevation of El. 447 ft, whichever was higher. For cross-sections adjacent to the Illinois River, a pool elevation of 442 ft was used; this is the approximately the lower-limit historic normal pool elevation (higher pool elevations provide more resisting force and therefore may be slightly unconservative).

Groundwater conditions for short-term slope stability analyses are only required at splitter dike Cross-Section A, where a sheet pile wall will be installed to support closure-by-removal excavation of the OWPP. This will occur prior to construction of the cover system, and therefore the use of long-term groundwater levels is not appropriate. At this cross-section, a groundwater elevation within the CCR corresponding to El. 452.4 ft was used, which corresponds to the groundwater elevation observed in 2017 Geosyntec test pit GS-T07. A groundwater elevation of 451 ft was used beneath the splitter dike, which corresponds to the normal pool elevation in the Old West Polishing Pond the November 2017 reading from piezometer HEN-P002.

Groundwater conditions for liquefaction screening analyses were taken as the groundwater elevation encountered at the time of CPT advancement, or El. 447 ft (approximate upper-most historic normal elevation of the adjacent Illinois River), whichever was higher.

5. LIQUEFACTION AND CYCLIC SOFTENING SCREENING ANALYSIS

The liquefaction screening analysis was performed using CPT-based methodology (Boulanger and Idriss, 2014) for the Sand and Gravel Dike Fill and Sand and Gravel Alluvium.

All liquefaction analyses were performed for a design seismic event with a 2% probability of exceedance within 50 years (e.g. 2,475-year return period earthquake). The design seismic event was selected using United States Geological Survey (USGS) 2008 probabilistic seismic hazard deaggregation data for the Site. The seismic site

classification was found to be Site Class D in accordance with ASCE 7-10 (ASCE, 2013), resulting in a site-class amplified peak ground acceleration of 0.117 g for the Site. The design earthquake magnitude was selected to be 6.11, which is the mean earthquake magnitude for the Site and is corresponds to background seismicity. Less than 15% of the seismic hazard at the Site is due to larger-magnitude earthquakes in the New Madrid Seismic Zone, as the Site is located approximately 300 miles to the north. Therefore, the mean earthquake magnitude of 6.11 is appropriate for design.

CPT-Based Liquefaction Triggering of Sand and Gravel Soils

Liquefaction triggering of the coarse-grained soils comprising the dikes and dike foundations were evaluated using the CPT-based approach by Boulanger and Idriss (2014). Fines content values were based on available laboratory test data and soil behavior types indicated by the CPTs. The soils were considered susceptible to liquefaction if calculated liquefaction factors of safety (FS_{liq}) were 1.1 or less. Only saturated soils were evaluated for liquefactions triggering, as unsaturated soils are not susceptible to liquefaction.

The analysis did not identify any laterally or vertically continuous zones of soil that were susceptible to liquefaction triggering during the design seismic event. Therefore, it can be concluded that liquefaction triggering is unlikely to occur in the Sand and Gravel Dike Fill or CCR structural fill beneath the perimeter dike. As a result, peak drained shear strength parameters can be assigned to the Sand and Gravel Dike Fill and Sand and Gravel Alluvium and peak undrained shear strength parameters can be assigned to structural fill beneath the perimeter dike for post-earthquake stability analysis.

Cyclic Softening Triggering Analysis of Clay and Silt Soils

A cyclic softening triggering analysis using the CPT-based approach by Idriss and Boulanger (2008) was performed to investigate the susceptibility of clay and silt soils to lose strength as a result of a seismic cyclic load. The approach estimates magnitude scaling factors and cyclic resistance ratios specific to clay and silt soils to evaluate a factor of safety against cyclic softening, $FS_{\gamma=3\%}$ (generating peak shear strains of 3% during cyclic loading). The soils would be considered susceptible to cyclic softening if the calculated factors of safety were less than 1.2.

Critical sections for this analysis were defined as sections that had relatively low post earthquake slope stability factors of safety. The two CPT's that were selected were adjacent to the two defined critical sections. Based on the results of the analysis, cyclic softening of clay and silt soils at the site is unlikely, as cyclic triggering factors of safety were approximately 2.3 and higher.

Seismic Demand Triggering of CCR

Triggering of liquefaction within the CCR below the Splitter Dike was estimated using a seismic demand approach. This is because the seismic demand approach compares the calculated cyclic stress ratio and number of seismic loading cycles during the design seismic event to the cyclic resistance ratio of the CCR at the same number of loading cycles. The cyclic resistance ratio of the CCR was based on published data from Wolfe and Butalia (2010) and is based on cyclic triaxial tests performed by the Ohio State University on reconstituted specimens of sluiced CCR. The cyclic resistance ratio was adjusted to account for site-specific overburden stresses following Youd et al. (2001) and was adjusted to account for both differences in laboratory vs. field loading and cyclic triaxial loading vs. cyclic direct simple shear loading following Seed (1979) and Bray and Sancio (2006), respectively. Both upper- and lower-bound cyclic resistance ratios of the CCR were then plotted vs. number of loading cycles to develop site-adjusted characteristic liquefaction triggering curves.

The Site-specific seismic demand was estimated to be a cyclic stress ratio of 0.08 for CCR beneath the crest of the dikes and 0.09 for CCR beneath the toe of the dike, using the Boulanger and Idriss (2014) liquefaction triggering methodology. The number of cyclic loading cycles from the design earthquake was estimated to range from 11 to 37 (Liu et al., 2001). The anticipated cyclic stress ratios and number of loading cycles were plotted on the characteristic liquefaction triggering curves for CCR present beneath the crest of the dike (Figure 19) and beneath the toe of the dike (Figure 20). As shown in Figures 20 and 21, seismic loading at the site is approximately 50% of the lower-bound loading required to cause liquefaction of the CCR. Therefore, it can be concluded that liquefaction triggering of CCR beneath the dikes of the OWAP is unlikely during the design seismic event, and peak undrained strengths can be used for CCR in post-earthquake slope stability analyses.

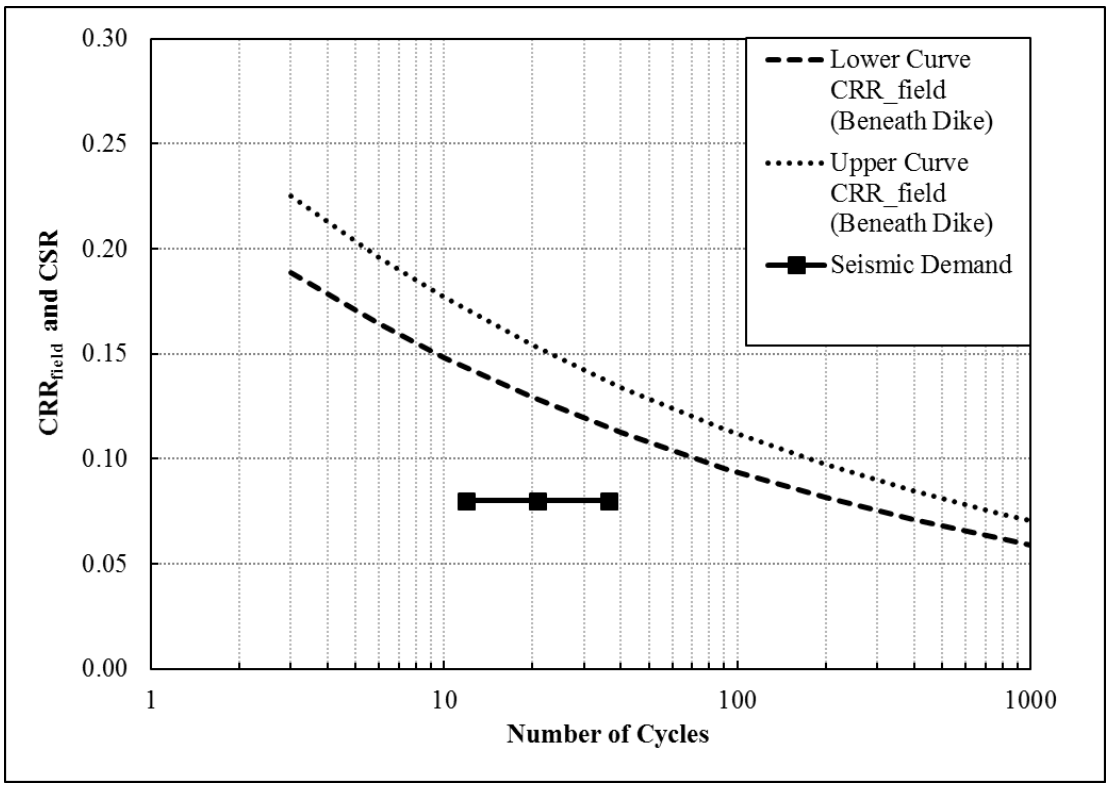

Figure 19. Seismic Demand versus Resistance for CCR Below the Dike Crest

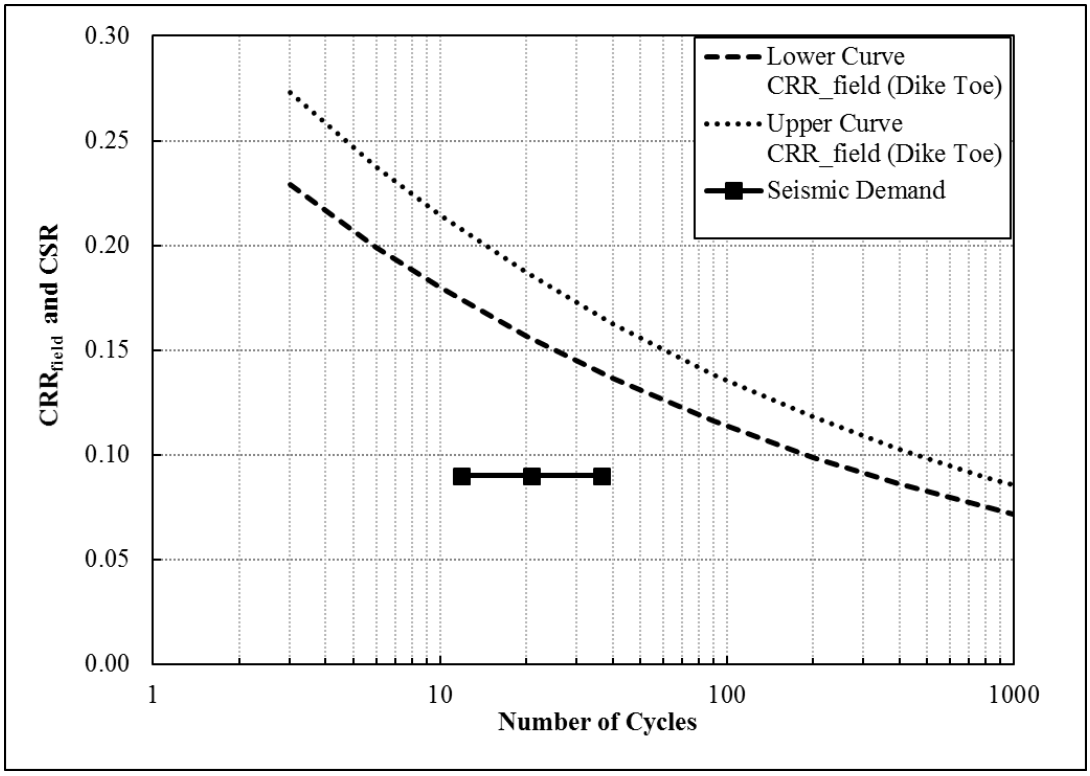

Figure 20. Seismic Demand versus Resistance for CCR Below the Dike Toe

Saturated CCR within the interior of the OWAP (below the assumed long-term groundwater level of elevation 447 feet) was conservatively assumed to be susceptible to liquefaction triggering. Only limited laboratory test data or CPT data was available on this material. The material comprises a limited thickness under most of the OWAP (i.e. 1 to 3 feet) and does not underlie the dikes. Therefore, liquefaction in this material does not have a significant effect on the stability of the OWAP perimeter dikes. The post-liquefaction residual shear strength of the saturated CCR was assumed to be a c/p' ratio of 0.045, which corresponds to a lower-bound value for clean sand, per Idriss and Boulanger (2008).

6. GLOBAL SLOPE STABILITY

Stability analyses for the OWAP were performed using limit-equilibrium SLIDE version 7.0 (Rocscience, 2017) software to calculate the factor of safety (FS) of the perimeter dikes around the West Ash Pond against global instability. Slope stability analyses

utilized the Spencer's method (1973) and evaluated both circular and non-circular optimized slip surfaces. Slope stability analyses were not performed for the OWPP as the OWPP will be closed by removal of CCR and the perimeter dikes. Slope stability analyses were analyzed for the following loading conditions:

Long-Term Static Conditions: This loading condition corresponds to the stability of the OWAP dikes under long-term, normal operating conditions with estimated static groundwater levels. Drained material properties, representing effective stress conditions, are used for all materials, as this condition corresponds to static conditions without the application of pore-pressure inducing loads. The minimum acceptable FS for this loading condition is 1.50, per the USEPA CCR Rule (USEPA, 2015).

Pseudostatic Seismic Conditions: This loading condition corresponds to the stability of the OWAP dikes under short-term seismic shaking conditions. Peak undrained material properties are used for all cohesive materials and peak drained shear strengths are used for all free-draining materials. The seismic loads are modeled as an outward-acting horizontal force. Upper-bound seismic loads were selected to be 0.015 g following the Bray and Travasarou (2009) methodology[1]. The minimum acceptable FS for this loading condition is 1.00, per the USEPA CCR Rule (USEPA, 2015).

Post-Earthquake Conditions: This loading condition corresponds to the stability of the OWAP dikes immediately following a seismic event. The liquefaction and cyclic softening analyses discussed in Section 5 did not identify materials expected to undergo liquefaction or cyclic softening for the design seismic event. Therefore, peak undrained strengths are used for cohesive materials not susceptible to liquefaction or cyclic softening triggering (e.g. silt and clay dike fill, silt and clay alluvium, and CCR), and peak drained strengths are used for free-draining materials not susceptible to liquefaction triggering (e.g. sand and gravel dike fill and sand and gravel alluvium). The minimum acceptable FS for this loading condition is 1.20, per the USEPA CCR Rule (USEPA, 2015).

[1] The Bray and Travasarou (2009) methodology utilizes a user-defined maximum tolerable deformation, which was assumed to be 1.0 ft, following *RCRA Subtitle D (258), Seismic Design Guidance for Municipal Solid Waste Landfill Facilities* (USEPA, 1996). If the calculated pseudostatic seismic factor of safety is above 1.00, the deformation is expected to be less than 1.0 ft.

All slope stability analyses include proposed post-closure grades within the OWAP and OWPP, and the estimated long-term groundwater levels. For the Splitter Dike between the closure-in-place OWAP and closure-by-removal OWPP, a temporary sheet pile wall was designed to maintain stability of the Splitter Dike during short-term closure-by-removal excavation. A permanent compacted clay buttress was designed for Section A-A' to maintain long-term static, pseudostatic, and post-earthquake stability of the Splitter Dike, and the analysis did not include any stabilization affects from the sheet pile wall; this is because the sheet pile wall may be removed upon installation of the buttress.

Subsurface material interfaces at each cross-section were developed using available boring data (Section 3), including interpolations between borings using available historic data (AECOM, 2016) and engineering judgment.

Selected Cross-sections

The critical sections for the OWAP were selected based on the dike height, dike slope, and thickness of the Silt and Clay Alluvium beneath the dike (Table 3). On the west side, Section A-A' was selected to represent the stability of the Splitter Dike between the OWAP and OWPP and contains a thick zone of Silt and Clay Alluvium. On the north side, Sections B-B' and C-C' were selected due to a thick zone of the Silt and Clay Alluvium and relatively steep (3.1H:1V) exterior dike slopes, respectively. On the south side, Section F-F' was selected due to relatively steep exterior dike slopes. Dike slopes were measured based on pre-construction conditions; slopes will generally remain a similar height after closure is completed.

Table 3. Summary of Cross-Sections Investigated for Stability Analyses

Section ID	Dike Height (feet)	Dike Slope	Thickness of Silt and Clay Alluvium (feet)
A-A'	21.5	3.4H:1V	45 at HEN-B001
B-B'	17	3.7H:1V	28 at HEN-B004
C-C'	18	3.1H:1V	0 at HEN-B006
F-F'	17	2.9H:1V	19 at HEN-B012

Cross-section locations are shown on attached Drawing 1. Slope stability analyses for the excavated portions of the dikes where rock-lined stormwater chutes are proposed were not performed. The dike crest will be lowered at these locations, by approximately 3 to 5 feet, and the slope will be graded to approximately 3H:1V. Therefore, these sections are not critical for slope stability due to the lowered dike height.

Results

The results of each of the design scenarios is presented in Table 4. Both circular and non-circular slip surfaces were evaluated, for each analysis case and cross-section, and the lower FS from the two slip surface shapes are presented. The output from SLIDE is provided in Appendix A for each of the design scenarios and Sections.

Table 4. Results of Stability Analyses

Loading Condition	Minimum Factor of Safety	Calculated Factor of Safety			
		A-A'	B-B'	C-C'	F-F'
Long-Term Static	1.50	1.86	2.10	1.51	1.91
Pseudostatic Seismic	1.00	1.15	1.37	1.61	1.42
Post-Earthquake	1.20	1.30	1.46	1.66	1.49

7. SHEET PILE WALL DESIGN

This section addresses the design of a temporary steel sheet pile (SSP) wall along the west side of the OWAP that will be installed to allow for closure by removal of the OWPP. Geosyntec Consultants completed the initial structural design of the SSP; the design was later independently reviewed by an Illinois-Licensed structural engineer, and the design drawings of the SSP were later sealed by the Illinois-Licensed structural engineer. The review memo is provided in Attachment G. Global slope stability analyses were completed by Geosyntec Consultants.

Selected Cross-section

Cross-section Section A-A' was used for design, as discussed in Section 6. This is considered the critical cross section because it has the largest unsupported wall height and a relatively thick zone of alluvial silts and clays within the subsurface. The same subsurface stratigraphy, soil properties, and groundwater conditions used for the slope stability analyses at Section A-A' were used for the SSP wall design.

The groundwater table behind the wall was assumed to be at E. 451 ft; this is the elevation measured by existing piezometers and the approximate normal pool elevation in the OWPP and was used because the sheet pile wall was assumed to be impermeable. The groundwater table in front of the wall was assumed equal to the closure-by-removal ground surface in the OWPP (El. 440.4 ft), resulting in 10.6 ft of hydrostatic imbalance. The proposed buttress at Section A-A' was not included in the analysis, as this buttress will not be constructed until after closure-by-removal of the OWPP is complete.

Methodology and Assumptions

Internal and global stability analyses were performed. All loads were assumed static, and both drained and undrained loading conditions were considered for the temporary scenario. The internal and global stability analyses outputs for the SSP wall design are provided in Appendix B.

Internal Stability Analyses

Internal stability analysis was performed utilizing Shoring Suite version 8.16h (CivilTech, 2015) software. CT Shoring was used to compute earth pressure, surcharge loads, shear forces, and wall bending moments, acting on or within the SSP wall. For the cantilevered condition, "fixed-earth" behavior was assumed, wherein design pressures are computed using simplified distributions without consideration of moment reductions due to flexure, displacement, and stress redistribution. The calculated maximum shear loads, bending moments, and required embedment from the internal stability analyses were used to select the appropriate SSP size and length for the wall. A 20% increase was applied to the embedment depth calculated to satisfy moment equilibrium, in order to calculate an embedment depth that would satisfy force equilibrium.

Both drained and undrained loading conditions were analyzed. For undrained analyses ($\varphi=0$, $c=s_u$), it is possible to calculate negative active earth pressures using classic earth pressure theory equations (e.g., Coulomb). For these analyses, negative active earth pressures were resolved to zero.

The following assumptions were used for the analyses applicable at all cross sections:

- Sheet piles will be Grade 50 steel. Following guidance in the American Institute of Steel Construction (AISC) Manual, 13th Edition (2005), the allowable bending stress (F_b), is 0.6 × 50 ksi = 30 ksi;

- The sheet piles will be free to deflect normal to the plane of the wall and thus active earth pressures will develop;
- Lateral earth pressures were calculated following Coulomb theory;
- A wall-to-soil interface friction angle of 10 degrees was applied for all interfaces;
- For the silt and clay alluvium, a drained friction angle of 30°, representing the shear strength determined from CIU triaxial tests, was used for earth pressure calculations instead of the friction angle calculated from direct shear strength tests. This is because the base angle of the active and passive wedges will be non-horizontal and oriented in a manner similar to a triaxial compression test, rather than a direct shear test.
- Seepage below the sheet pile tip was neglected because the sheet piling extends through the low permeability silt and clay alluvium unit and the sheet pile is assumed to act as a hydraulic cutoff;
- For undrained analyses, it was assumed that the CCR material would behave drained. Excess pore pressures that may develop within the CCR are expected to dissipate more rapidly than the silt and clay alluvium and thus behave drained relative to the native materials. Furthermore, assuming the CCR behaves drained imposes a greater load on the SSP wall which conservatively models the CCR loading on the SSP;
- A 1.3 reduction factor was applied to the passive wedge for the CCR removal scenario (temporary loading); and
- The required moment of inertia to limit deflection of the wall was calculated. For the dredging scenarios, the deflection was limited to three inches, based on Geosyntec's experience in temporary shoring design in both urban- and non-urban environments. Deflection was calculated at the top of retained material.

Net apparent lateral pressure distributions, shear diagrams, and bending moment diagrams are provided in Appendix B.

Global Stability Analyses

Global stability was analyzed using the same software and approach discussed in Section 6. For the global stability analyses, both rotational (circular) and optimized wedge (block) mechanisms were analyzed for each scenario and condition. The global stability analyses

were used to verify that the embedment required for internal stability would be adequate for the global stability.

The following assumptions were used for the analyses:

- The steel sheet pile material was modeled as a 1-ft thick material with 150 pcf unit weight and infinite strength. This selection was made to prevent potential failure surfaces from extending through the bulkhead in the analyses; and

- Failure surface entry points were limited to the upslope side of the SSP and exit points for were limited to within the OWPP.

The minimum FS for global end-of-construction stability is 1.30 per the USEPA CCR Rule. This loading condition is appropriate for use in designing the temporary SSP wall for the splitter dike.

Interim Construction Global Stability Analyses

The global stability of the splitter dike was analyzed for conditions where a crane is placed on the dike, for installation of a sheet pile wall, but the wall has not yet been fully installed. This case is intended to evaluate the stability of the dike, under construction surcharge loading, for temporary construction conditions. The construction contractor, Ryan Central, Incorporated (Ryan), proposes to lower the splitter dike by approximately 2 feet or more. Although Ryan originally proposed using a 3H:1V slope, initial calculations indicates that this may not provide an acceptable factor of safety, so a 4H:1V slope was used in the analysis between the sheet pile wall location to the lowered crest of the splitter dike.

The crane will be driven along the south dike to reach the working area; therefore, stability of the south dike was evaluated at cross-section F-F'.

A Link-Belt LS-218H II crane (110-ton) will be used to install the sheet pile wall. The weight of the crane, sheet pile, hammer, and other equipment is expected to weigh 210,906 lbs (maximum operating crane weight of 193,906 lbs, plus 17,000 lbs for the sheet pile and hammer) (Ryan Central, 2019). This results in a track surcharge of 1,970 psf or a surcharge of 990 psf if mats are placed beneath the crane (equal to the exterior area of the crane tracks or larger) when the tracks are retracted and 680 psf when the tracks are extended. For the case of the crane driving on the south dike, only the operating

weight of the crane was included, and no crane mats were used, resulting in a track surcharge of 1,810 psf.

Using these loading magnitudes, surcharges were applied to the downstream edge of the dikes to represent the crane loading. The slope stability analysis was performed using the same software and approach discussed in Section 6. Both rotational (circular) and optimized wedge (block) mechanisms were analyzed for each scenario. At the splitter dike separate analyses were performed considering drained and undrained soil properties; on the south dike, only undrained conditions were considered as the crane loading is expected to be transient (i.e. loading for a few hours or less).

The minimum FS for global interim construction stability is 1.30 per the USEPA CCR Rule. Preliminary analyses indicated that the splitter dike would have a factor of safety below 1.30 if crane mats were not used, so the analyses were updated assuming that crane mats were present. The analyses performed on the south dike at cross-section F-F' resulted in a factor of safety greater than 1.30.

Results

Summaries of the results of the analyses are provided in Tables 5 and 6 for the internal stability analyses and global stability analyses, respectively. Interim construction global stability analyses are summarized in Table 7.

Table 5. Summary of Internal Stability Analyses for SSP Wall Design

Scenario	Condition	Max Bending Moment, M_{max}	Required Plastic Section Modulus, Z_x	Max Shear, V_{max}	Required Moment of Inertia, I	Required Embedment, D	Minimum Pile Length, L(2)	Deflection
		(ft*kip/lf)	(in^3/ft)	(kip/ft)	(in^4/ft)	(ft)	(ft)	(in)
Cut El. 440.4'	Undrained	100.6	40.3	12.5	419.9	39.5	53.5	2.6
Cut El. 440.4'	Drained	119.4	47.9	24.3	419.9	34.2	48.2	2.1

Notes
1) Required moment of inertia to limit deflection. For CCR removal from the OWPP the limit is 3 inches.
2) Top of pile is at El. 454.4feet.

Table 6. Summary of Global Stability Analyses for SSP Wall Design

Loading Condition	Minimum Factor of Safety	Calculated Factor of Safety Section A-A'
Drained	1.30	1.98
Undrained	1.30	1.55

Table 7. Summary of Interim Construction Global Stability Analyses for Crane Loading Conditions

Crane Track Spacing	Loading Condition	Minimum Factor of Safety	Calculated Factor of Safety	
			Section A-A'	Section F-F'
Retracted	Drained	1.30	1.96	-
	Undrained	1.30	1.31	1.32
Extended	Drained	1.30	2.32	-
	Undrained	1.30	1.41	-

The SSP wall along the existing splitter dike at the Hennepin West Ash Complex will be a cantilevered sheet pile wall consisting of one type of section. The required sheet pile section is NZ 26 (equivalent or better) and minimum 53.5 ft long (39.5 ft minimum embedment depth, with a maximum free height of 14 ft). Top of sheet piling shall be set level with the ground surface along the proposed alignment. The ground surface typically ranges from El. 453 to 454 ft, although it reaches approximately El. 460 ft at the north and south ends of the wall. During sheet pile installation, construction surcharges on the splitter dike should be limited to 990 psf and crane mats should be used.

8. OLD WEST POLISHING POND SEEPAGE ANALYSIS

Seepage analyses were performed to evaluate groundwater inflows during closure by removal excavation of the OWPP so that they can be provided to the construction contractor for their use in excavation groundwater inflow management. Seepage analyses were performed using the two-dimensional finite-element seepage analysis module within the SLIDE Version 7.0 software package (Rocscience, 2017).

Four cross-sections (G, H, I, and A) were analyzed, with each section representing each of the four sides of the OWPP. Cross-section locations are shown on attached Figure 1.

Subsurface stratigraphy for each cross-section was developed in AutoCAD Civil3D using available boring data and was imported into SLIDE. Data from existing piezometers present at each cross-section (HEN-P001, GS-P07, GS-P08, and HEN-P002, respectively) were used to develop the phreatic surface profile.

Seepage analyses were first performed for existing conditions to calibrate the seepage models to piezometric conditions observed in November of 2017 (the date of Geosyntec's field investigation [Geosyntec, 2018]). The existing conditions included a pool elevation of 451 ft within the OWPP based on the 2015 Weaver Consultants survey of the site and is assumed to represent the normal pool in the OWPP based on Geosyntec's visual site observations. Far-field groundwater conditions (i.e. curb conditions) were assumed to be El. 443 ft, based on the approximate elevation of the Illinois River during November of 2017. Hydraulic conductivities for subsurface materials (Sand and Gravel Dike Fill, CCR, and Sand and Gravel Alluvium) were based on available information collected by Geosyntec (2018) and others (NRT, 2017). The hydraulic conductivity of the Silt and Clay Alluvium at each section was adjusted during calibration until the modeled total head at each section's piezometer matched the measured head from November of 2017 within 0.2 ft. Table 8 lists the calibrated hydraulic conductivity values for each cross-section and how each value was determined.

Table 8. Summary of Hydraulic Conductivities used for Seepage Analyses

Cross-Section	Calibrated Hydraulic Conductivity							
	Sand & Gravel Dike Fill		CCR		Silt & Clay Alluvium		Sand & Gravel Alluvium	
	k^1 (cm/sec)	Source	k^3(cm/sec)	Source	k^1 (cm/sec)	Source	k^1 (cm/sec)	Source
G	$1x10^{-2}$	NRT (2017)	$8.2 x10^{-6}$	Rebound Testing[2] (Geosyntec, 2018)	$1 x10^{-6}$	Calibration	$1 x10^{-2}$	NRT (2017)
H					$3 x10^{-6}$			
I					$8 x10^{-6}$			
A			$6x10^{-6}$	Hydraulic Conductivity Testing[3] (Geosyntec, 2018)	$5 x10^{-6}$			

Notes:
[1]All hydraulic conductivity values are horizontal. Vertical hydraulic conductivity was assumed to be 50% of the horizontal hydraulic conductivity for all cross-sections.
[2]CCR hydraulic conductivity based on pumping and rebound tests of piezometers installed at each cross-section. The CCR at these cross-sections is generally a mixture of native soil, slag, and coal, per the boring logs.
[3]CCR hydraulic conductivity based on laboratory vertical permeability testing of samples collected from the Old West Ash Pond. Horizontal hydraulic conductivity was assumed to be 5 times the vertical hydraulic conductivity, based on Geosyntec's experience and calibration. The CCR at this cross-section is predominantly fly ash.

Section A represents the side of the OWPP that is connected to the OWAP where a sheet pile wall will be constructed to facilitate OWPP removal. The sheet pile wall will be constructed using hot-rolled NZ 26 sheets with Larssen interlocks. The interlocks will not be sealed. For seepage analysis, the sheet pile was modeled as an equivalent one-meter thick slurry wall. The hydraulic conductivity of the sheet pile wall was calculated as 2.86×10^{-5} cm/sec using published methodologies (ArcelorMittal, 2015). After the seepage analysis for each cross-section was calibrated, the seepage analyses were modified to represent conditions that may occur during closure-by-removal excavation of the OWPP. These cases include:

- **Pond Unwatered**: This case represents seepage inflows that are expected to occur when the free water pool is pumped out of the OWPP, but prior to closure-by-removal excavation. The interior of the OWPP was modeled as a potential seepage face. The far-field curb boundary condition was assumed as a groundwater level equal to the far-field ground surface (Sections G, H, and I). For Section I, the Illinois River pool elevation was assumed as El. 447 ft, which is the upper-most historic normal elevation of the river (USACE, 2018). A sheet pile wall was not

assumed to be installed at Section A, as the sheet pile may not be installed until after unwatering is complete, and the sheet pile will reduce seepage inflows once installed.

- **Pond Unwatered – River Flood Stage:** This case is similar to the Pond Unwatered case but assumes that the Illinois River is at flood stage (El. 450 ft [USACE, 2018]).
- **Pond Excavated:** This case is similar to the Pond Unwatered case but assumes that the three exterior dikes of the OWPP (north, west, and south) have been completely removed and that final closure-by-removal excavation grades have been reached in the OWPP. Far-field groundwater levels and Illinois River pool elevations were assumed to be the same as the Pond Unwatered case. The sheet pile wall was included in this analysis.
- **Pond Excavated – High River:** This case is similar to the Pond Excavated case but assumes that the Illinois River is at a higher stage (El. 448 ft). This is the rim elevation of the excavation, and the Illinois River would flow into the excavation if it exceeded El. 448 ft. The sheet pile wall was included in this analysis.

Estimated inflows for each cross-section were multiplied by the length of the side of the OWPP representing each section and added together to develop a single excavation inflow value for the entire OWPP. Inflows are presented in both gallons per minute and gallons per day and are listed in Table 9. A factor of safety of 1.45 was applied to the seepage inflows, the corrected values are also presented in Table 9. The factor of safety was developed based on a factor of safety for design data of 0.10, experience of 0.10, and criticality of 0.25 (NAVFAC, 1983), these are then added together to get a factor of safety of 1.45.

In summary, excavation inflows are relatively low (approximately 1,000 to 7,000 gal/day, depending on scenario), primarily due to the thick layer of relatively low-permeability Silt and Clay Alluvium under the OWPP and the presence of the sheet pile wall between the OWPP and OWAP. Seepage analysis output is presented in Appendix D.

Table 9. Summary of Seepage Analyses

Scenario	Calculated Infiltration Rate			
Pond Unwatered	0.78	gal/min	1200	gal/day
Pond Excavated	3.15	gal/min	4600	gal/day
Pond Excavated (High River El. 448 ft)	3.37	gal/min	4900	gal/day
Pond Unwatered - River Flood Stage (El. 450 ft)	1.39	gal/min	2100	gal/day
	With Factor of Safety (FS=1.45)			
Pond Unwatered	1.14	gal/min	1700	gal/day
Pond Excavated	4.57	gal/min	6600	gal/day
Pond Excavated (High River El. 448 ft)	4.88	gal/min	7100	gal/day
Pond Unwatered - River Flood Stage (El. 450 ft)	2.02	gal/min	3000	gal/day

9. VENEER COVER STABILITY

Veneer stability refers to the shallow, translational stability of the cover system and each material interface within the cover system. While veneer stability calculations are not expressly required by the CCR Rule, they were performed to develop minimum interface friction specifications for construction purposes. Veneer stability calculations have been performed to determine minimum interface friction angles between each of the material interfaces. Material interfaces within the cover system include, from top to bottom:

- Cover soil against vegetative support soil (erosion layer),
- Geocomposite drainage layer or geotextile against cover soil,
- Geomembrane liner to geotextile or geocomposite drainage layer, and
- Subgrade against geomembrane liner.

Veneer stability for static loading conditions was evaluated following published methodology (Giroud, et al., 1995). Five final cover system slopes were evaluated at the site and represent critical veneer stability sections. The evaluated slopes are listed in Table 10 and shown in plan in Figure 21. Both the cover soil and vegetative soils were assumed to have a unit weight of 120 pcf and a drained friction angle of 27 degrees with zero cohesion, which is consistent with a compacted cohesive cover soil.

Table 10 – Slopes Evaluated for Veneer Stability

Slope	Location	Grade	Height (ft)	Length (ft)	Toe Elevation (ft)	Cushion Material	Reason for Selection
A	Western exterior	20%	6.7	33.9	462.5	Geocomposite	Tallest 20% slope with geocomposite
B	Western interior	2.10%	6.6	312.6	462.4	Geotextile	Tallest of the 2.1% slopes
C	Southern interior	19%	1.9	9.9	463.1	Geotextile	Tallest interior ~20% slope
E	Eastern exterior	20%	6.8	33.3	464	Geotextile	Highest 20% slope without a geocomposite

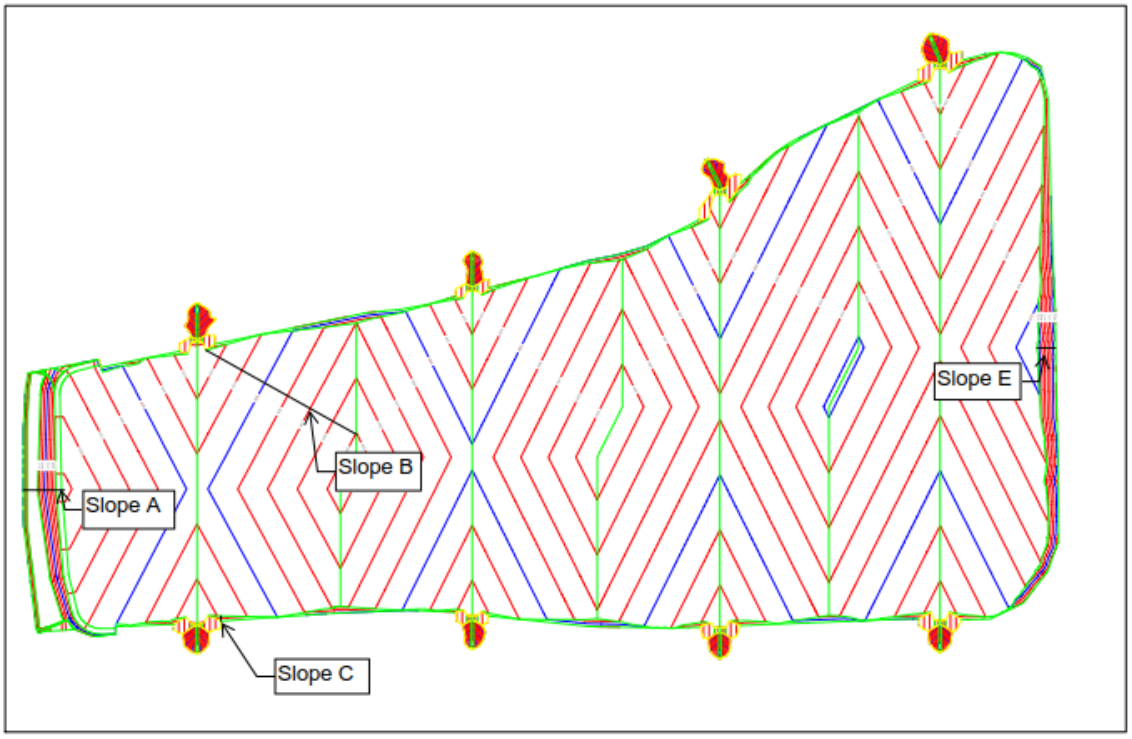

Figure 21 – Veneer Stability Slope Locations

Analyses were performed for the lower interfaces (one analysis for subgrade against geomembrane liner, geomembrane liner against geotextile or geocomposite drainage

layer, and geotextile or geocomposite drainage layer against cover soil, as the effective stresses would be the same for all three interfaces) and the upper interface (cover soil against vegetative soil, which was used to select the minimum shear strength of both soils). Each analyzed loading condition is described below:

Normal Conditions: This analysis considers the stability of the cover system under normal, static, steady-state operating conditions. The cover system soil is assumed to be unsaturated, and 0.25 inches of water is present within the geotextile (where present) which corresponds to a full thickness of water within a geotextile. For slopes with a geocomposite drainage layer (Slope A only), the head in the drainage layer was calculated as 0.13 inches based on the 25-year, 24-hour storm, following Giroud & Houlihan (1995) and was used for analysis. This is approximately half the geonet core thickness of 0.25 inches. The minimum acceptable FS for this condition is 1.50, as recommended by Koerner and Soong (1998). Minimum peak friction angles were calculated for this condition.

Saturated Conditions: This analysis considers the stability of the cover system under static, saturated operating conditions that may occur after a rainfall event on slopes that utilize a cushion geotextile in lieu of a geocomposite drainage layer. The cover system soil is assumed to be fully saturated, with two feet of water present (full cover thickness). A minimum acceptable FS for this condition of 1.20 was selected for design. This case was not analyzed for slopes that include a geocomposite, as the geocomposite was sized to convey infiltration resulting from the 25-year, 24-hour storm event, and therefore the cover soils are unlikely to become saturated when a geocomposite is used. Minimum peak friction angles were calculated for this condition.

Seismic Conditions: Veneer stability for seismic conditions was calculated following Matasovic (1991), for the same slope orientations as the static veneer analyses. Flood or saturated conditions were not considered for the seismic analyses as the likelihood of a flood event occurring at the same time as a seismic event is low. A pseudostatic seismic coefficient of 0.076 g was selected for analysis, which is 65% of the site-class amplified peak ground acceleration of 0.117 g, as recommended by Matasovic (1991). The minimum acceptable factor of safety for this condition is 1.00, as recommended by Matasovic (1991). Minimum peak friction angles were calculated for this condition.

Post-Earthquake Conditions: This analysis considers the stability of the final cover condition under conditions immediately after a seismic event, when seismic shaking has stopped. The seismic event may induce strains on the cover system, potentially straining the soils and/or interfaces to a reduced post-peak strength condition. The minimum factor of safety for this condition was assumed to be 1.20, which corresponds to the USEPA CCR Rule (USEPA, 2015) regulatory guidance for global dike stability. Minimum residual friction angles were calculated for this condition

The minimum design interface friction angles calculated for each interface are shown in Table 11. The friction angles reflect the highest calculated friction angle required to maintain the stability of the interface out of all analyzed loading conditions. No adhesion was assumed in the analyses.

Written by: DC Date: 08-03-20 (DD MM YY) Reviewed by: LPC Date: 08-03-20 (DD MM YY)

Client: Dynegy Project: Hennepin Final Design Project No.: CHE8356B Task No.: B-02

Table 11. Calculated Minimum Interface Friction Angle for Final Cover Stability

		Calculated Minimum Interface Friction Angle (d, deg)					
	Interface	**Static Conditions (Min FS = 1.50)**	**Saturated Conditions (Min FS = 1.20)**	**Seismic Conditions (Min FS = 1.00)**	**Post-EQ Conditions (Min FS = 1.00)**	**Peak Design Interface Friction Angle (d_d, deg)[1]**	**Residual Large-Displacement Design Interface Friction Angle (d_d, deg)[1]**
Slope A	Lower Interfaces[2]	12.0	Not Evaluated	16.0	9.0		
	Vegetative Soil to Cover Soil	16.0	Not Evaluated	16.0	13.0		
Slope B	Lower Interfaces[2]	1	1	6	1		
	Vegetative Soil to Cover Soil	1	3	6	1		
Slope C	Lower Interfaces[2]	1	18	16	1		
	Vegetative Soil to Cover Soil	13	23	16	7		
Slope E	Lower Interfaces[2]	13.0	23.0	16.0	7.0		
	Vegetative Soil to Cover Soil	16.0	26.0	16.0	11.0		
Minimum Design Values	Lower Interfaces[2]	13.0	23.0	16.0	9.0	**23.0**	**9.0**
	Vegetative Soil to Cover Soil	16.0	26.0	16.0	13.0	**26.0**	**13.0**

Notes:

[1]Design interface friction angle is taken as the maximum calculated required interface friction angle for all evaluated loading

[2]Lower interfaces refer to geomembrane-to-subgrade, geomembrane-to-geotextile, and geotextile-to-cover soil. Friction angles were not calculated separately for each interface and refer to the most conservative hydraulic conditions for each interface.

10. GEOMEMBRANE PUNCTURE ANALYSIS

The cover system design at Hennepin includes a geomembrane with a 16-ounce geotextile cushion layer installed on top to provide protection from rocks or sharp objects within the cover soil. Rocks in the subgrade system (below the geomembrane) will be removed prior to geomembrane deployment, in accordance with the project specifications. A puncture analysis was performed on sand and gravel from the South Borrow Area at the site to determine its suitability as cover soil at the OWAP. Sand and gravel material parameters including grain size and angularity were determined based on laboratory testing. Puncture calculations were performed in accordance with GRI White Paper #14 (2008) and considered the following; gravel particles up to 3 inches in diameter, the presence of a 16-ounce geotextile on top of the geomembrane, 2 feet of soil on top of the geotextile, and a maximum construction equipment surcharge of 20 psi. The analysis resulted in a factor of safety of 3 against geomembrane puncture, indicating a low potential for puncture of the geomembrane.

An addition sensitivity analysis was performed for construction loading immediately after the geomembrane is installed (long-term chemical/biological degradation factor of 1.0, and a minimum factor of safety against puncture of 2.0). This analysis found that a maximum ground pressure of 34 psi may be applied to the geomembrane during installation. The 20 psi limit should be applied to long-term conditions after construction is completed.

Laboratory test results and puncture analysis calculations are provided in Appendix F.

11. SETTLEMENT ANALYSES

Settlements were calculated to evaluate post-settlement drainage grades (to check for hydraulic grade reversals in ditches) and to evaluate strains induced in geosynthetics. Closure of the OWAP will induce settlements in foundation soils due to added load (contoured fill and cover soil) and the long-term lowering of phreatic levels beneath the cover system, due to reduced infiltration. The ditches were designed with 1% slopes.

Compressibility parameters for CCR and the Silt & Clay Alluvium were estimated using available consolidation test data (AECOM, 2016; Geosyntec, 2018). Compressibility parameters for the Sand & Gravel alluvium were estimated using SPT N-value correlations (Hough, 1969) from borings at the OWAP advanced into the Sand & Gravel

Alluvium (AECOM, 2016; Geosyntec, 2018). Design compressibility parameters are provided in Table 12.

Table 12 – Design Compressibility Parameters

Material	Preconsolidaton Pressure (P'_p) (tsf)	Compression Index (C_c)	Recompression Index (C_r)	Initial Void Ratio (e_o)	Bearing Capacity Index (C)
CCR	1.5	0.306	0.025	0.84	Cohesive Material Consol. Settlement Only
Silt & Clay Alluvium	Normally Consolidated	0.274	0.018	1.28	
Sand & Gravel Alluvium	Free-Draining Material with Elastic Settlement Only				93

Settlements were calculated using one-dimensional consolidation theory. One-dimensional theory is appropriate for the site due to the gentle closure grades (approximately 2.2% in the middle of the OWAP). Settlements were calculated at 100-ft increments along five settlement sections: SS-1 through SS-5. SS-1 through SS-4 correspond to each of the four north-south stormwater channels while SS-5 corresponds to an east-west section along the highest planned fill thicknesses in the OWAP. Existing grades, post-closure grades, and subsurface material interfaces were taken from an AutoCAD Civil 3D model of the site.

Existing phreatic levels for each settlement analysis section were taken from recent piezometer and test pit data. Future groundwater levels were assumed to be El. 447 ft (the approximate upper-normal pool elevation in the Illinois River). Immediate settlements, consisting of recompression settlement of the CCR and settlement of the alluvial sand and gravel, was assumed to occur immediately (e.g. during construction). Long-term consolidation settlements (consisting of virgin compression of the alluvial clay) are expected to occur over a period of several years, after construction is complete. These settlements were used to calculate post-closure grades along each settlement section.

The settlement analyses found consolidation settlements of up to 15 inches at the highest fill areas (at the west side of the site). However, settlements decrease to near-zero around the perimeter of the OWAP because there is minimal added load. No areas of post-closure grade reversal, of either the stormwater ditches (SS-1 through SS-4) of the final cover peaks (SS-5), were identified.

In some limited areas, ditch grades reduced by up to 0.5% (post-settlement ditch grades grade of 0.5% compared to a design grade of 1%) but remained positive. In most areas, grades reduced by 0.1% or less. This indicates that settlement-induced grade reversals, and associated issues with stormwater drainage or ponding are unlikely due to settlement. Figures showing the location of each settlement section and profiles of the settlement analysis layering and results can be found in Appendix E.

12. CONCLUSIONS

The calculations presented herein demonstrate that the proposed closure plan for the Dynegy-Hennepin OWAP and OWPP will satisfy geotechnical dike stability criteria for static, seismic, and post-earthquake loading conditions. The sheet pile wall supporting the Splitter Dike between the OWAP and OWPP will satisfy geotechnical dike stability criteria (end-of-construction conditions) and during temporary excavation conditions. Additionally, the cover system veneer stability satisfies design criteria for static and seismic conditions. Lastly, closure-induced settlements are expected to be minor and unlikely to result in grade reversals or other settlement-induced drainage issues.

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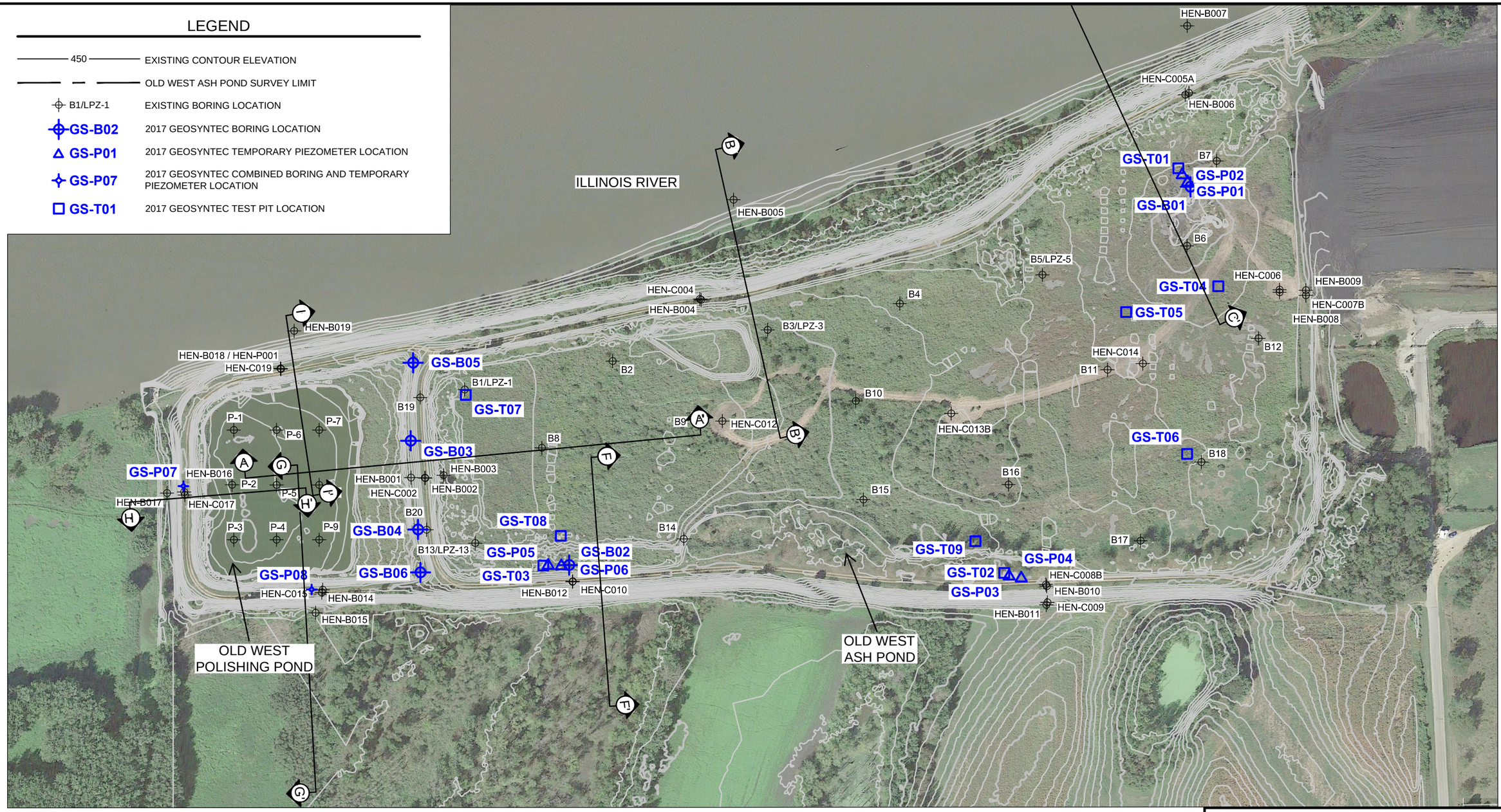
DRAWING 1

Geotechnical Site Plan

LEGEND

- 450 — EXISTING CONTOUR ELEVATION
- OLD WEST ASH POND SURVEY LIMIT
- B1/LPZ-1 — EXISTING BORING LOCATION
- GS-B02 — 2017 GEOSYNTEC BORING LOCATION
- GS-P01 — 2017 GEOSYNTEC TEMPORARY PIEZOMETER LOCATION
- GS-P07 — 2017 GEOSYNTEC COMBINED BORING AND TEMPORARY PIEZOMETER LOCATION
- GS-T01 — 2017 GEOSYNTEC TEST PIT LOCATION



NOTES:

1. COORDINATES AND DIRECTIONS SHOWN ON THIS DRAWING ARE BASED ON ILLINOIS STATE PLANE COORDINATE SYSTEM (NAD83) (US FEET). ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) (US FEET).
2. ALL 2017 GEOSYNTEC BORINGS, PIEZOMETERS, AND TEST PIT LOCATIONS WERE TAKEN FROM SURVEY DATA COLLECTED BY INGENAE, LLC ON JANUARY 17, 2018.
3. LOCATIONS OF 2015 AECOM BORINGS AND CPTS (HEN- PREFIX) WERE TAKEN FROM SURVEY DATA COLLECTED BY WEAVER CONSULTANTS IN 2015, IF AVAILABLE. IF SURVEY DATA WAS NOT AVAILABLE FOR A 2015 AECOM BORING OR CPT, THE LOCATION WAS ESTIMATED BASED ON COORDINATES REPORTED IN THE 2016 AECOM "30% DESIGN DATA REPORT FOR DYNEGY HENNEPIN POWER STATION", DATED JANUARY 12, 2016.
4. LOCATIONS OF 2016 CEC OLD WEST POLISHING POND AND 2017 CEC OLD WEST ASH POND BORINGS WERE TAKEN FORM AN AUTOCAD FILE PROVIDED BY CEC TITLED "BORING LOCATION MAP, OLD WEST ASH POND SYSTEM, HENNEPIN POWER STATION", DATED MARCH 29, 2017.
5. EXISTING GRADE CONTOURS WERE BASED ON TOPOGRAPHIC SURVEYS PERFORMED BY WEAVER CONSULTANTS IN 2015, INGENAE, LLC IN 2017, AND INGENAE, LLC IN 2018.

N

0 200

HORIZONTAL SCALE IN FEET

GEOTECHNICAL SITE PLAN
HENNEPIN - OLD WEST ASH POND COMPLEX

Geosyntec consultants

PROJECT NO: CHE8356B | MARCH 2018

FIGURE 1

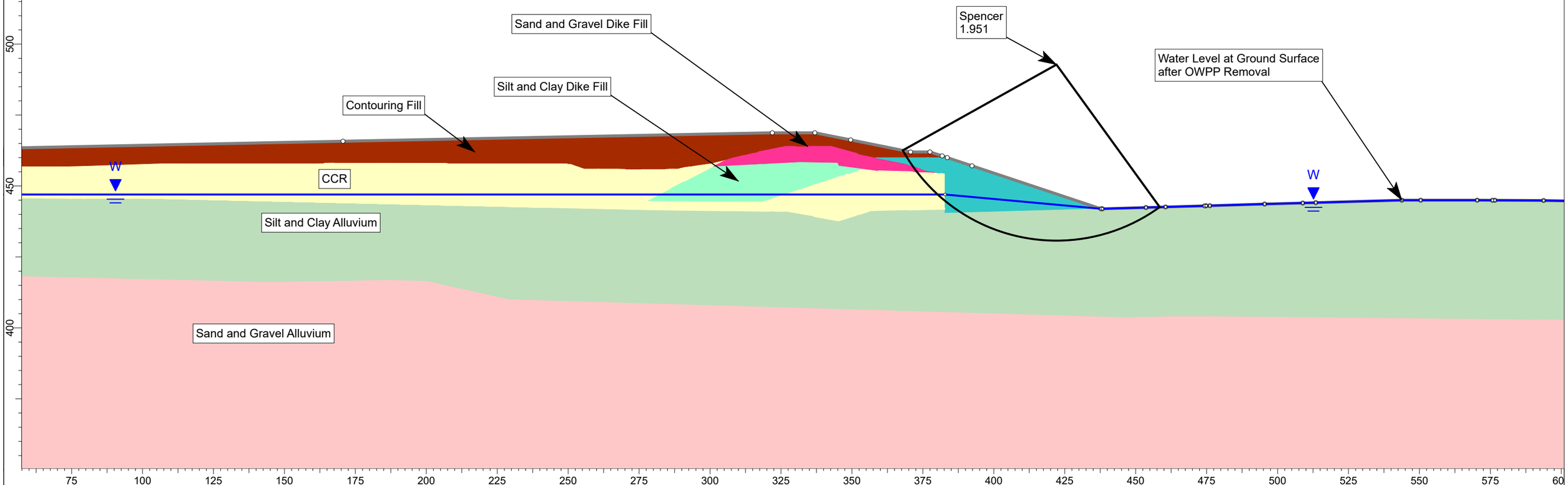
G:\CWP\CHE8356- HENNEPIN WEST ASH POND SYSTEM\500 - TECHNICAL\556 - 90% DESIGN\CAD\2018-02-15_CAD\CHE8356 F007

APPENDIX A

Global Slope Stability Analyses SLIDE Output

Static Slope Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	33		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			Silt and Clay Alluvium	Water Surface	Custom	1
Contouring Fill		120		Anisotropic function			Contouring Fill	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			Silt and Clay Dike Fill	Water Surface	Custom	1
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Buttress		125	125	Mohr-Coulomb	75	34		Water Surface	Custom	1



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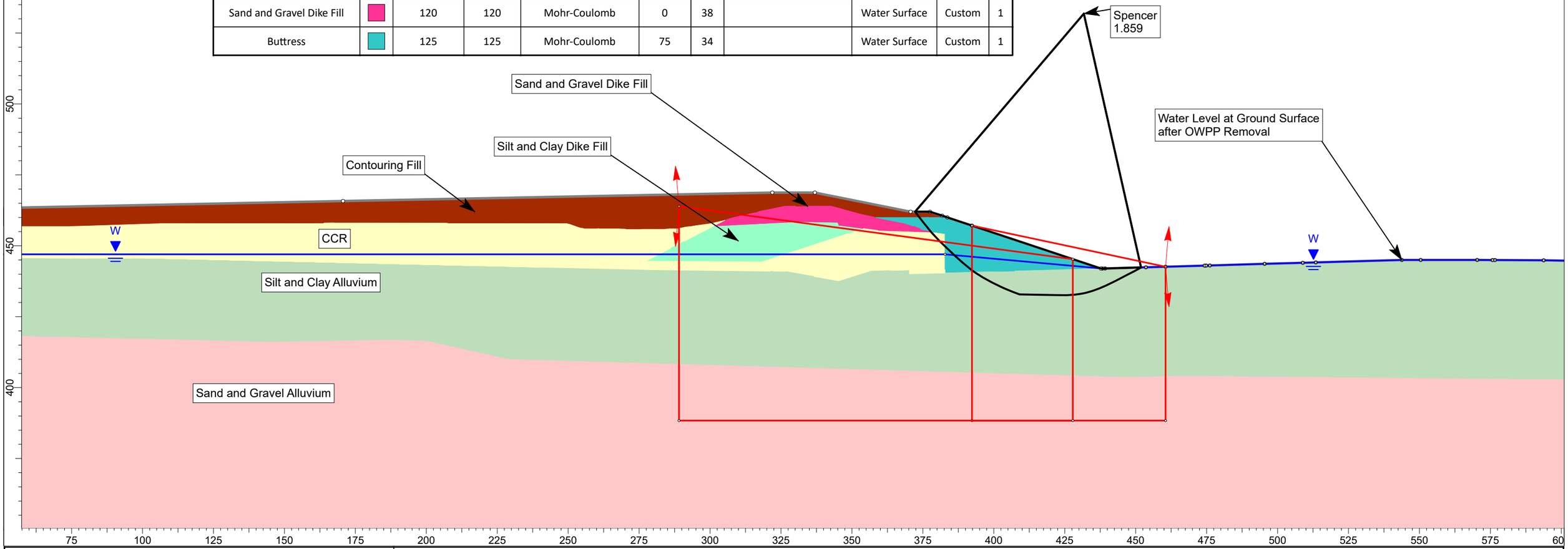
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Drained Conditions - Circular Mechanism		
Analysis By	DC	*Client*	Dynegy
Date	7/28/2020	*Scale* 1:400	*File Name* 20200728_A-A'_Drained_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	33		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			Silt and Clay Alluvium	Water Surface	Custom	1
Contouring Fill		120		Anisotropic function			Contouring Fill	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			Silt and Clay Dike Fill	Water Surface	Custom	1
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Buttress		125	125	Mohr-Coulomb	75	34		Water Surface	Custom	1



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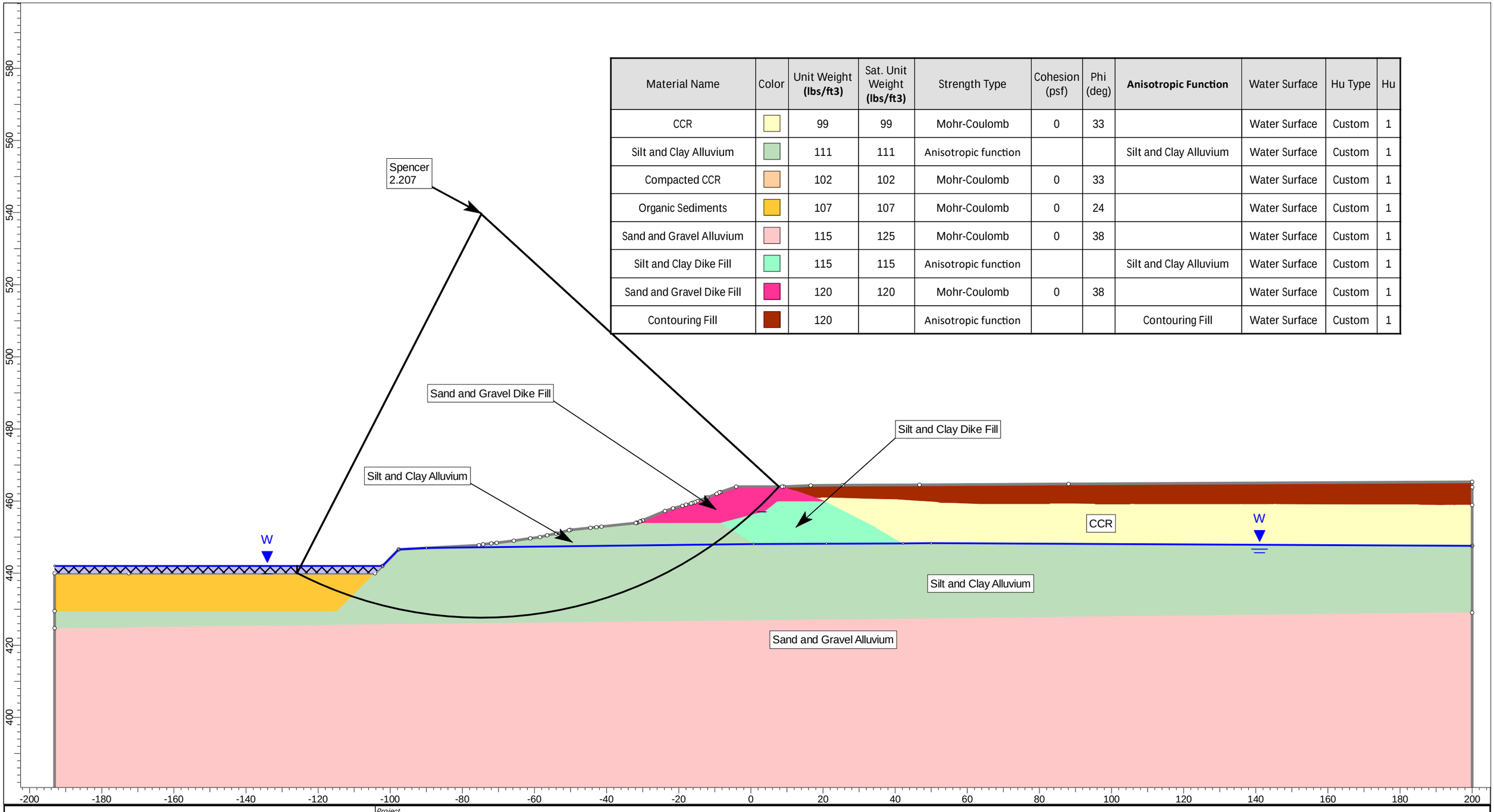
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Drained Conditions - Wedge Mechanism		
Analysis By	DC	*Client*	Dynegy
Date	7/28/2020	*Scale* 1:400	*File Name* 20200728_A-A'_Drained_Wedge.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	33		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			Silt and Clay Alluvium	Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33		Water Surface	Custom	1
Organic Sediments		107	107	Mohr-Coulomb	0	24		Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			Silt and Clay Alluvium	Water Surface	Custom	1
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Contouring Fill		120		Anisotropic function			Contouring Fill	Water Surface	Custom	1



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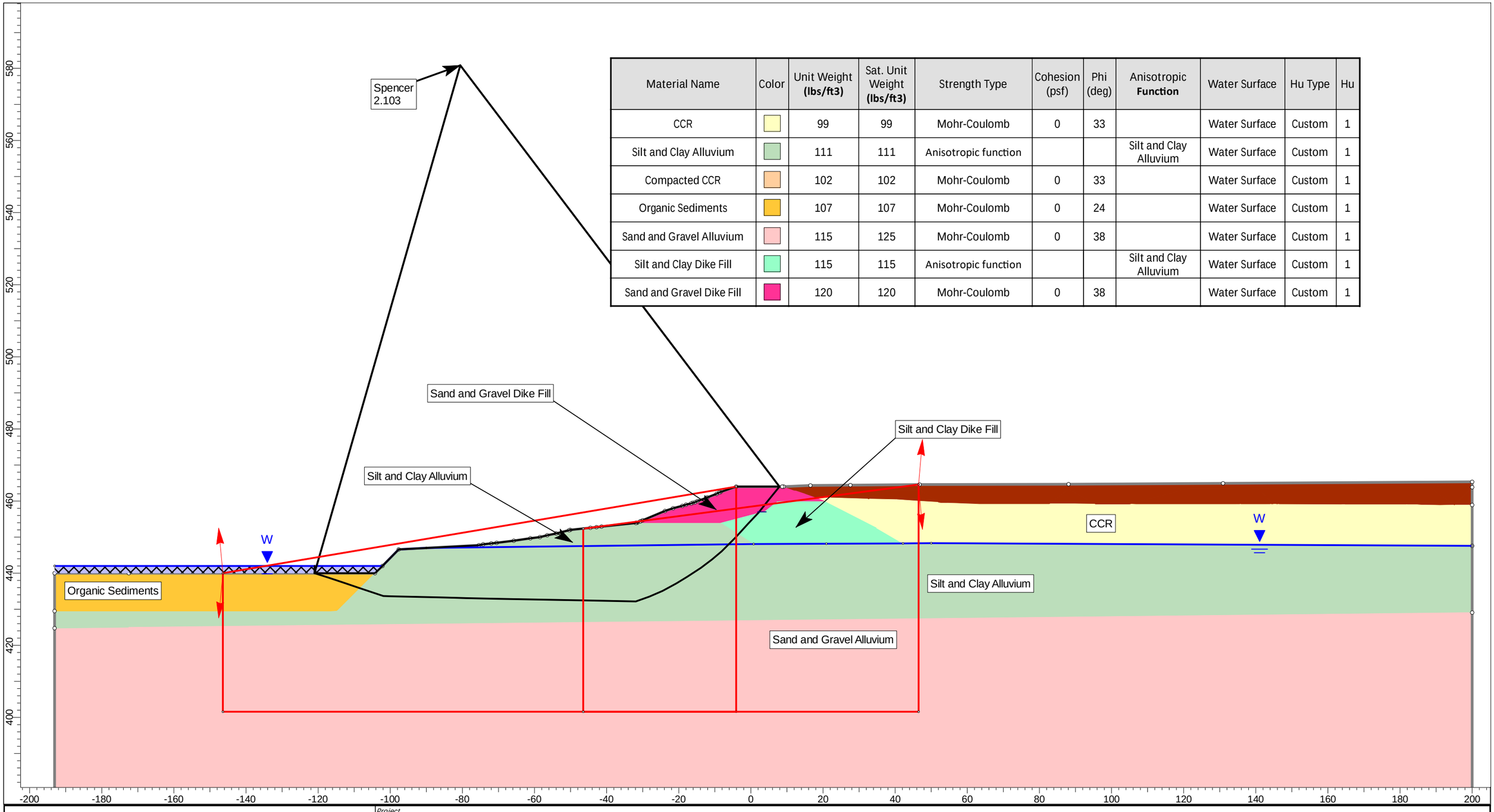
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond Closure		
Analysis Description	Section B-B' - Drained Conditions - Circular Mechanism		
Analysis By	DC	Client	Dynegy
Date	05/18/2020	Scale	1:300	File Name	20200514_B-B'_Drained_Circular.slim

Material Name	Color	Unit Weight **(lbs/ft3)**	Sat. Unit Weight **(lbs/ft3)**	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic **Function**	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	33		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			Silt and Clay Alluvium	Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33		Water Surface	Custom	1
Organic Sediments		107	107	Mohr-Coulomb	0	24		Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			Silt and Clay Alluvium	Water Surface	Custom	1
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1



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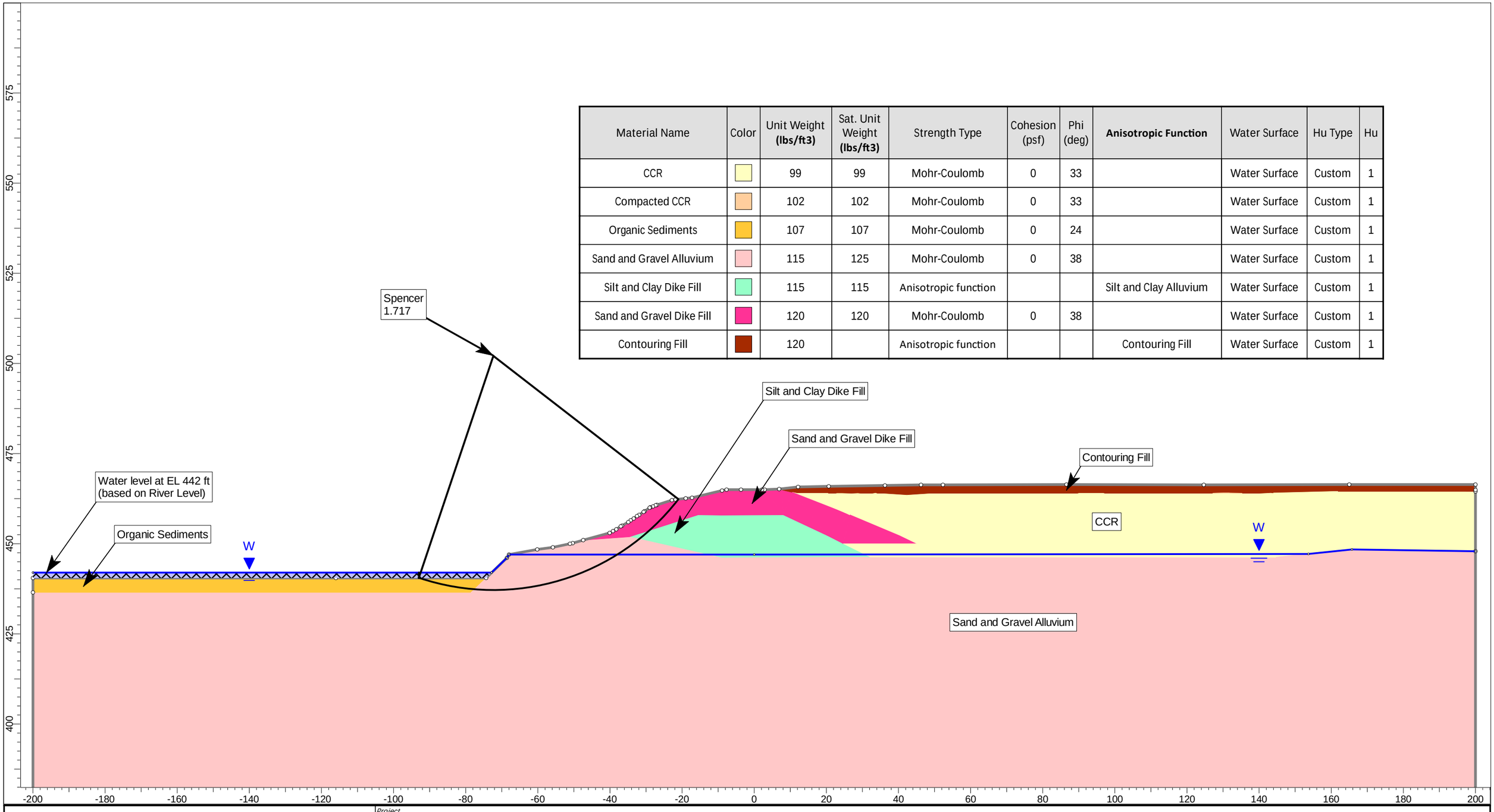
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond Closure		
Analysis Description	Section B-B' - Drained Conditions - Circular Mechanism		
Analysis By	DC		*Client* Dynegy
Date 05/18/2020	*Scale* 1:1		*File Name* 20200514_B-B'_Drained_Wedge.slim

Material Name	Color	Unit Weight **(lbs/ft3)**	Sat. Unit Weight **(lbs/ft3)**	Strength Type	Cohesion (psf)	Phi (deg)	**Anisotropic Function**	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	33		Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33		Water Surface	Custom	1
Organic Sediments		107	107	Mohr-Coulomb	0	24		Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			Silt and Clay Alluvium	Water Surface	Custom	1
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Contouring Fill		120		Anisotropic function			Contouring Fill	Water Surface	Custom	1



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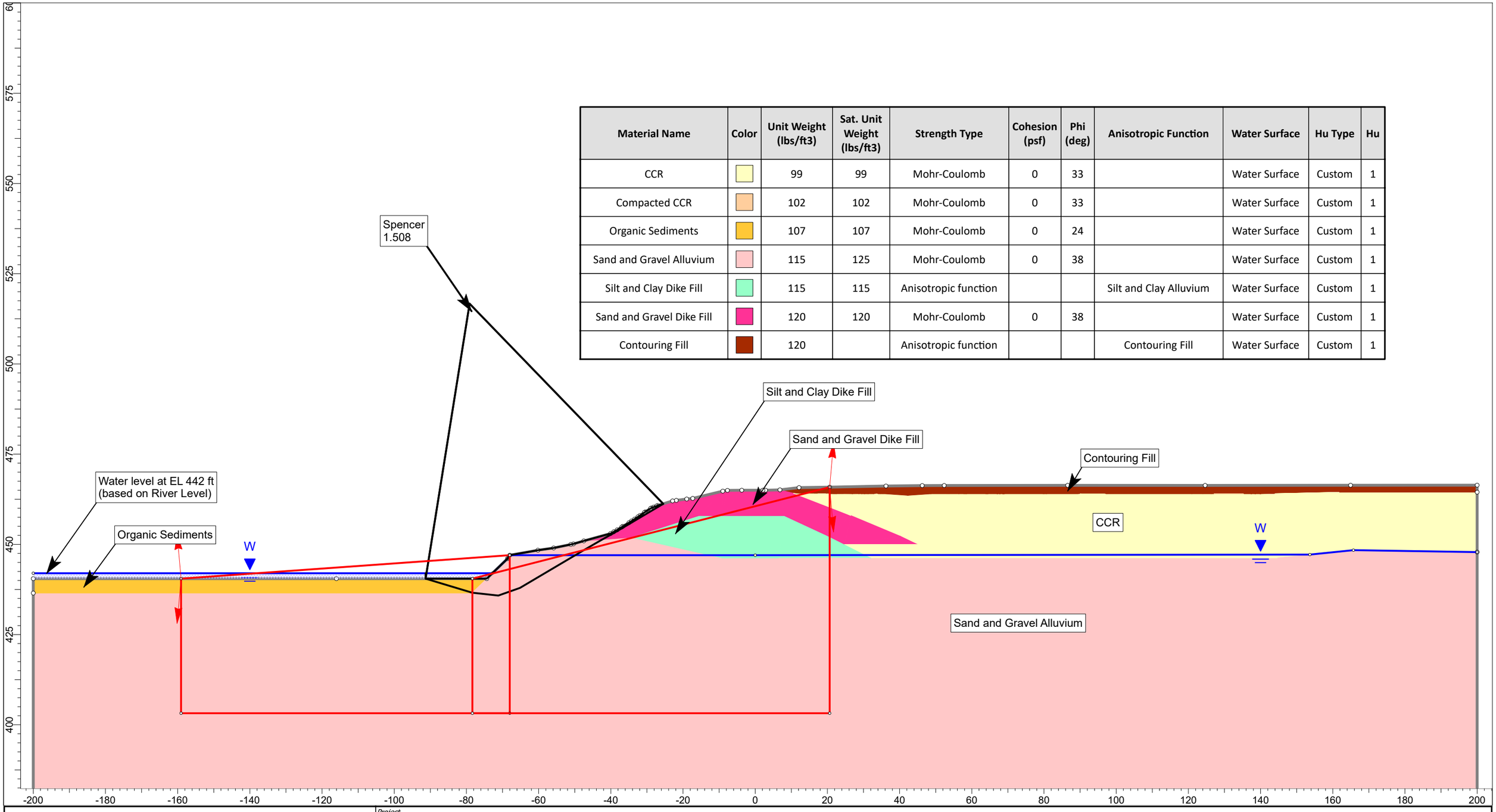
Project	Hennepin West Ash Pond Closure		
Analysis Description	Section C-C' - Drained Conditions - Circular Mechanism		
Analysis By	DC	*Client*	Dynegy
Date	05/18/2020	*Scale* 1:300	*File Name* 20200518_C-C'_Drained_Circular.slim

SLIDEINTERPRET 8.024

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	33		Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33		Water Surface	Custom	1
Organic Sediments		107	107	Mohr-Coulomb	0	24		Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			Silt and Clay Alluvium	Water Surface	Custom	1
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Contouring Fill		120		Anisotropic function			Contouring Fill	Water Surface	Custom	1



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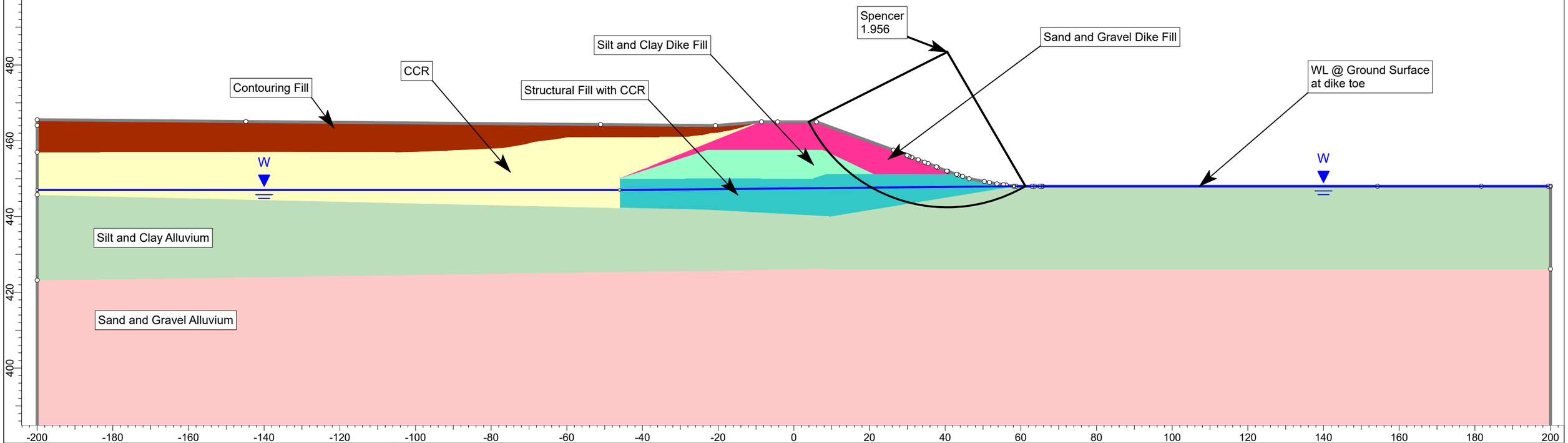
Project	Hennepin West Ash Pond Closure		
Analysis Description	Section C-C' - Drained Conditions - Wedge Mechanism		
Analysis By	DC	Client	Dynegy
Date	07/28/2020	Scale	1:300
File Name	20200728_C-C'_Drained_Wedge.slim		

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	33		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			Silt and Clay Alluvium	Water Surface	Custom	1
Contouring Fill		120	120	Anisotropic function			Contouring Fill	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			Silt and Clay Dike Fill	Water Surface	Custom	1
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Structural Fill with CCR		99	99	Mohr-Coulomb	0	33		Water Surface	Custom	1



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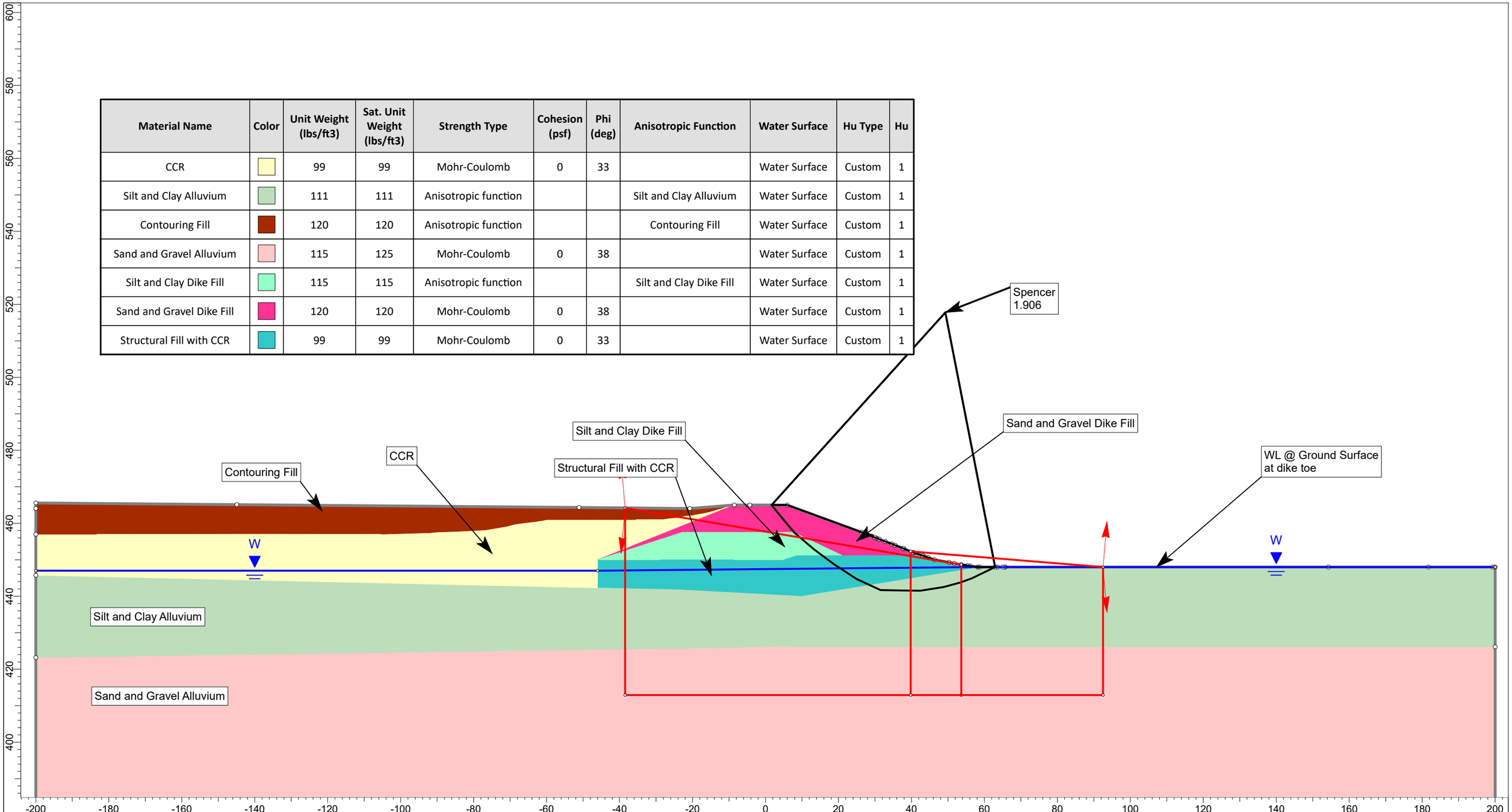
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond Closure		
Analysis Description	Section F-F' - Drained Conditions - Circular Mechanism		
Analysis By	DC		*Client* Dynegy
Date 07/28/2020	*Scale* 1:300		*File Name* 20200728_F-F'_Drained_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	33		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			Silt and Clay Alluvium	Water Surface	Custom	1
Contouring Fill		120	120	Anisotropic function			Contouring Fill	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			Silt and Clay Dike Fill	Water Surface	Custom	1
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Structural Fill with CCR		99	99	Mohr-Coulomb	0	33		Water Surface	Custom	1



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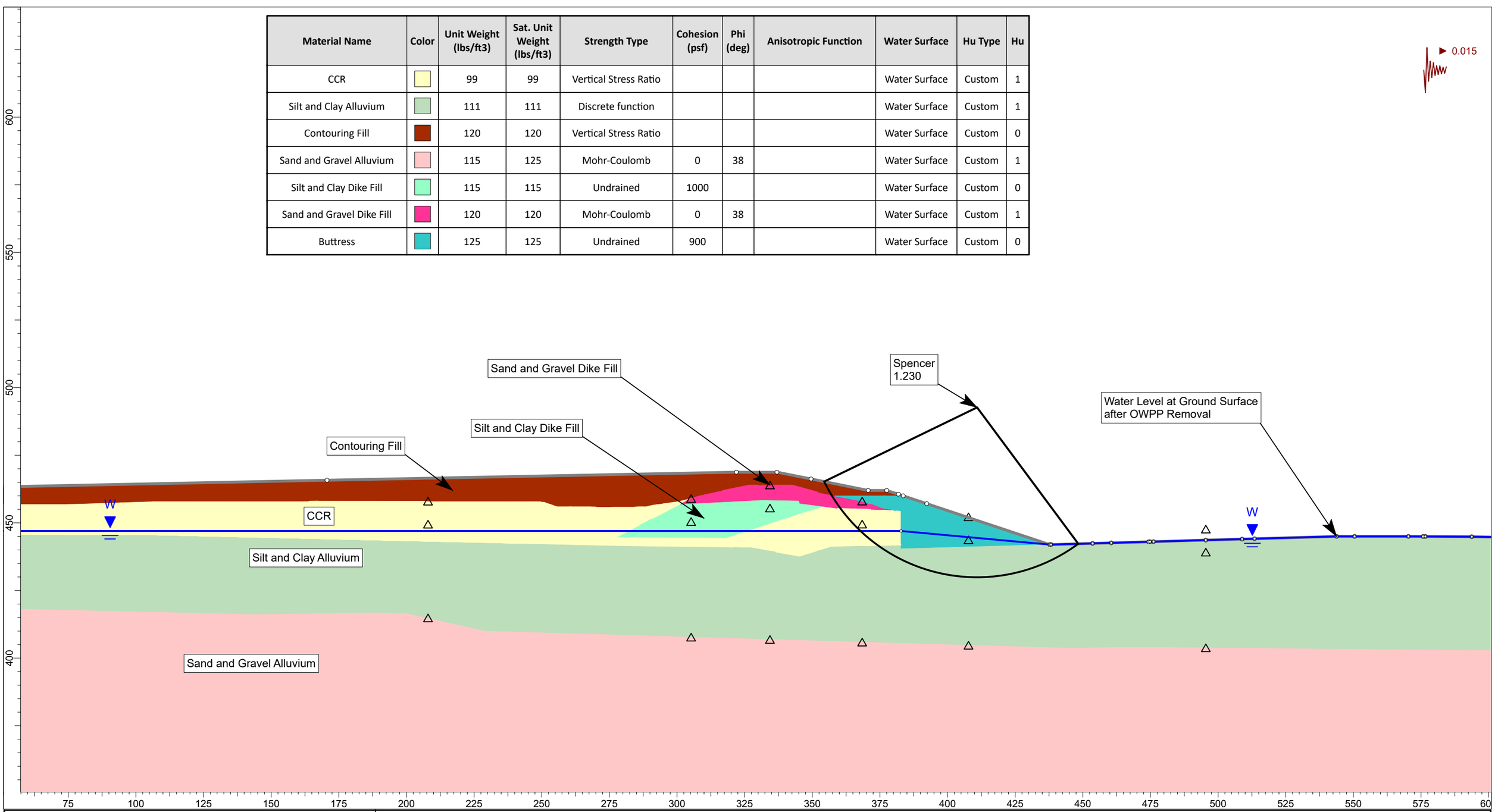
Project	Hennepin West Ash Pond Closure		
Analysis Description	Section F-F' - Drained Conditions - Wedge Mechanism		
Analysis By	DC		Client: Dynegy
Date: 07/28/2020	Scale: 1:300		File Name: 20200728_F-F'_Drained_Wedge.slim

Pseudostatic Slope Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Buttress		125	125	Undrained	900			Water Surface	Custom	0



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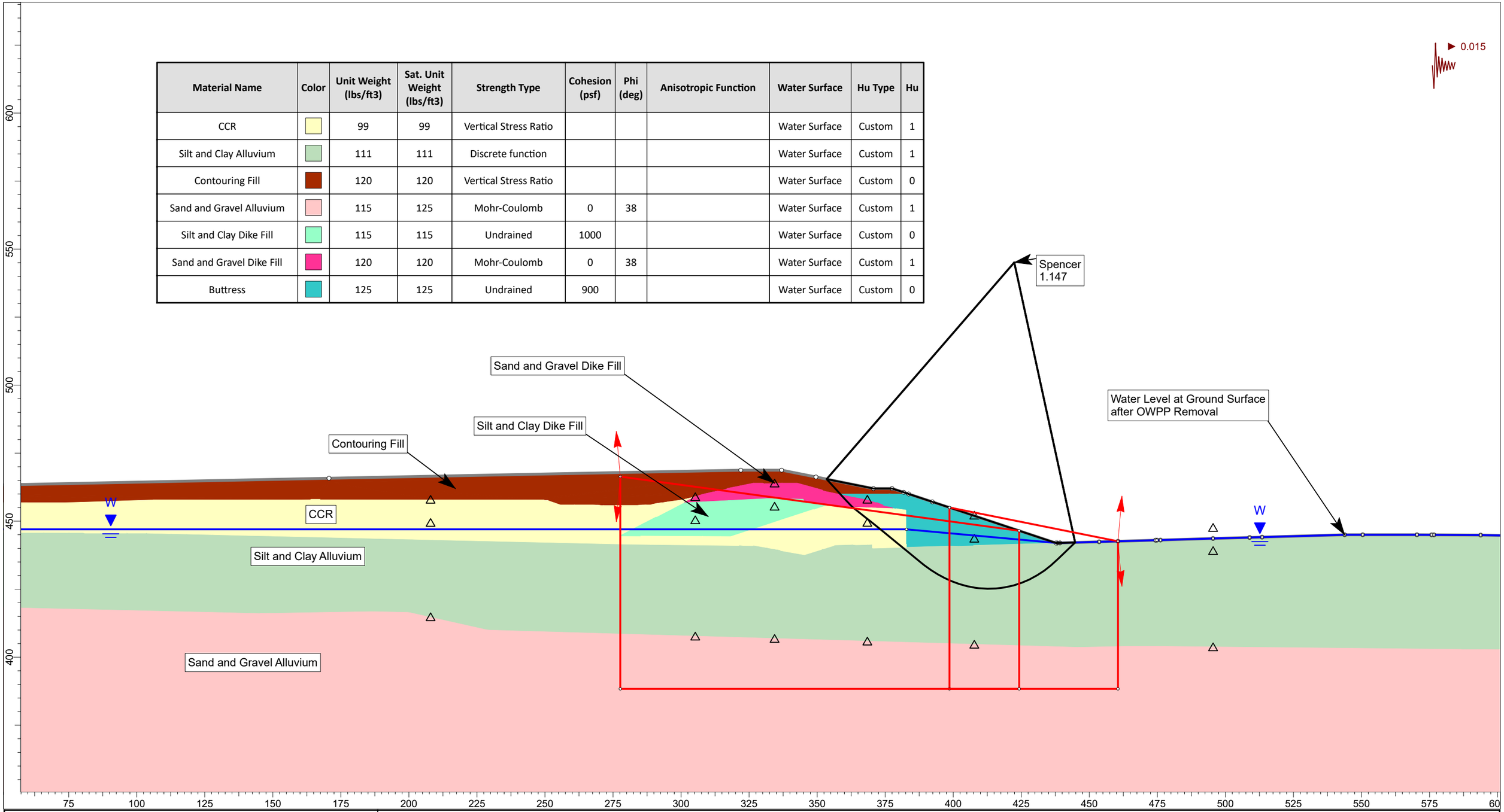
Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Pseudostatic - Circular Mechanism		
Analysis By	DC	Client	Dynegy
Date	6/26/2020	Scale	1:400
File Name	20200626_A-A'_Pseudostatic_Circular.slim		

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Buttress		125	125	Undrained	900			Water Surface	Custom	0



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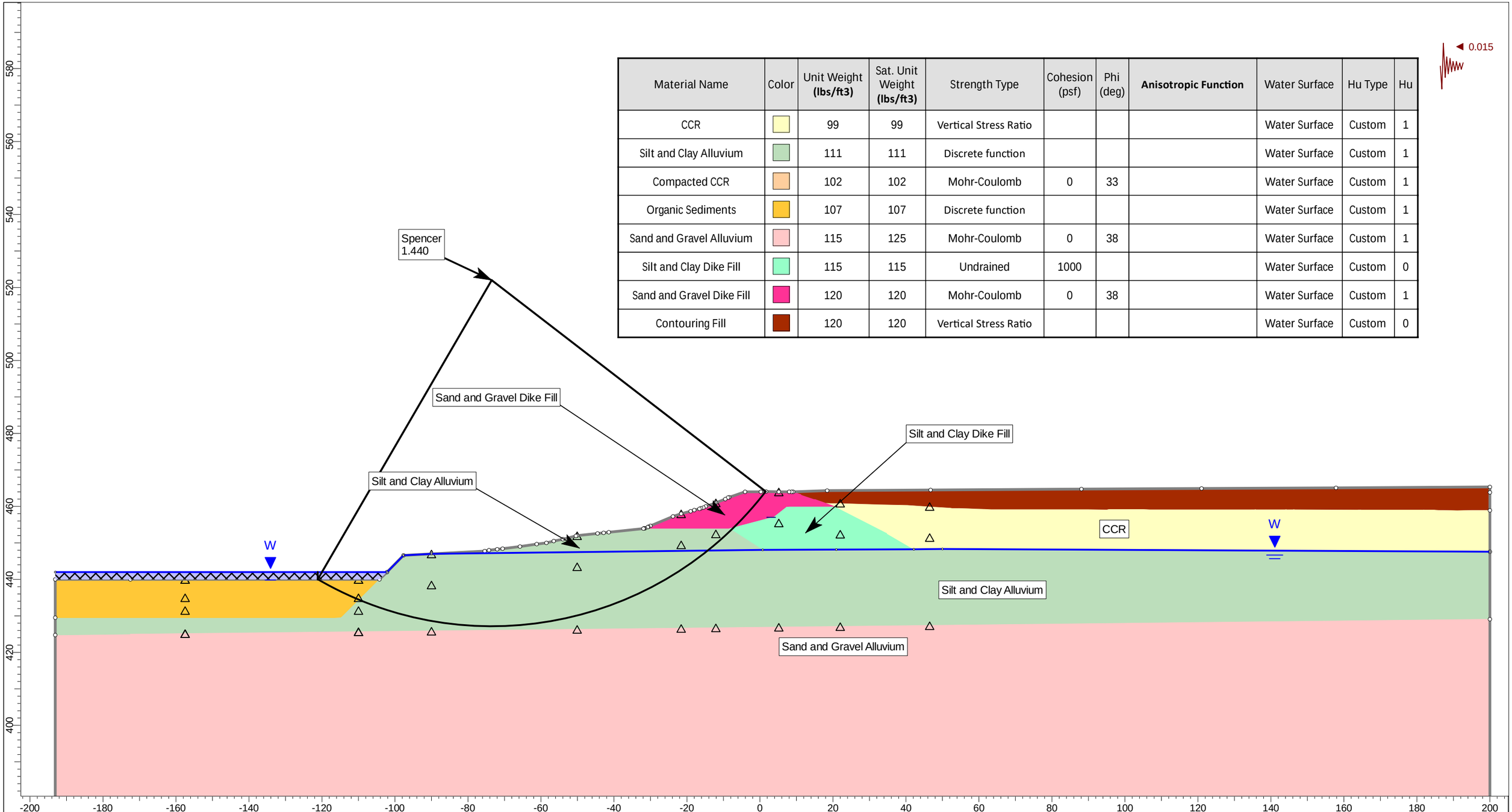
Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Pseudostatic - Wedge Mechanism		
Analysis By	DC	Client	Dynegy
Date	7/28/2020	Scale	1:400
File Name	20200728_A-A'_Pseudostatic_Wedge.slim		

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33		Water Surface	Custom	1
Organic Sediments		107	107	Discrete function				Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0



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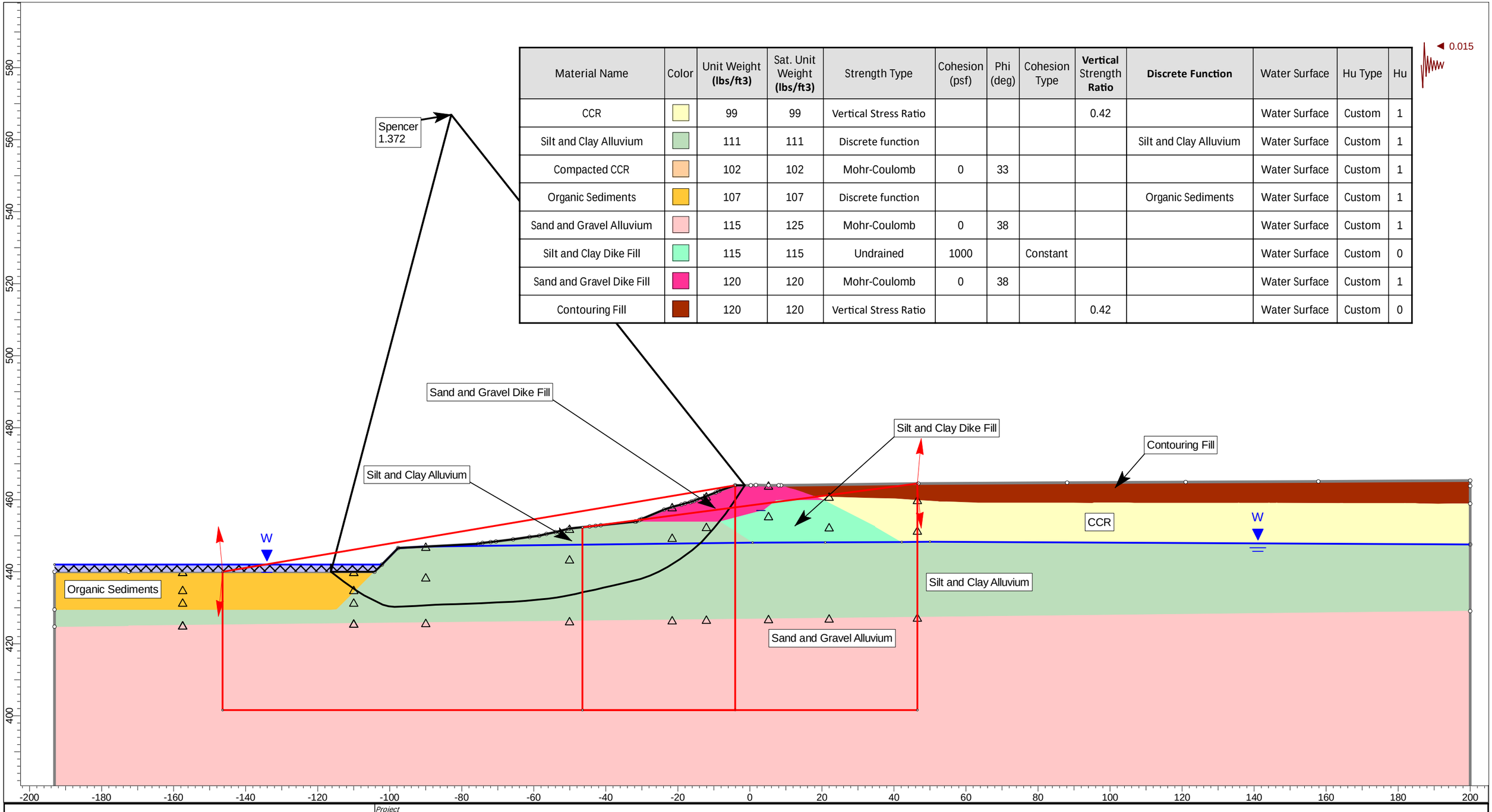
Project	Hennepin West Ash Pond Closure		
Analysis Description	Section B-B' - Pseudostatic - Circular Mechanism		
Analysis By	DC		Client: Dynegy
Date: 05/18/2020	Scale: 1:300		File Name: 20200518_B-B'_Pseudostatic-EQ_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Discrete Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				0.42		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function					Silt and Clay Alluvium	Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33				Water Surface	Custom	1
Organic Sediments		107	107	Discrete function					Organic Sediments	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38				Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000		Constant			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38				Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				0.42		Water Surface	Custom	0



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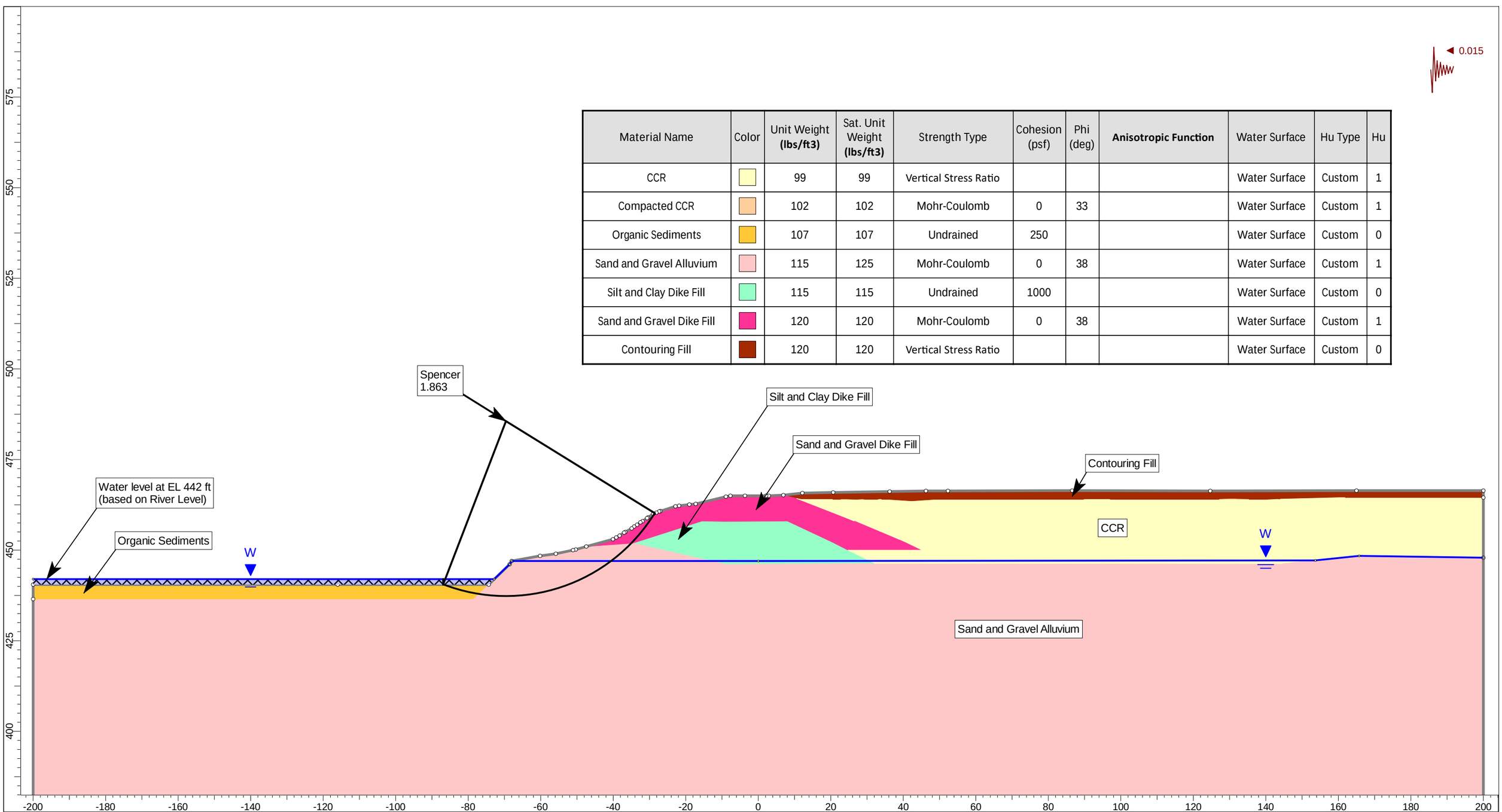
Project	Hennepin West Ash Pond Closure		
Analysis Description	Section B-B' - Pseudostatic - Wedge Mechanism		
Analysis By	DC		Client: Dynegy
Date: 05/18/2020	Scale: 1:300		File Name: 20200518_B-B'_Pseudostatic-EQ_Wedge.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33		Water Surface	Custom	1
Organic Sediments		107	107	Undrained	250			Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0



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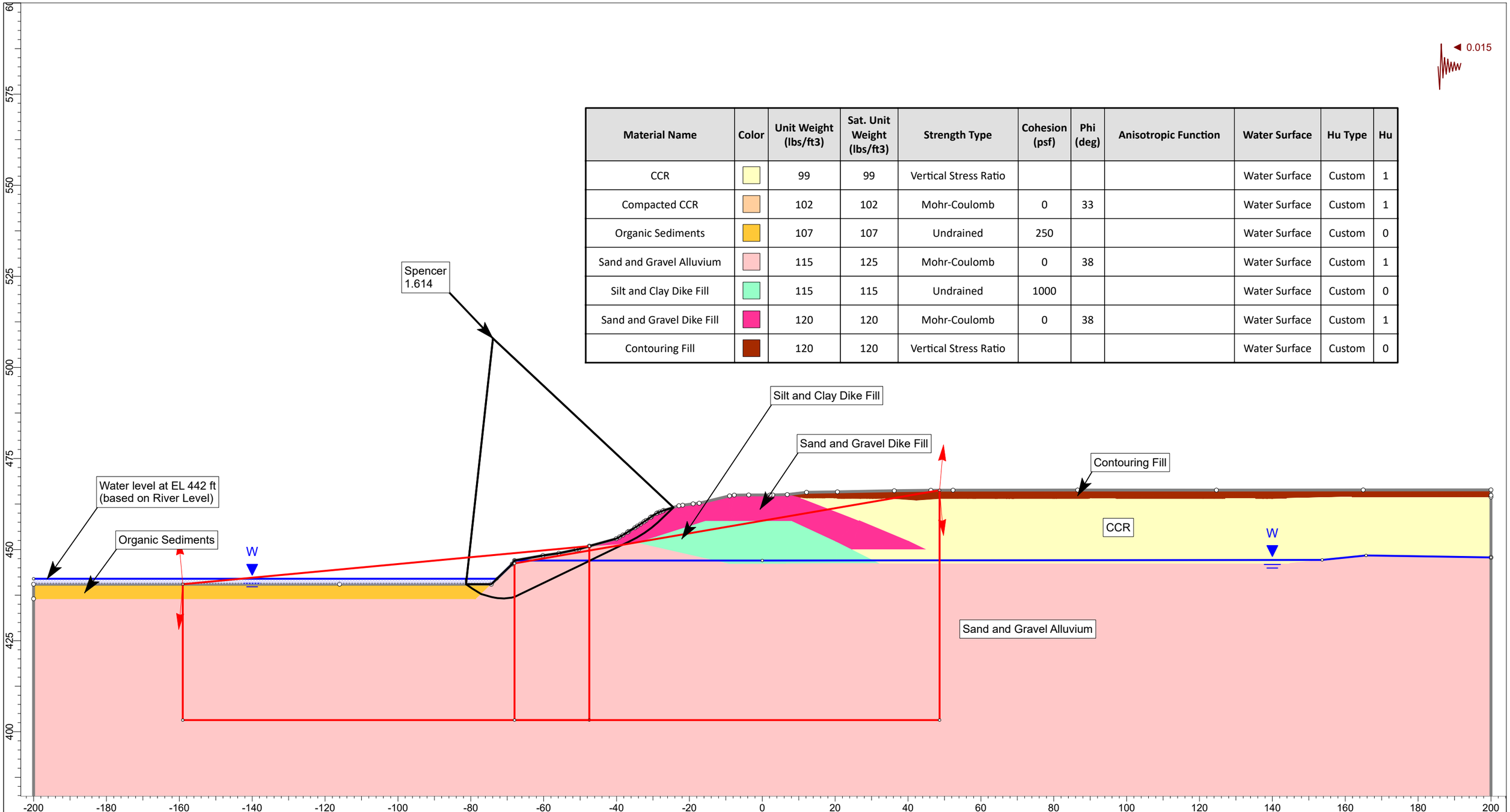
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond Closure		
Analysis Description	Section C-C' - Pseudostatic - Circular Mechanism		
Analysis By	DC	*Client*	Dynegy
Date	05/18/2020	*Scale* 1:300	*File Name* 20200518_C-C'_Pseudostatic_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33		Water Surface	Custom	1
Organic Sediments		107	107	Undrained	250			Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0



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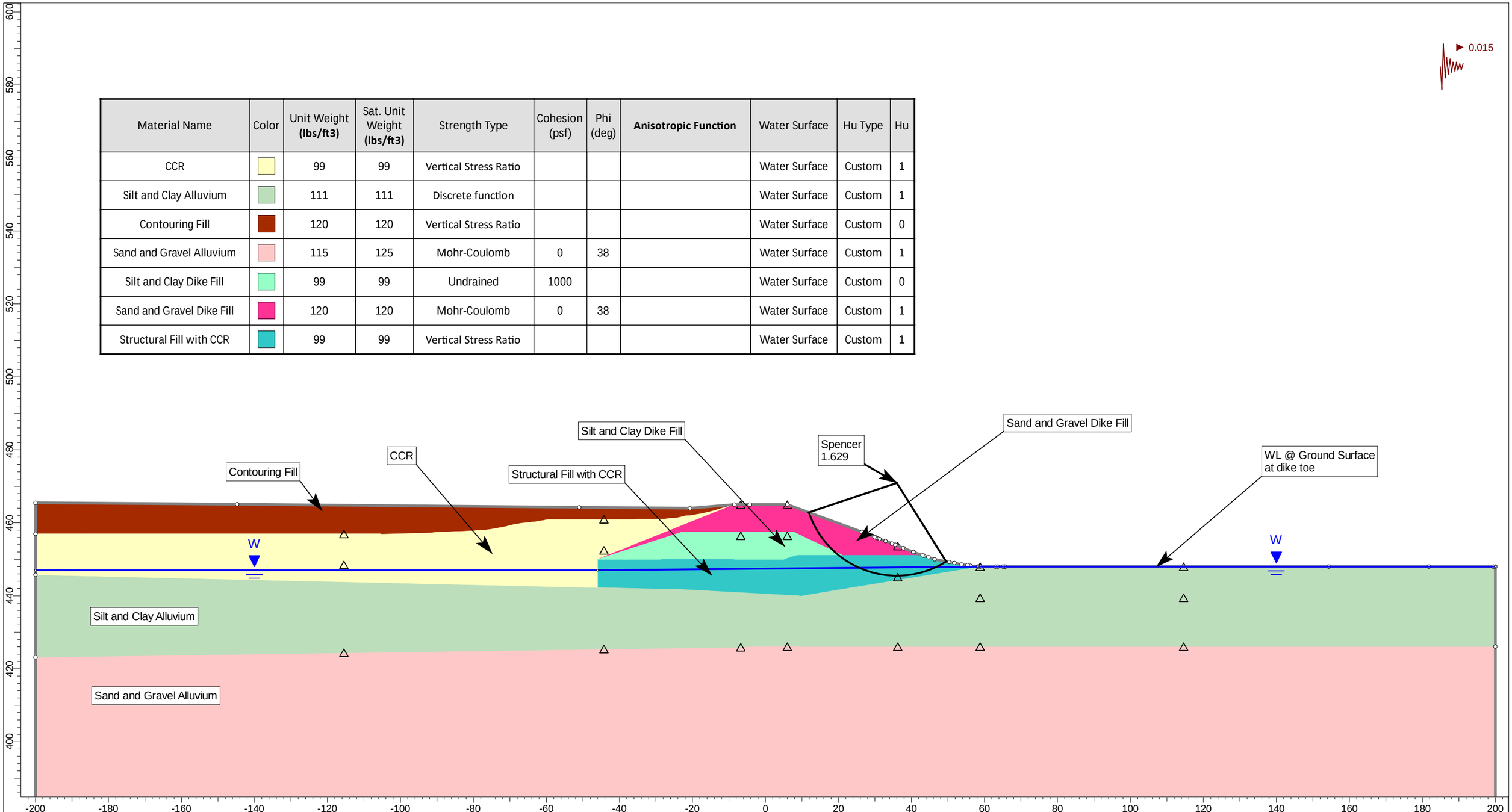
Project	Hennepin West Ash Pond Closure		
Analysis Description	Section C-C' - Pseudostatic - Wedge Mechanism		
Analysis By	DC	Client	Dynegy
Date	7/28/2020	Scale	1:300
File Name	20200728_C-C'_Pseudostatic_Wedge.slim		

Material Name	Color	Unit Weight **(lbs/ft3)**	Sat. Unit Weight **(lbs/ft3)**	Strength Type	Cohesion (psf)	Phi (deg)	**Anisotropic Function**	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		99	99	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Structural Fill with CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1



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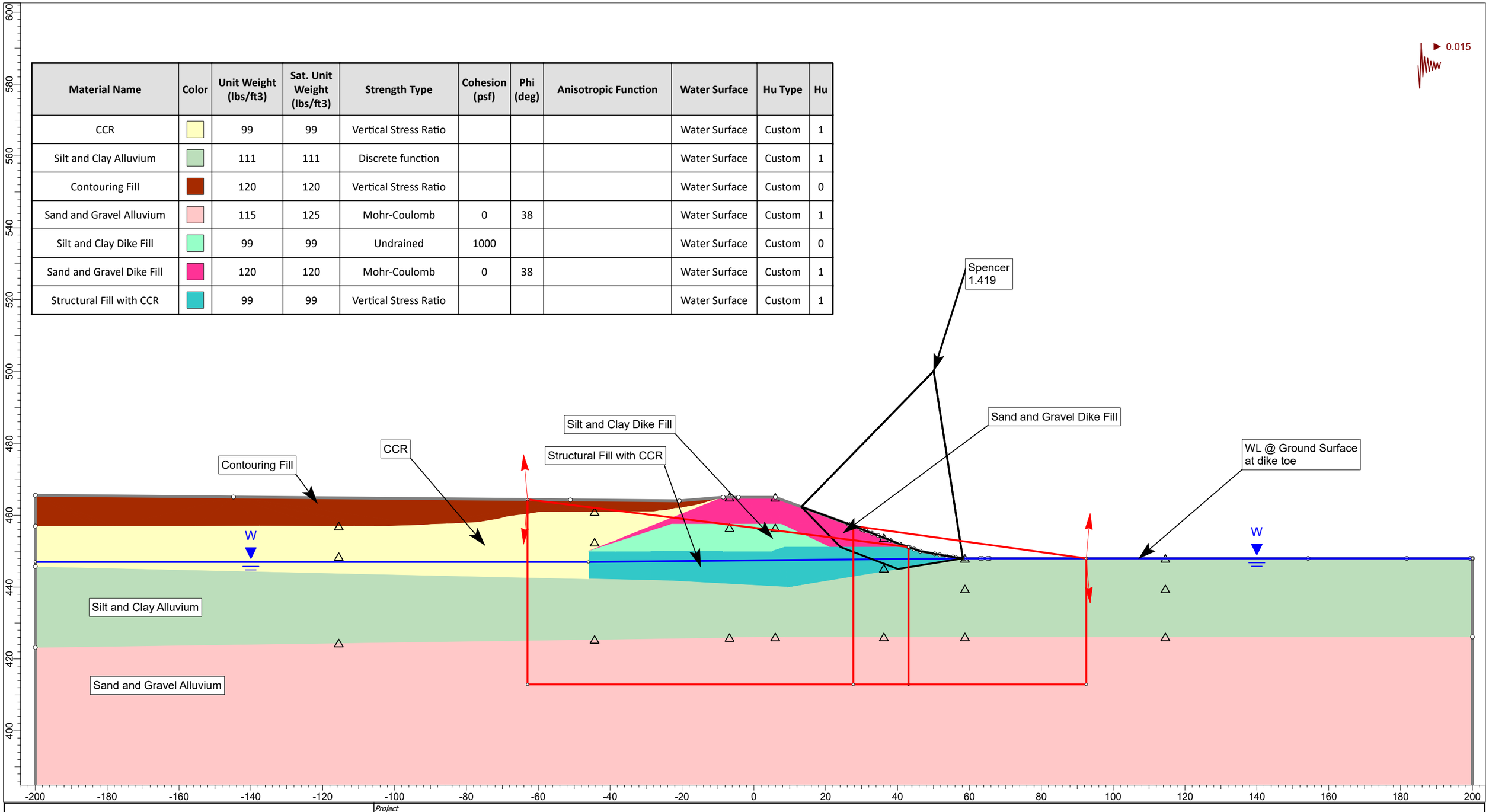
Project	Hennepin West Ash Pond Closure		
Analysis Description	Section F-F' - Pseudostatic - Circular Mechanism		
Analysis By	DC		*Client* Dynegy
Date 05/18/2020	*Scale* 1:300		*File Name* 20200518_F-F'_Pseudostatic_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		99	99	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Structural Fill with CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1



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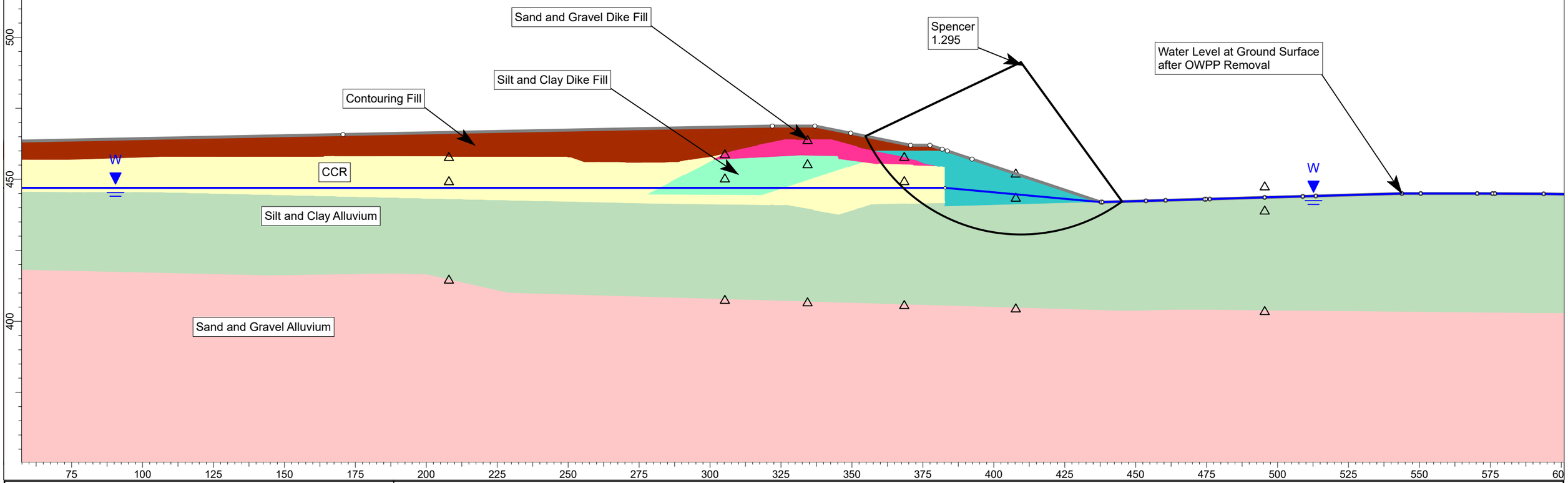
Project	Hennepin West Ash Pond Closure		
Analysis Description	Section F-F' - Pseudostatic - Wedge Mechanism		
Analysis By	DC		Client: Dynegy
Date: 7/28/2020	Scale: 1:300		File Name: 20200728_F-F'_Pseudostatic_Wedge.slim

Post-Earthquake Slope Stability Analysis

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Buttress		125	125	Undrained	900			Water Surface	Custom	0



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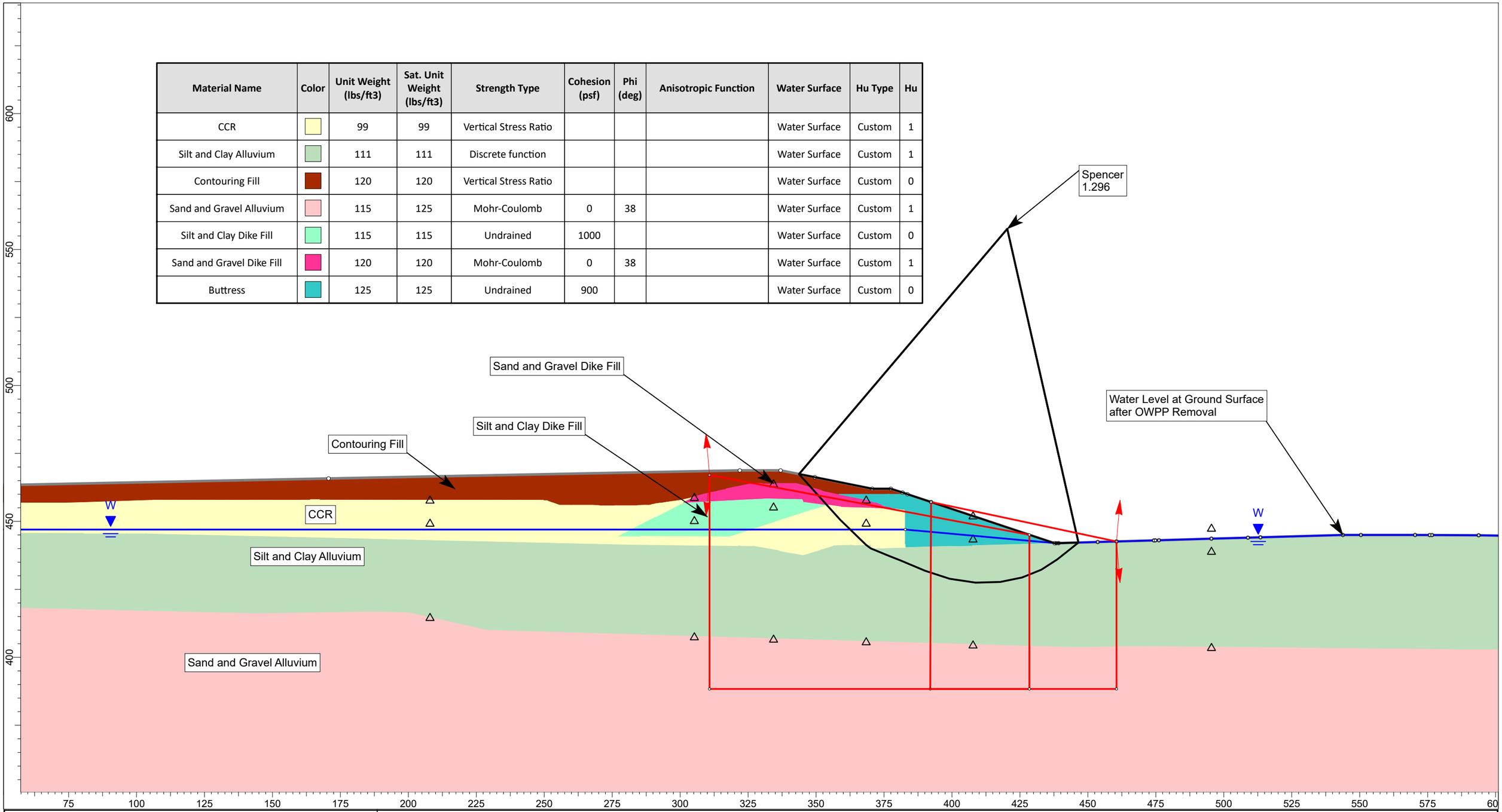
Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Post Earthquake - Circular Mechanism		
Analysis By	DC	*Client*	Dynegy
Date	7/28/2020	*Scale* 1:400	*File Name* 20200728_A-A'_Post-EQ_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Buttress		125	125	Undrained	900			Water Surface	Custom	0



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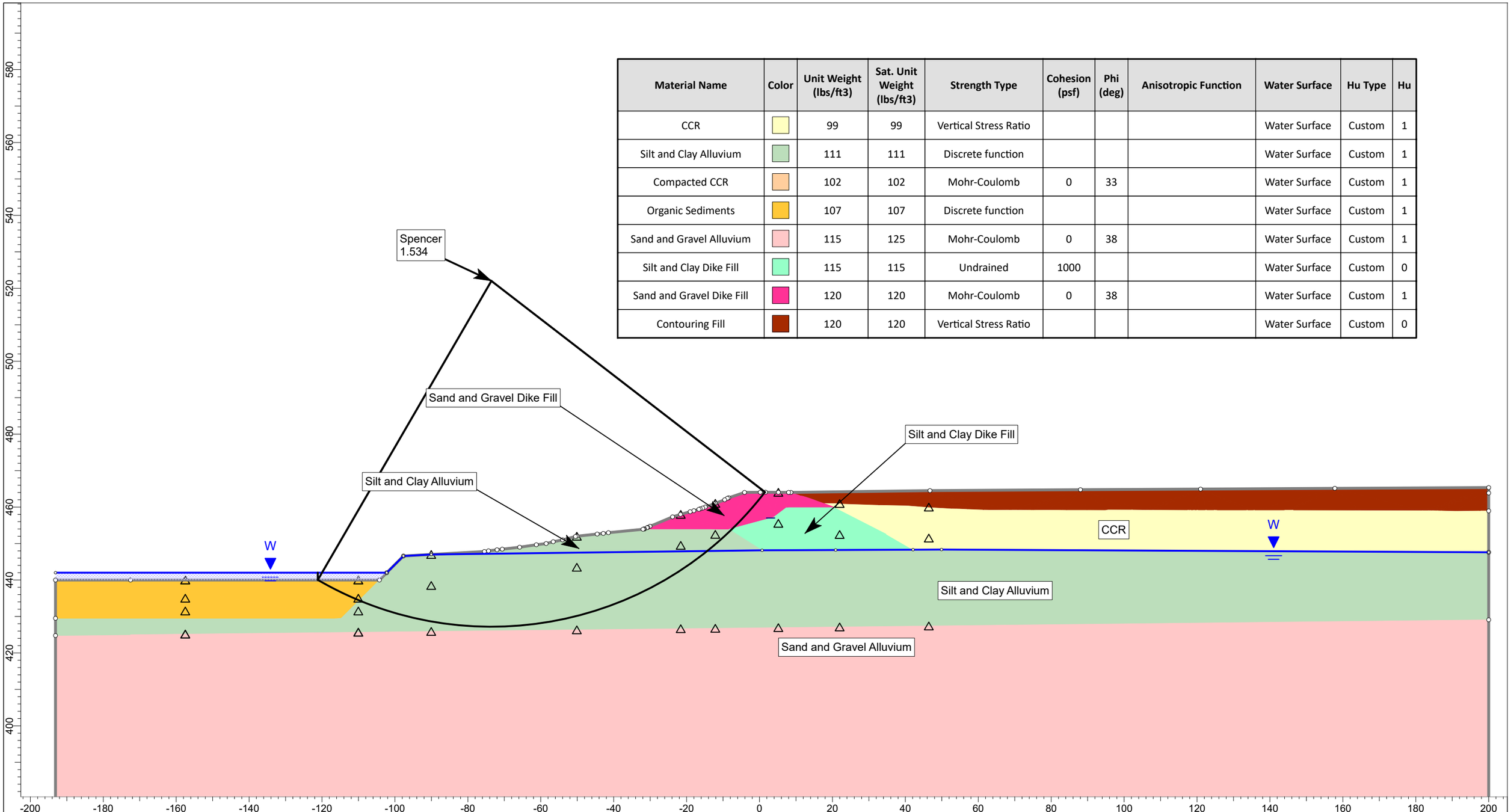
Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Post Earthquake - Wedge Mechanism		
Analysis By	DC	Client	Dynegy
Date	6/26/2020	Scale	1:400	File Name	20200728_A-A'_Post-EQ_Wedge.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33		Water Surface	Custom	1
Organic Sediments		107	107	Discrete function				Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0



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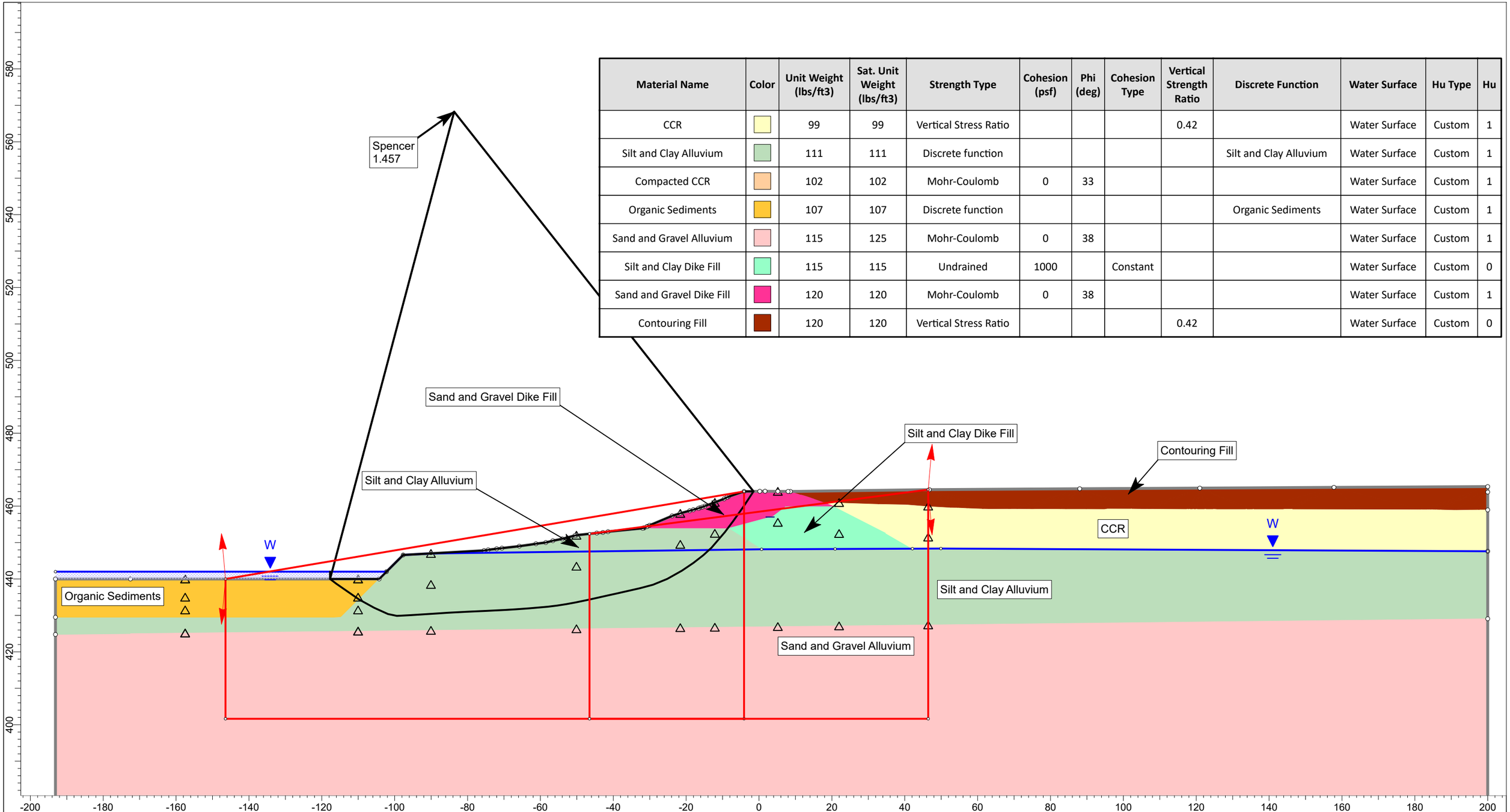
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond Closure		
Analysis Description	Section B-B' - Post Earthquake - Circular Mechanism		
Analysis By	DC	Client	Dynegy
Date	7/28/2020	Scale	1:300	File Name	20200728_B-B'_Post-EQ_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Discrete Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				0.42		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function					Silt and Clay Alluvium	Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33				Water Surface	Custom	1
Organic Sediments		107	107	Discrete function					Organic Sediments	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38				Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000		Constant			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38				Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				0.42		Water Surface	Custom	0



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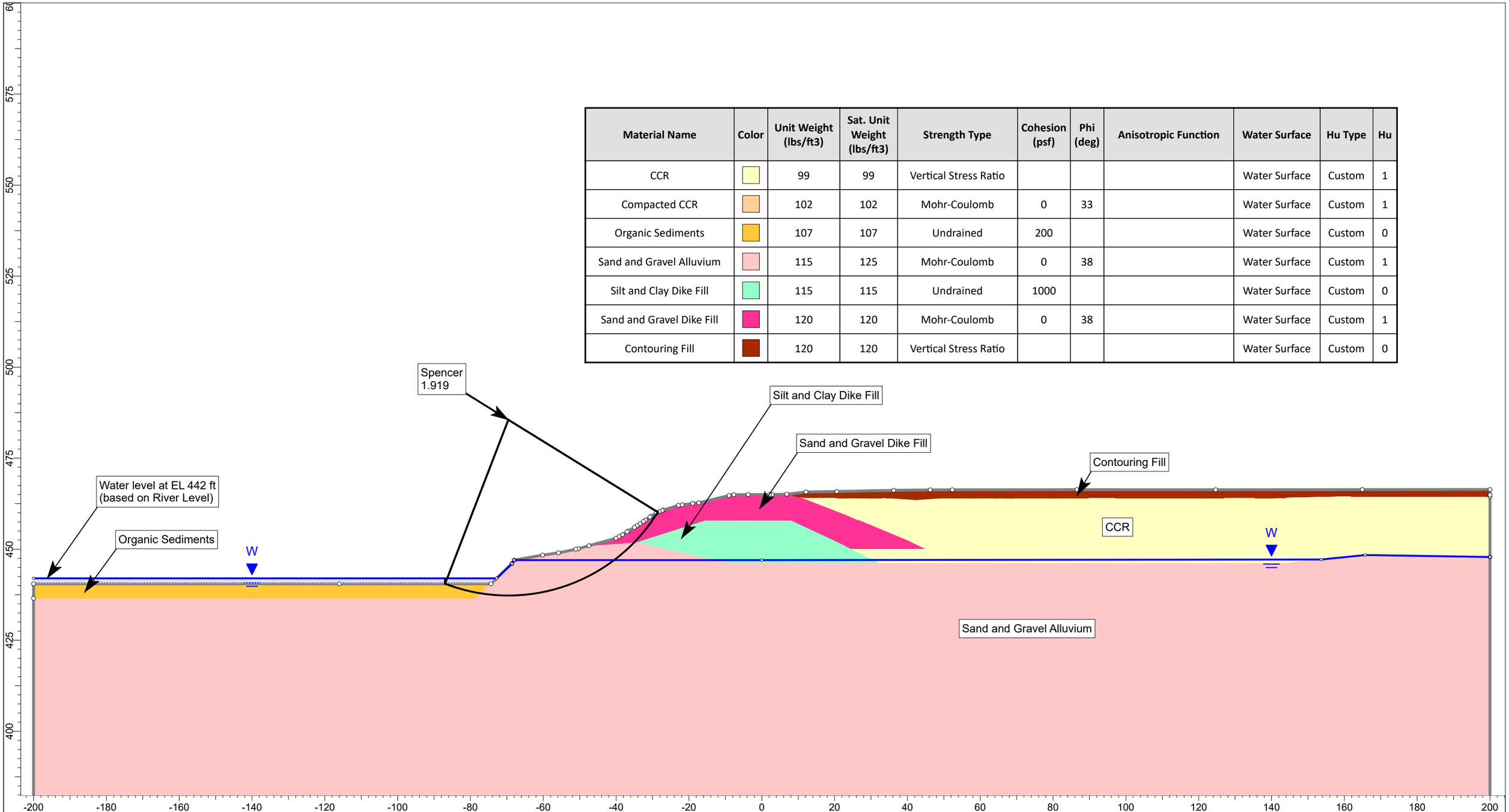
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond Closure		
Analysis Description	Section B-B' - Post Earthquake - Wedge Mechanism		
Analysis By	DC	*Client*	Dynegy
Date	7/28/2020	*Scale* 1:300	*File Name* 20200728_B-B'_Post-EQ_Wedge.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33		Water Surface	Custom	1
Organic Sediments		107	107	Undrained	200			Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0



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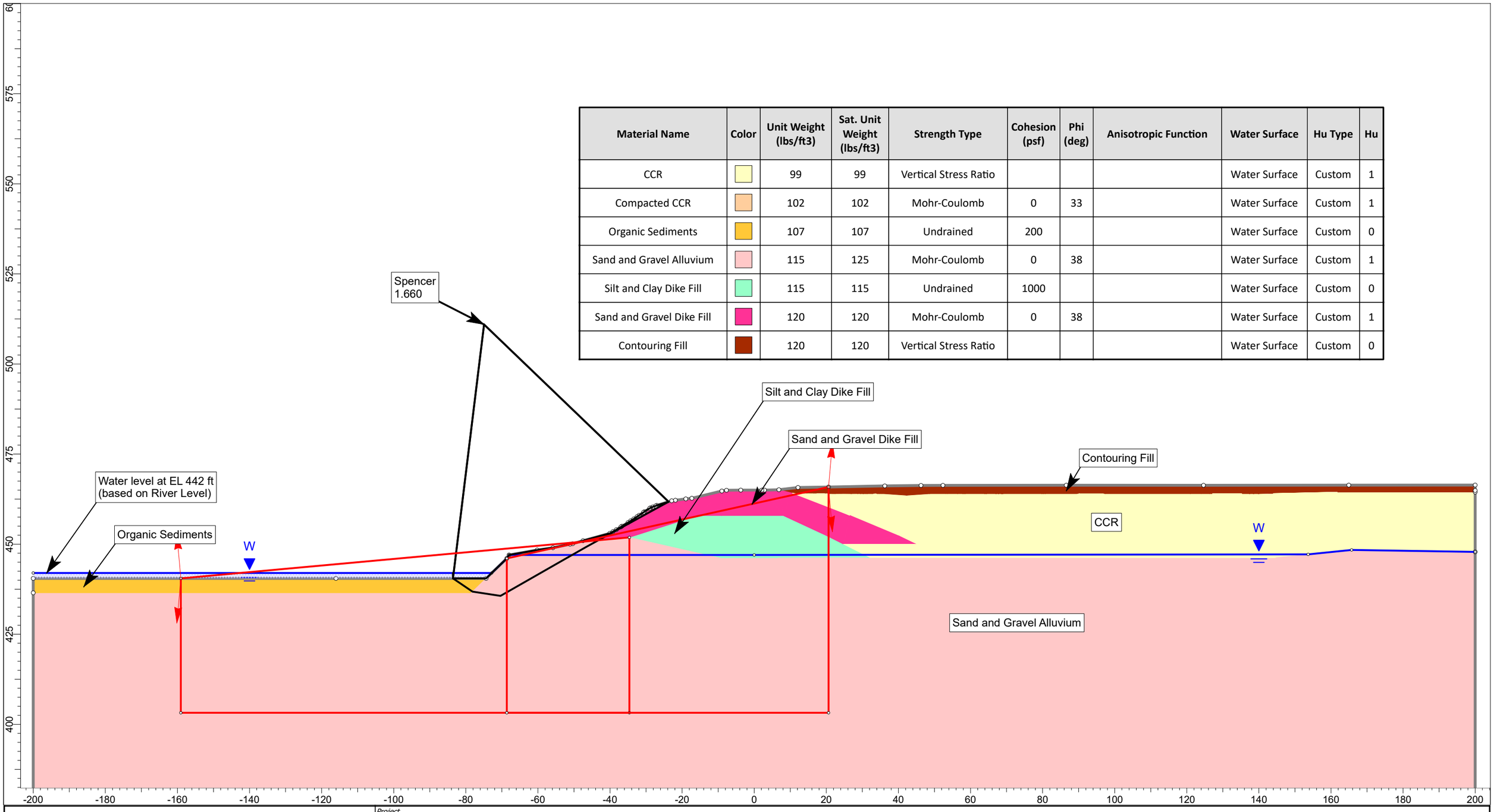
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond Closure		
Analysis Description	Section C-C' - Post Earthquake - Circular Mechanism		
Analysis By	DC	Client	Dynegy
Date	7/28/2020	Scale	1:300	File Name	20200728_C-C'_Post-EQ_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Compacted CCR		102	102	Mohr-Coulomb	0	33		Water Surface	Custom	1
Organic Sediments		107	107	Undrained	200			Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0



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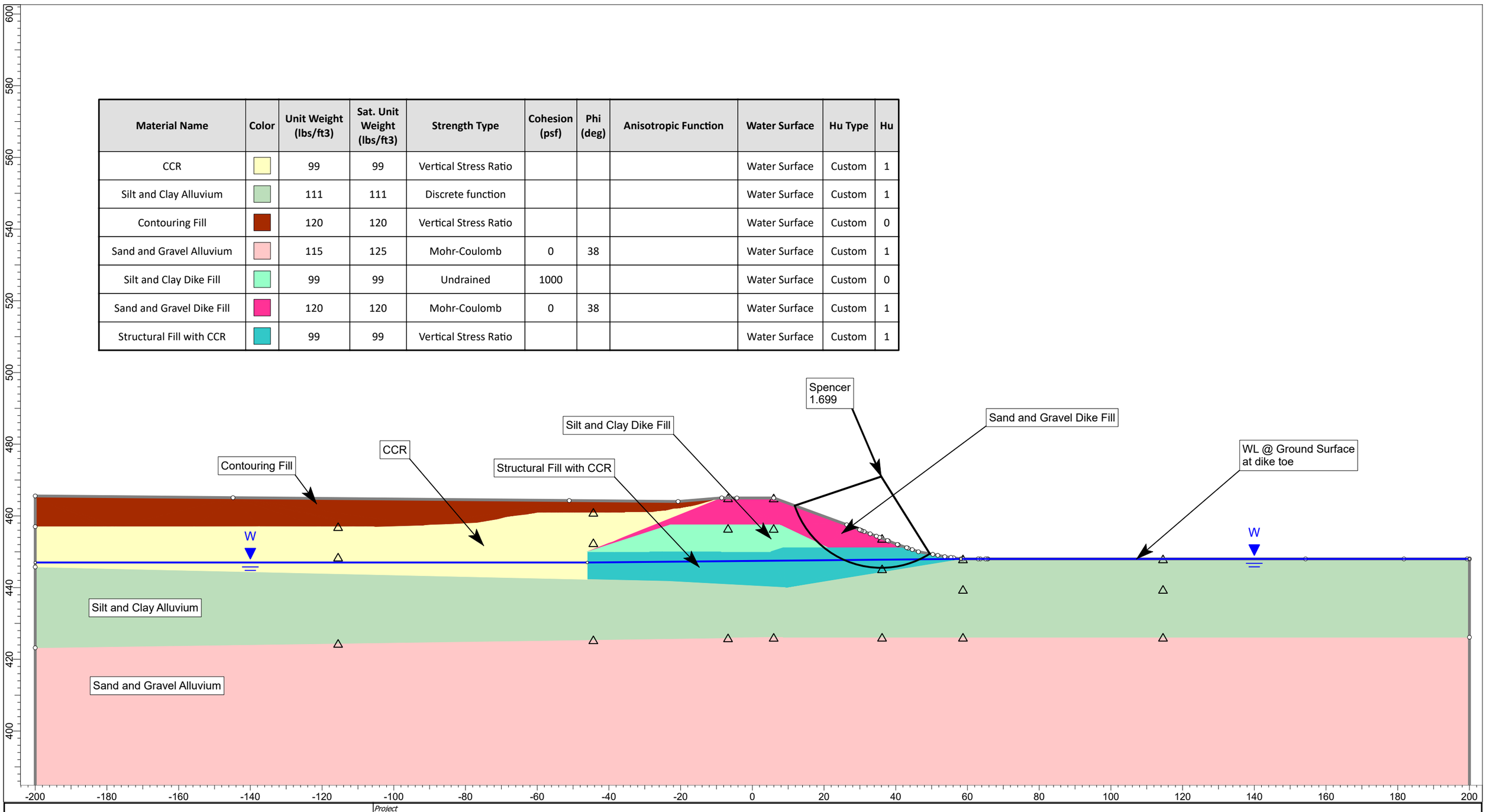
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond Closure		
Analysis Description	Section C-C' - Post Earthquake - Wedge Mechanism		
Analysis By	DC	Client	Dynegy
Date	7/28/2020	Scale	1:300
File Name	20200728_C-C'_Post-EQ_Wedge.slim		

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		99	99	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Structural Fill with CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1



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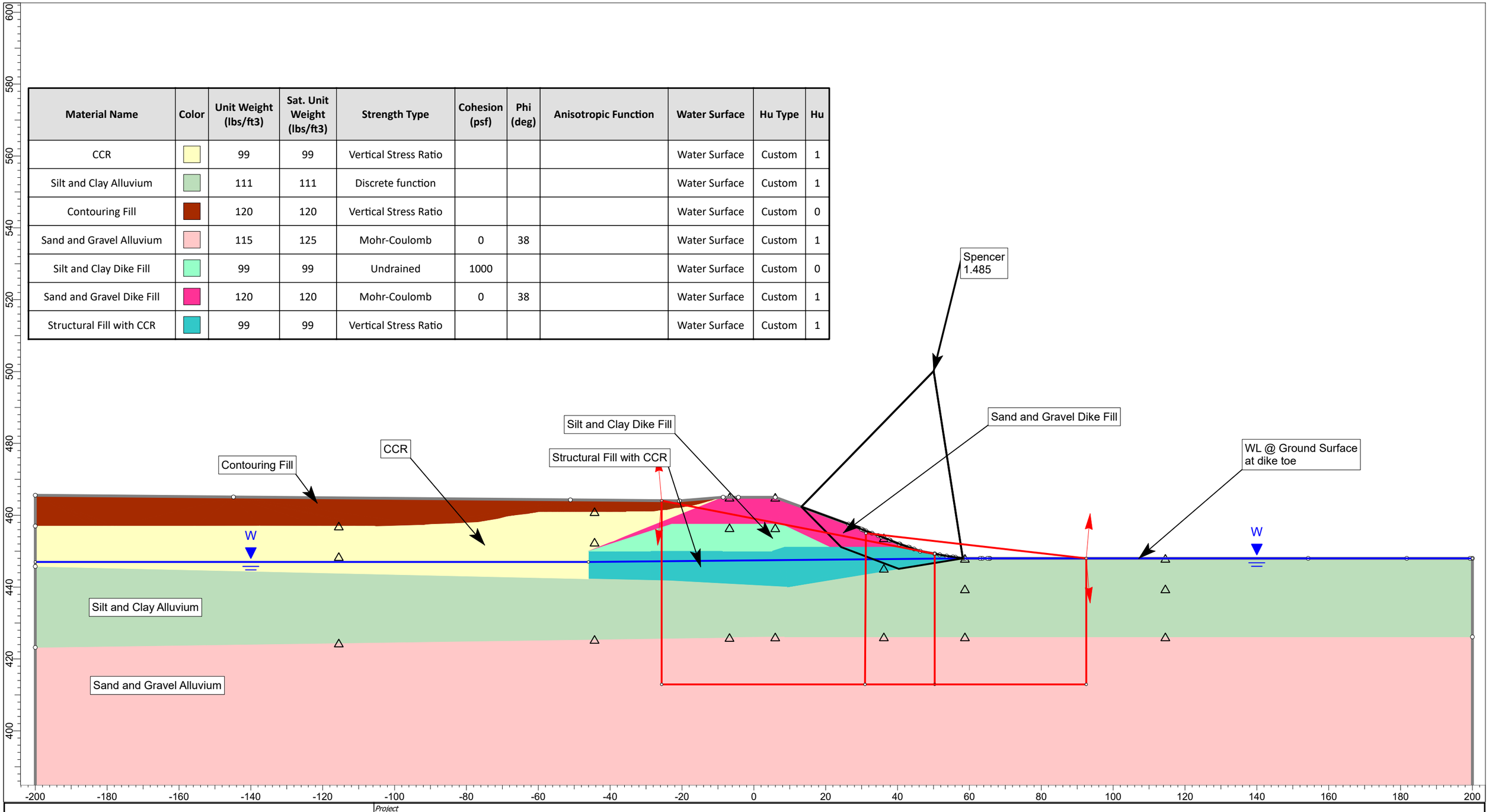
SLIDEINTERPRET 8.024

Project	Hennepin West Ash Pond Closure		
Analysis Description	Section F-F' - Post Earthquake - Circular Mechanism		
Analysis By	DC		Client: Dynegy
Date: 7/28/2020	Scale: 1:300		File Name: 20200728_F-F'_Post-EQ_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Contouring Fill		120	120	Vertical Stress Ratio				Water Surface	Custom	0
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		99	99	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Structural Fill with CCR		99	99	Vertical Stress Ratio				Water Surface	Custom	1



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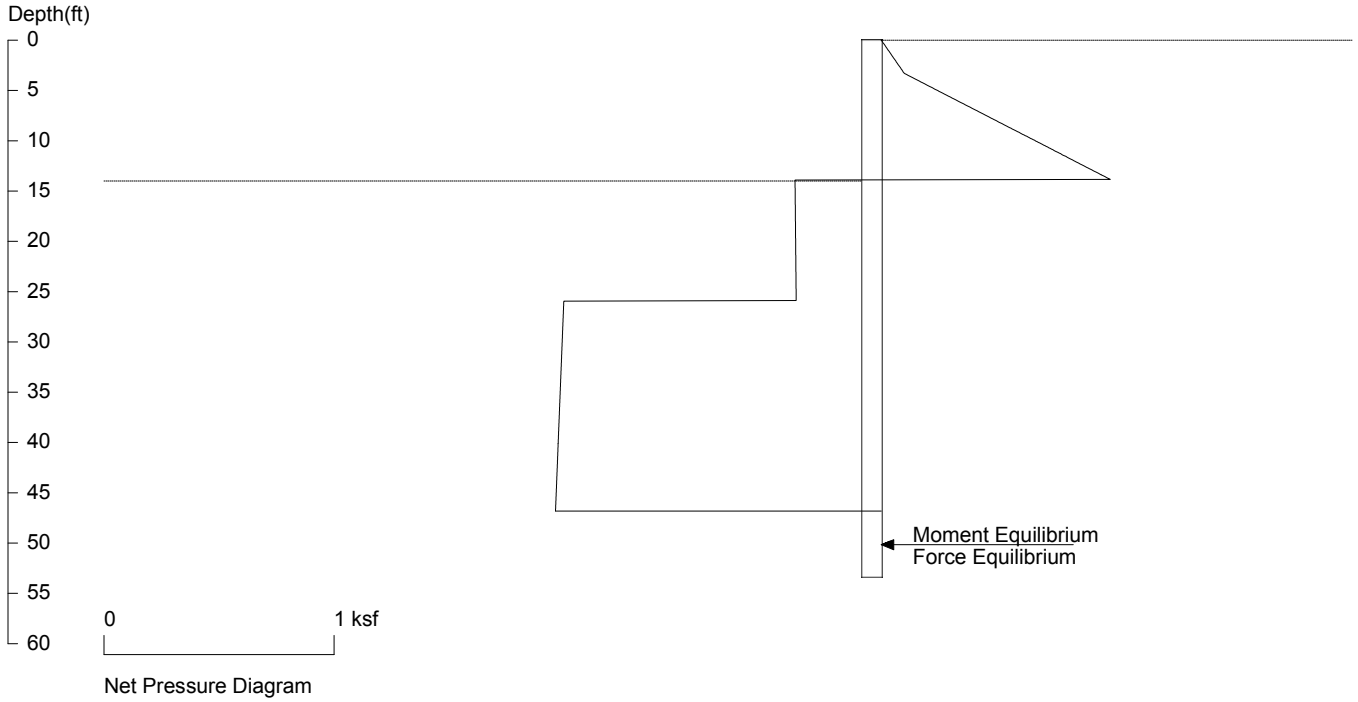
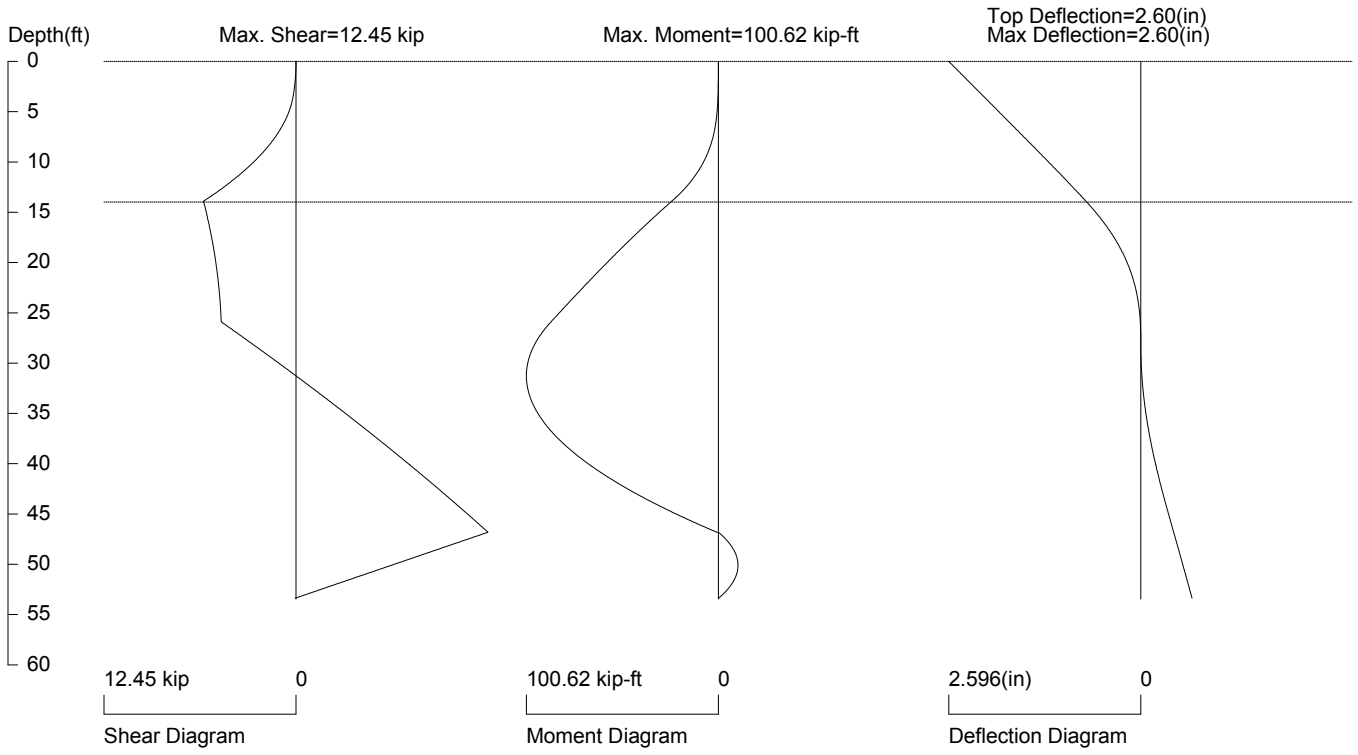
Project	Hennepin West Ash Pond Closure		
Analysis Description	Section F-F' - Post Earthquake - Wedge Mechanism		
Analysis By	DC		Client: Dynegy
Date: 7/28/2020	Scale: 1:300		File Name: 20200728_F-F'_Post-EQ_Wedge.slim

APPENDIX B

Sheet Pile Wall Analyses

CT Shoring Undrained Analysis Output





PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 1.0 foot or meter

User Input I: E (ksi)=29000.0, I (in4)/foot=419.9

\CHE8356- Hennepin West Ash Pond System\500 - Technical\556 - 90% Design\02_Geotech\Sheetpile\CT_Shoring\20180315\Dike Modeled\20180320\CHE8356_Und

CT Shoring Undrained Analysis Output

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ShoringSuite Software is developed by CivilTech Software, Bellevue, WA, USA.
The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. AASHTO HB-17, American Association of State and Highway Transportation Officials, 2 September 2002

UNITS: Width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft3, Deflection - in

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Date: 3/20/2018 File: G:\CWP\CHE8356- Hennepin West Ash Pond System\500 - Technical\556 - 90% Design\02_Geotech\Sheetpile\CT_Shoring\20180315\Dike Modeled\20180320\CHE8356_Undrained.sh8

Title:
Subtitle:

**********INPUT DATA**********

Wall Type: 1. Sheet Pile
Wall Height: 14.00
Pile Diameter: 1.00
Pile Spacing: 1.00
Factor of Safety (F.S.): 1.30
Lateral Support Type (Braces): 1. No
Top Brace Increase (Multi-Bracing): Add 15%*
Embedment Option: 1. Yes
Friction at Pile Tip: No
Pile Properties:
Steel Strength, Fy: 50 ksi = 345 MPa
Allowable Fb/Fy: 0.66
Elastic Module, E: 29000.00
Moment of Inertia, I: 419.9

CT Shoring Undrained Analysis Output

User Input Pile: NZ-26

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	3.3	.1	0.030303
2	3.3	0.1	13.9	1	0.084906
3	13.9	.525	25.9	1.13	0.050417
4	25.9	0.57	48.8	1.68	0.048472
5	48.8	1.3	94.3	2	0.015385

* PASSIVE PRESSURE *

The pressures below will be divided by a Factor of Safety =1.3

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	13.90	0.90	25.90	1.50	0.0500
2	25.90	1.95	48.80	3.10	0.0502
3	48.80	11.00	94.30	28.45	0.3835

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	1.00
2	14.00	1.00

* PASSIVE SPACE *

No.	Z depth	Spacing
1	13.90	1.00

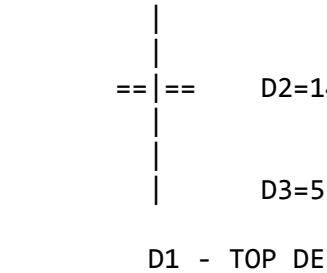
*For Tieback: Input1 = Diameter; Input2 = Bond Stength
*For Plate: Input1 = Diameter; Input2 = Allowable Pressure
*For Deaman: Input1 = Horz. Width; Input2 = Allowable Pressure; Angle = 0

**********CALCULATION**********

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00

| D1=0.00
|



D1 - TOP DEPTH
D2 - EXCAVATION BASE
D3 - PILE TIP (20% increased, see EMBEDMENT Notes below)

MOMENT BALANCE: M=0.00 AT DEPTH=46.88 WITH EMBEDMENT OF 32.88
FORCE BALANCE: F=0.00 AT DEPTH=53.45 WITH EMBEDMENT OF 39.45

The program calculates an embedment for moment equilibrium, then increase the embedment by 20% to reach force equilibrium.
A Balance Force=12.51 is developed from depth=46.88 to depth=53.45
Total Passive Pressure = Total Active Pressure, OK!

**********RESULTS**********

* EMBEDMENT Notes *
Based on USS Design Manual, fist calculate embedment for moment equilibrium, then increased by 20 to 40 % to reach force equilibrium.
The embedment for moment equilibrium is 32.88
* The 20% increased embedment for force equilibrium is 39.45 (Used by Program)
The 30% increased embedment for force equilibrium is 42.74
The 40% increased embedment for force equilibrium is 46.03

Based on AASHTO 2002 Standard Specifications, fist calculate embedment for moment equilibrium, then add safety factor of 30% for temporary shoring; add safety factor of 50% for permanent shoring.
The embedment for moment equilibrium is 32.88
Add 30% embedment for temporary shoring is 42.74
Add 50% embedment for permanent shoring is 49.31

* BASED ON USS DESIGN MANUAL (20% increased), PROGRAM CALCULATED MINIMUM EMBEDMENT = 39.45
TOTAL MINIMUM PILE LENGTH = 53.45

* MOMENT IN PILE (per pile spacing)*
Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 100.62 at 31.30
Maximum Shear = 12.45
Moment and Shear are per pile spacing: 1.0 foot or meter

* VERTICAL LOADING *

```
Vertical Loading from Braces = 0.00
Vertical Loading from External Load = 0.00
Total Vertical Loading = 0.00

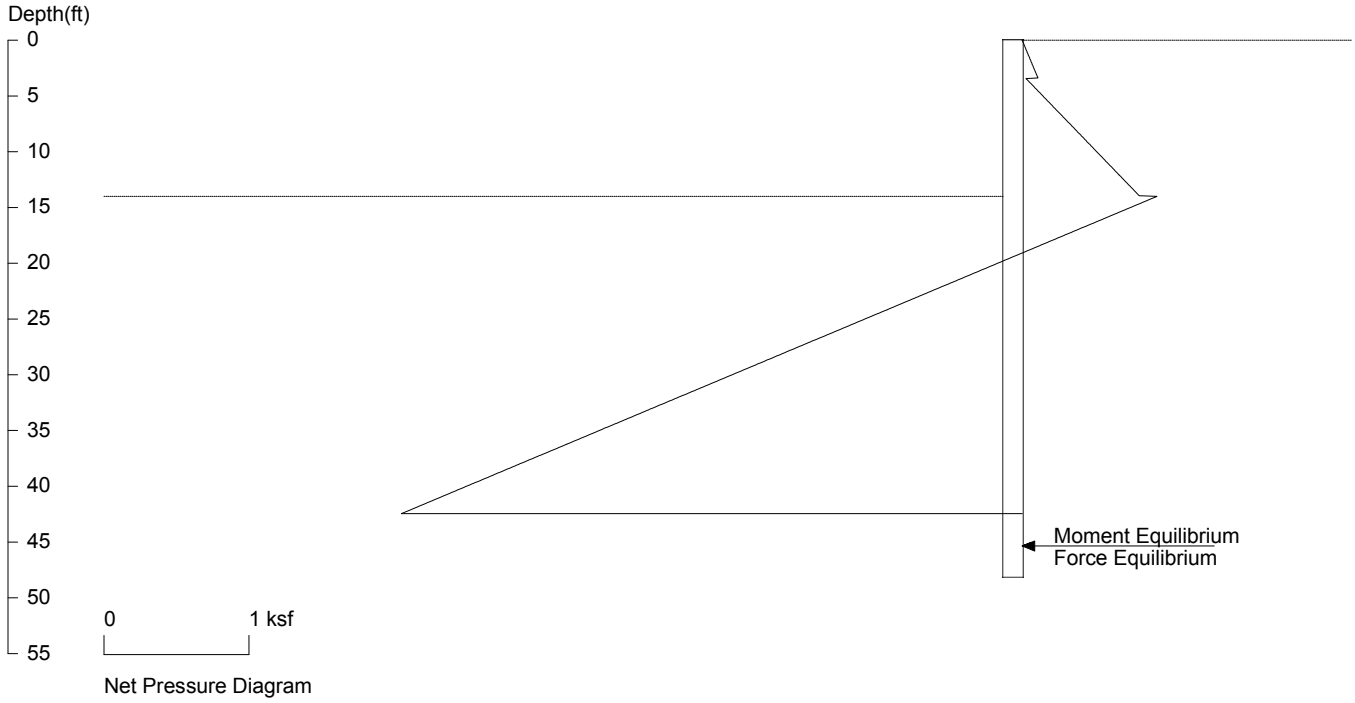


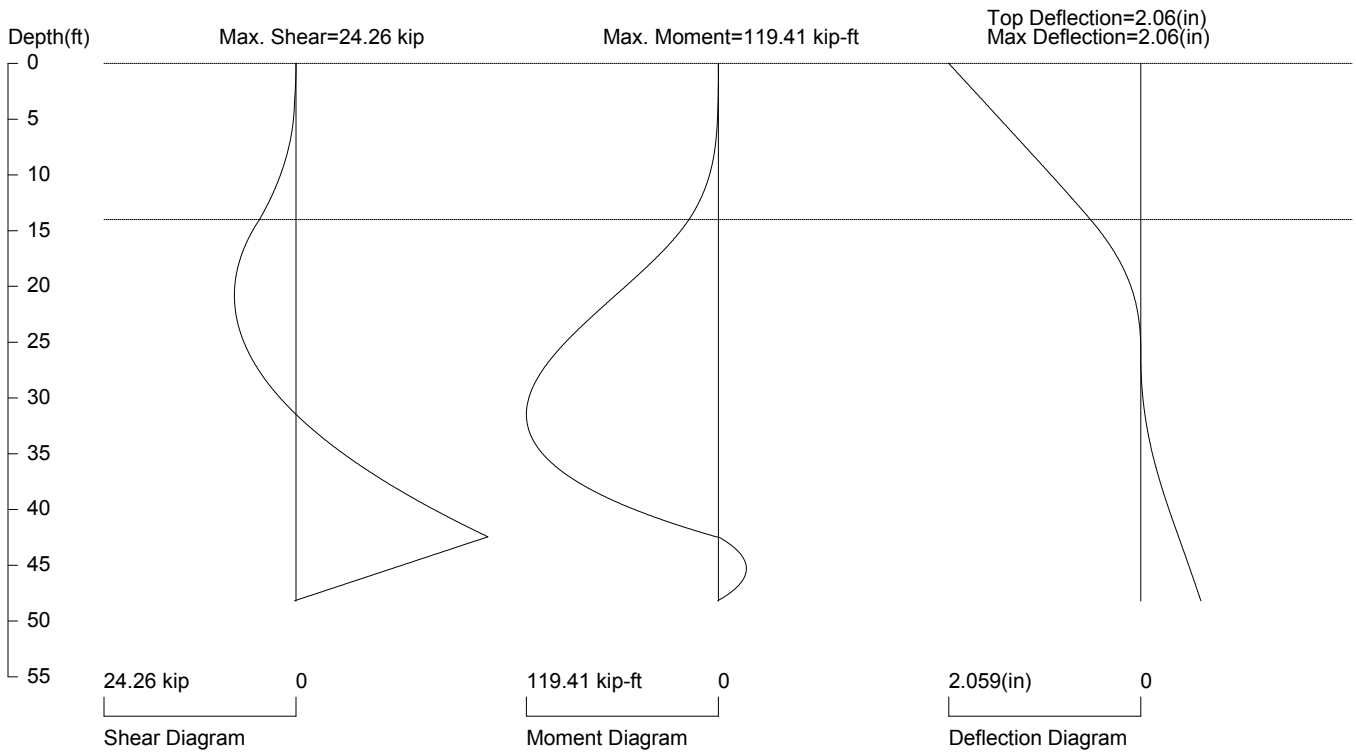
* DEFLECTION *
   I (in4)/foot=419.90
   Top deflection = 2.596(in)
   Max. deflection = 2.596(in)
```

CT Shoring Drained Analysis Output

CHE8356-Hennepin-Sheet Pile

Drained





PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 1.0 foot or meter

User Input I: E (ksi)=29000.0, I (in4)/foot=419.9

P\CHE8356- Hennepin West Ash Pond System\500 - Technical\556 - 90% Design\02_Geotech\Sheetpile\CT_Shoring\20180315\Dike Modeled\20180320\CHE8356_Dra

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************************************************************
                EARTH PRESSURE ANALYSIS SUMMARY
                        <EarthPres>
           Software Copyright by CivilTech Software
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Date: 3/20/2018           File: G:\CWP\CHE8356- Hennepin West Ash Pond System\500 -
Technical\556 - 90% Design\02_Geotech\Sheetpile\CT_Shoring\20180315\Dike
Modeled\20180320\CHE8356_Drained.ep8

Title 1: CHE8356-Hennepin-Sheet Pile
Title 2: Drained

Input data: ***********************************************

Wall Height = 14.00
Depth of Ground at Active Side = 0.00
Depth of Ground at Passive Side = 14.00
Apparent Pressure Envelope: 1.* Actual Pressures   (All walls, All soils)
Pressure Type: 1.* Active, Ka
Earthquake Loading Apply to: 1. No Earthq. Loads
        Earthquake Horizontal Acceleration, Kh = 0
        Earthquake Vertical Acceleration, Kv = 0
Calculation Methods: 3. Formulary Solution (Coulomb Equation)
Wall Friction Options: 3. Both sides (for sheet pile)
        Wall Friction = 10
        Wall Batter Angle = 0
Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*
Water Density = 62.4
Water Pressure: 1.* No seepage at wall tip
User's Settings
        Ignore Passive from Depth = 0
        Multiplier of Active Pressure = 1
        Multiplier of Passive Pressure = 1
        Multiplier of Water Pressure = 1
        Multiplier of Earthq. Pressure = 1
        Estimated Embedment: Deep: 4H
Program's Settings
        Max. Height, Hmax = 70.00
        Analysis Segment, dz = 0.35
        No. of Active Segment at H, nz0 = 2
        No. of Active Segment at Hmax, nz = 5
        No. of Passive Segment, nzp = 2
        Active Depth at H, Zh = 14.00
        Active Depth at Hmax, Z = 70.00
```

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Passive Depth at Hmax, Zp = 70.00
Max. Pressure = 19.43

Total Soil Types= 6

Soil	Weight	W(S)	Phi	Cohesion	Nspt	Type	Description
1	120.0	120.0	38.0	0.0	0	4	SGDF
2	99.0	99.0	33.0	0.1	0	3	CCR-Unsat
3	99.0	99.0	33.0	0.1	0	4	CCR-Sat
4	111.0	111.0	30.0	0.0	0	4	SCA1
5	111.0	111.0	30.0	0.0	0	1	SCA2
6	125.0	125.0	38.0	0.0	0	4	SGA

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.
1	0.0	0.0	-200.0	800.0	2
2	3.4	0.0	3.4	800.0	3
3	14.0	0.0	14.0	800.0	4
4	26.0	0.0	26.0	800.0	5
5	48.9	0.0	48.9	800.0	6

Water Table at Active Side:

Point	Z-water	X-water
1	3.4	0.0
2	3.4	80000.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.
1	14.0	0.0	14.0	800.0	5
2	48.9	0.0	48.9	800.0	6

Water Table at Passive Side:

Point	Z-water	X-water
1	14.0	0.0
2	14.0	80000.0

Output data: **********

Eae (Active/At-Rest Force above Base)= 1.11 per one linear foot (or meter) width along wall height
Ea (Total Static Force above Base)= 1.11

Apparent Pressure above Base - Output to Shoring
Active/At-Rest Force above Base, Ea = 1.11

No	Z1	P1	Z2	P2	Slope	Ka or Ko
0	0.0	0.00	3.4	0.11	0.0322	0.3253
1	3.4	0.02	14.0	0.15	0.0119	0.3253

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Driving Pressure below Base - Output to Shoring

No	Z1	P1	Z2	P2	Slope	Ka or Ko
0	14.0	0.27	26.0	0.49	0.0181	0.3723
1	26.0	0.49	48.9	0.90	0.0181	0.3723
2	48.9	0.63	70.0	0.97	0.0162	0.2584

Passive Pressure below Base - Output to Shoring

No	Z1	P1	Z2	P2	Slope	Kp
0	14.0	0.00	48.9	7.03	0.2014	4.1433
1	48.9	10.55	70.0	18.77	0.3894	6.2198

Water Pressure - Output to Shoring

No	Z1	P1	Z2	P2	Slope
0	3.4	0.00	14.0	0.66	0.06
1	14.0	0.66	70.0	0.66	0.00

****

DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

Z, Xa, Xp - Coordinates of ground lines
Z- Depth measured from wall top
Xa - Distance measure from wall to active side.
Xp - Distance measure from wall to passive side

Z1, P1, Z2, P2 - Four values to define a pressure diagram
Z1- Top depth of the diagram
P1- Top pressure of the diagram
Z2- Bottom depth of the diagram
P2- Bottom pressure of the diagram
Slope - (P2-P1)/(Z2-Z1), Slope of the diagram. It also called
Equivalent fluid density. It equals to Ka*Gamma or Kp*Gamma
Ka - Active Earth Pressure Coefficient
Kp - Passive Earth Pressure Coefficient

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SHORING WALL CALCULATION SUMMARY
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ShoringSuite Software is developed by CivilTech Software, Bellevue, WA, USA.
The calculation method is based on the following references:

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6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. AASHTO HB-17, American Association of State and Highway Transportation Officials, 2 September 2002

UNITS: Width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft3, Deflection - in

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Date: 3/20/2018 File: G:\CWP\CHE8356- Hennepin West Ash Pond System\500 - Technical\556 - 90% Design\02_Geotech\Sheetpile\CT_Shoring\20180315\Dike Modeled\20180320\CHE8356_Drained.sh8

Title: CHE8356-Hennepin-Sheet Pile
Subtitle: Drained

**********INPUT DATA**********

Wall Type: 1. Sheet Pile
Wall Height: 14.00
Pile Diameter: 1.00
Pile Spacing: 1.00
Factor of Safety (F.S.): 1.30
Lateral Support Type (Braces): 1. No
Top Brace Increase (Multi-Bracing): Add 15%*
Embedment Option: 1. Yes
Friction at Pile Tip: No
Pile Properties:
Steel Strength, Fy: 50 ksi = 345 MPa
Allowable Fb/Fy: 0.66
Elastic Module, E: 29000.00
Moment of Inertia, I: 419.9

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User Input Pile: NZ-26

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	*	Above	Base		
2	0.000	0.000	3.400	0.110	0.032209
3	3.400	0.024	14.000	0.150	0.011908
4	*	Below	Base		
5	14.000	0.270	26.000	0.487	0.018096
6	26.000	0.487	48.900	0.901	0.018096
7	48.900	0.626	70.000	0.967	0.016177
8	*	Water	Pres.		
9	3.400	0.000	14.000	0.661	0.062400
10	14.000	0.661	70.000	0.661	0.000000

* PASSIVE PRESSURE *

The pressures below will be divided by a Factor of Safety =1.3

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	14.00	0.00	48.90	7.03	0.2014
2	48.90	10.55	70.00	18.76	0.3894

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	1.00
2	14.00	1.00

* PASSIVE SPACE *

No.	Z depth	Spacing
1	14.00	1.00

*For Tieback: Input1 = Diameter; Input2 = Bond Stength
*For Plate: Input1 = Diameter; Input2 = Allowable Pressure
*For Deaman: Input1 = Horz. Width; Input2 = Allowable Pressure; Angle = 0

**********CALCULATION**********

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00

```
        |      D1=0.00
        |
        |
        |
      ==|==    D2=14.00
        |
        |
        |      D3=48.20

        D1 - TOP DEPTH
        D2 - EXCAVATION BASE
        D3 - PILE TIP (20% increased, see EMBEDMENT Notes below)

   MOMENT BALANCE: M=0.00   AT DEPTH=42.50  WITH EMBEDMENT OF 28.50
   FORCE BALANCE: F=0.00   AT DEPTH=48.20  WITH EMBEDMENT OF 34.20

   The program calculates an embedment for moment equilibrium, then increase the
embedment by 20% to reach force equilibrium.
   A Balance Force=24.45 is developed from depth=42.50 to depth=48.20
   Total Passive Pressure = Total Active Pressure,    OK!


**********RESULTS**********

* EMBEDMENT Notes *
Based on USS Design Manual, fist calculate embedment for moment equilibrium, then
increased by 20 to 40 % to reach force equilibrium.
The embedment for moment equilibrium is 28.50
* The 20% increased embedment for force equilibrium is 34.20 (Used by Program)
The 30% increased embedment for force equilibrium is 37.06
The 40% increased embedment for force equilibrium is 39.91

Based on AASHTO 2002 Standard Specifications, fist calculate embedment for moment
equilibrium, then add safety factor of 30% for temporary shoring; add safety factor
of 50% for permanent shoring.
The embedment for moment equilibrium is 28.50
Add 30% embedment for temporary shoring is 37.06
Add 50% embedment for permanent shoring is 42.76

* BASED ON USS DESIGN MANUAL (20% increased), PROGRAM CALCULATED MINIMUM EMBEDMENT
= 34.20
TOTAL MINIMUM PILE LENGTH = 48.20

* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 119.41 at 31.46
```

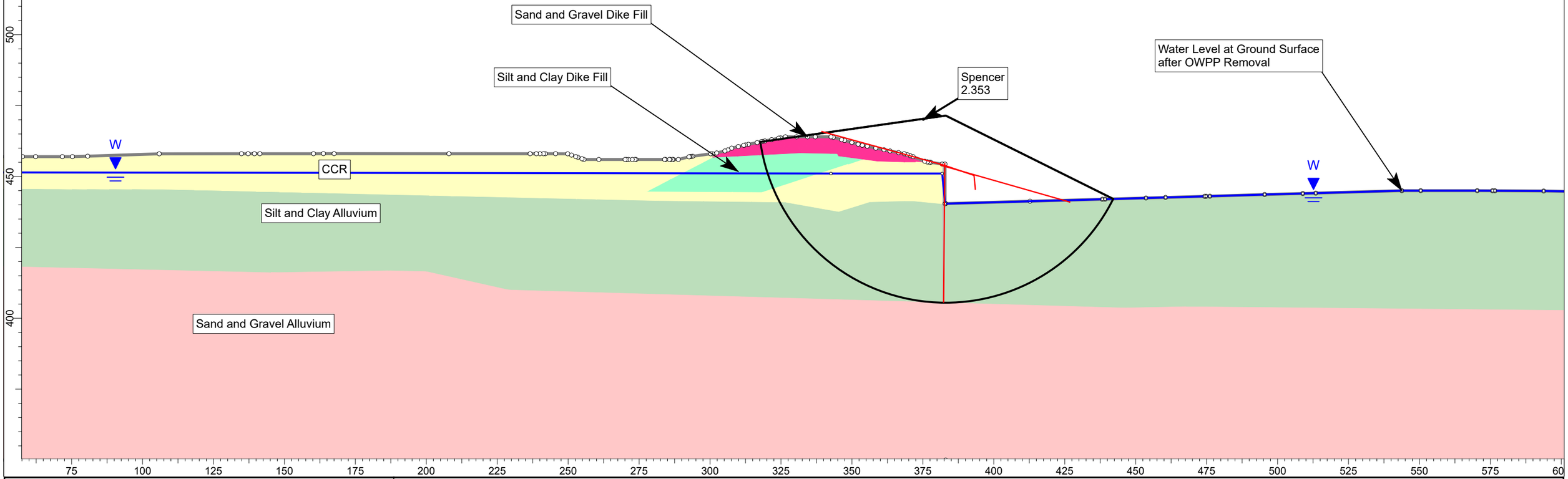
report.out

Maximum Shear = 24.26
Moment and Shear are per pile spacing: 1.0 foot or meter

* VERTICAL LOADING *
Vertical Loading from Braces = 0.00
Vertical Loading from External Load = 0.00
Total Vertical Loading = 0.00

* DEFLECTION *
I (in4)/foot=419.90
Top deflection = 2.059(in)
Max. deflection = 2.059(in)

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	1	33		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			User Defined 1	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			User Defined 1	Water Surface	Custom	1
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1
Buttress		110	110	Mohr-Coulomb	0	38		Water Surface	Custom	1



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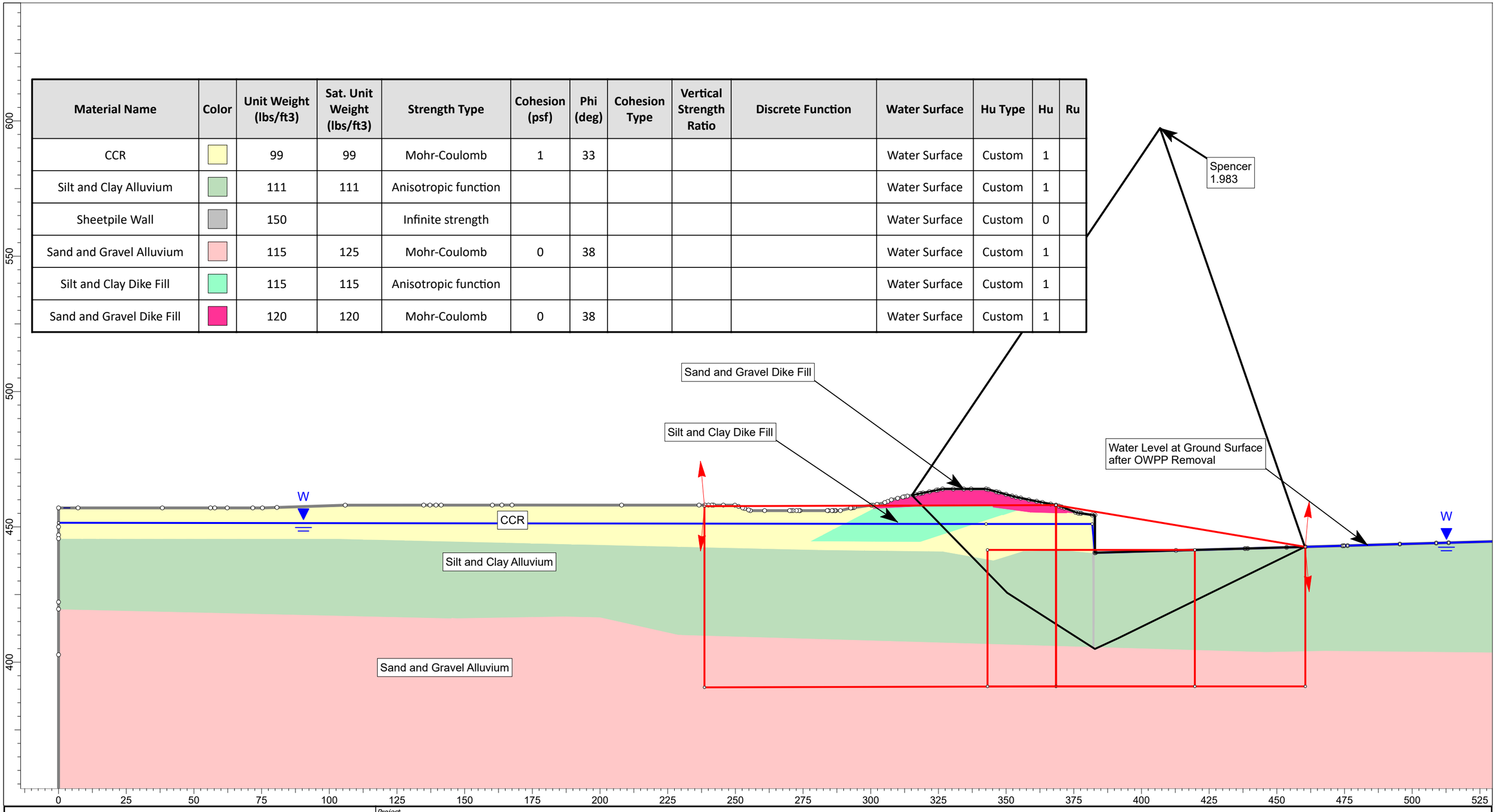
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Sheetpile Analysis - Section A-A' Drained - Circular Mechanism		
Analysis By	DJR	*Client*	Dynegy
Date	03/16/2018	*Scale* 1:400	*File Name* 20180316_A-A'_Revised_Sheetpile_D-R.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Discrete Function	Water Surface	Hu Type	Hu	Ru
CCR		99	99	Mohr-Coulomb	1	33				Water Surface	Custom	1	
Silt and Clay Alluvium		111	111	Anisotropic function						Water Surface	Custom	1	
Sheetpile Wall		150		Infinite strength						Water Surface	Custom	0	
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38				Water Surface	Custom	1	
Silt and Clay Dike Fill		115	115	Anisotropic function						Water Surface	Custom	1	
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38				Water Surface	Custom	1	



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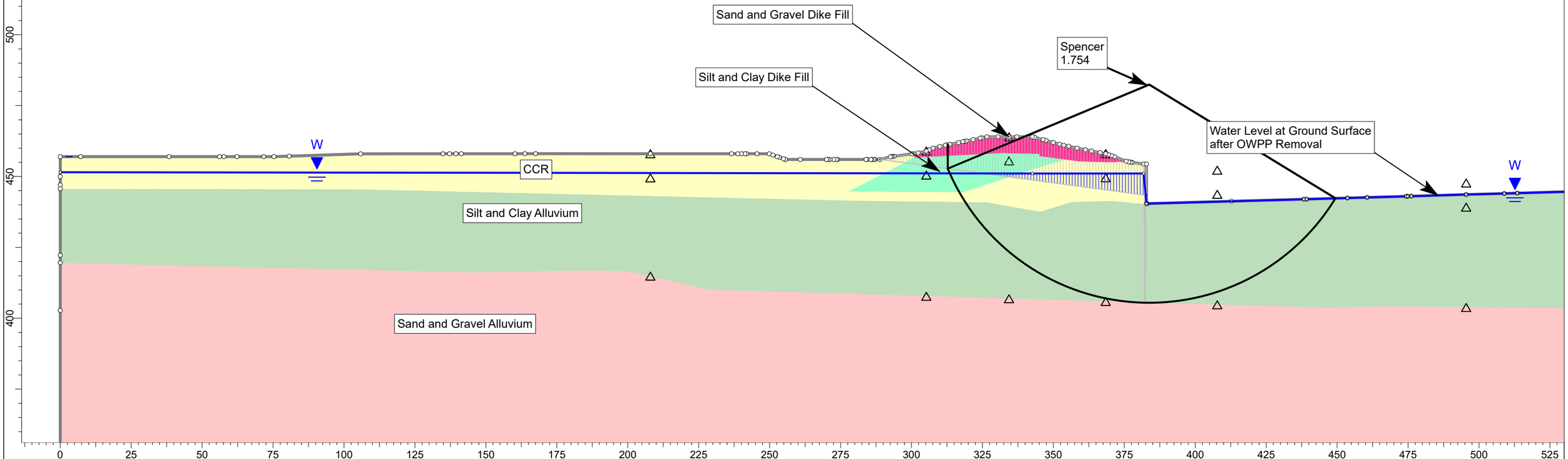
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Sheetpile Analysis - Section A-A' Drained - Wedge Mechanism		
Analysis By	DJR		*Client* Dynegy
Date 03/16/2018	*Scale* 1:400		*File Name* 20180316_A-A'_Revised_Sheetpile_D-T.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Discrete Function	Water Surface	Hu Type	Hu	Ru
CCR		99	99	Vertical Stress Ratio				0.42		Water Surface	Custom	1	
Silt and Clay Alluvium		111	111	Discrete function					Silt and Clay Alluvium	Water Surface	Custom	1	
Sheet Pile Wall		150		Infinite strength						Water Surface	Custom	0	
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38				Water Surface	Custom	1	
Silt and Clay Dike Fill		115	115	Undrained	1000		Constant			Water Surface	Custom	0	
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38				Water Surface	Custom	1	



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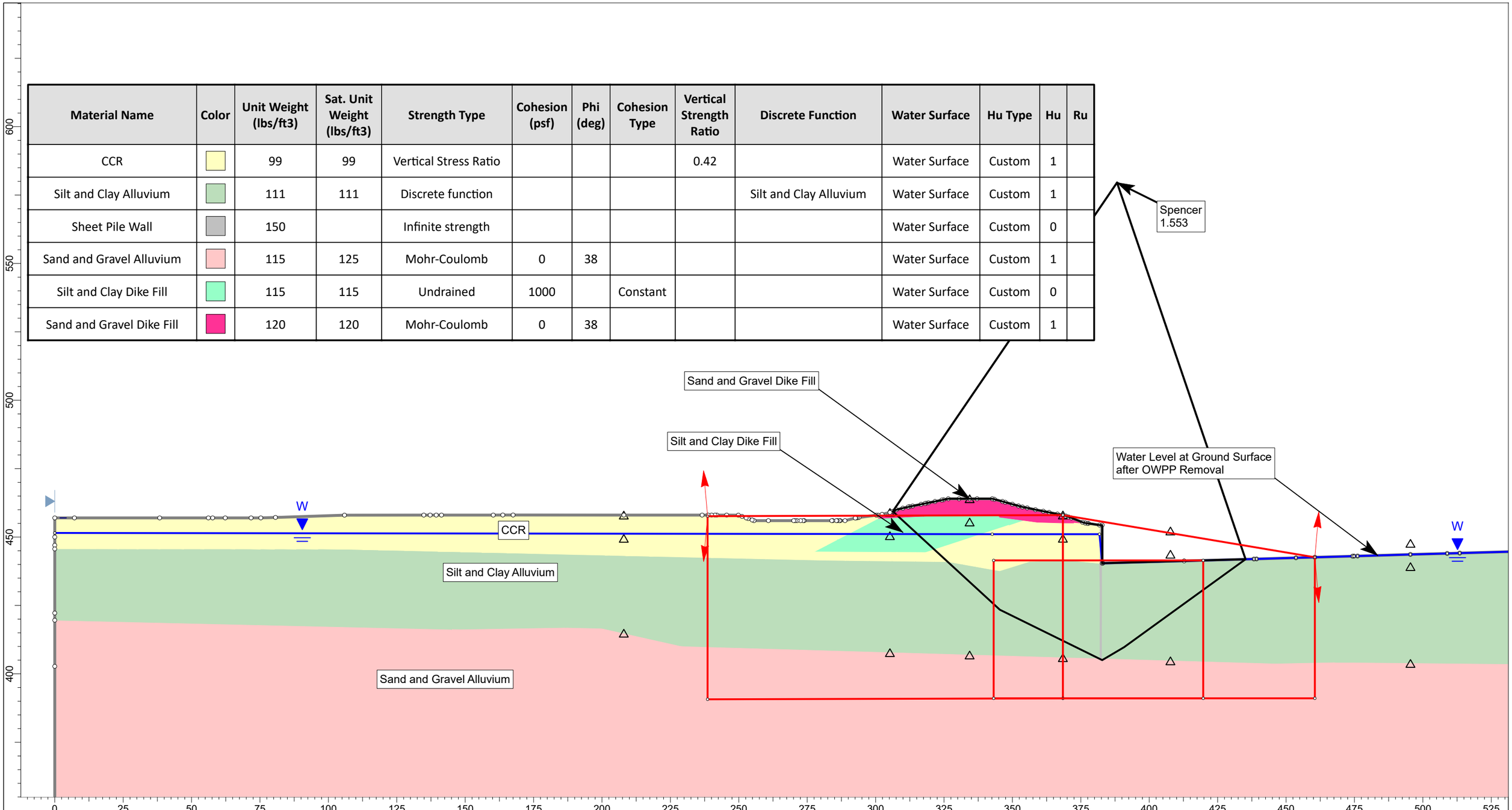
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Sheetpile Analysis - Section A-A' - Circular Mechanism		
Analysis By	DJR	*Client*	Dynegy
Date	03/16/2018	*Scale* 1:400	*File Name* 20180316_A-A'_Revised_Sheetpile_UD-R.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Discrete Function	Water Surface	Hu Type	Hu	Ru
CCR		99	99	Vertical Stress Ratio				0.42		Water Surface	Custom	1	
Silt and Clay Alluvium		111	111	Discrete function					Silt and Clay Alluvium	Water Surface	Custom	1	
Sheet Pile Wall		150		Infinite strength						Water Surface	Custom	0	
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38				Water Surface	Custom	1	
Silt and Clay Dike Fill		115	115	Undrained	1000		Constant			Water Surface	Custom	0	
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38				Water Surface	Custom	1	



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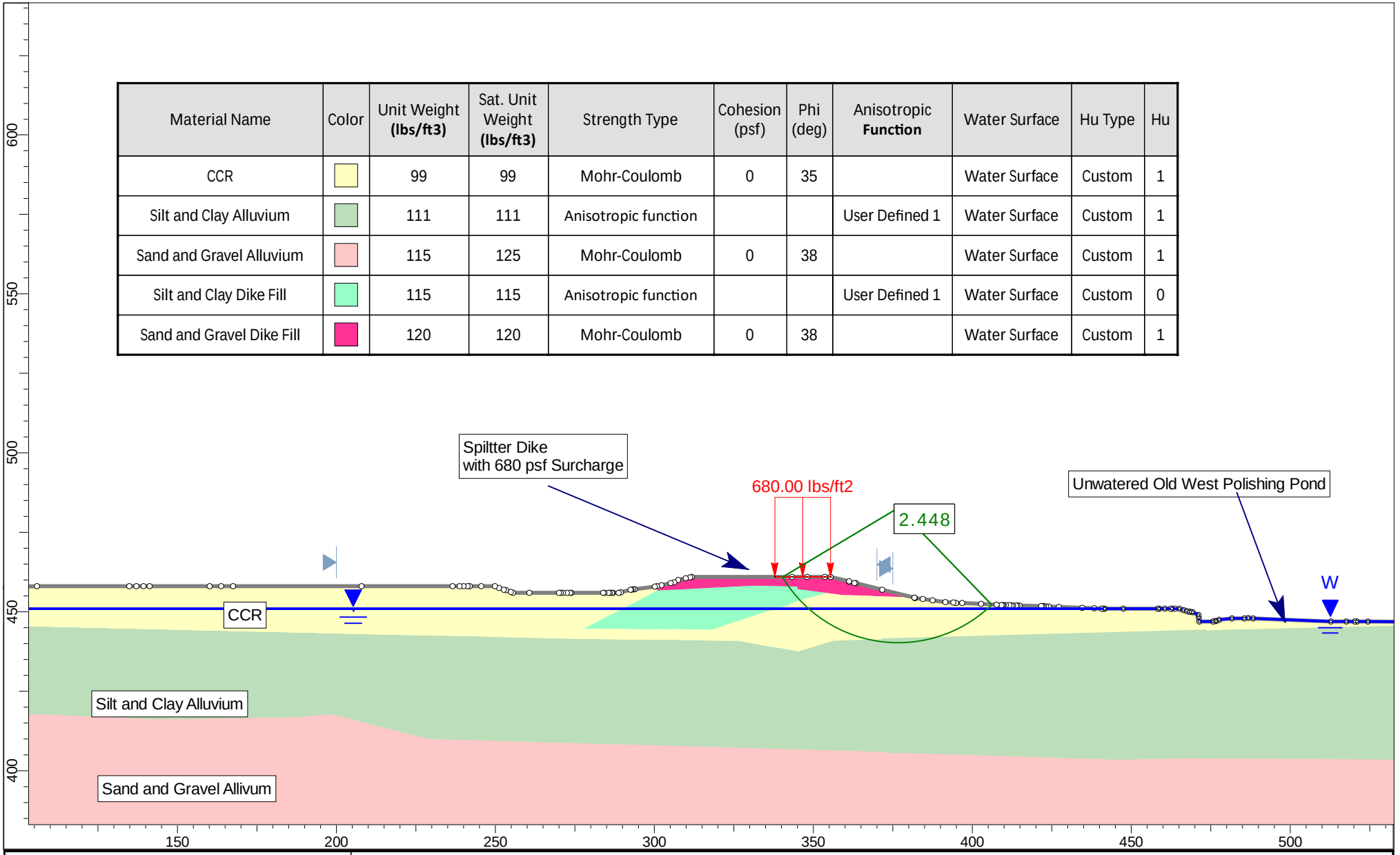
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Sheetpile Analysis - Section A-A' - Wedge Mechanism		
Analysis By	DJR	Client	Dynegy
Date	03/16/2018	Scale	1:400
File Name	20180316_A-A'_Revised_Sheetpile_UD-T.slim		

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	35		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			User Defined 1	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			User Defined 1	Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1



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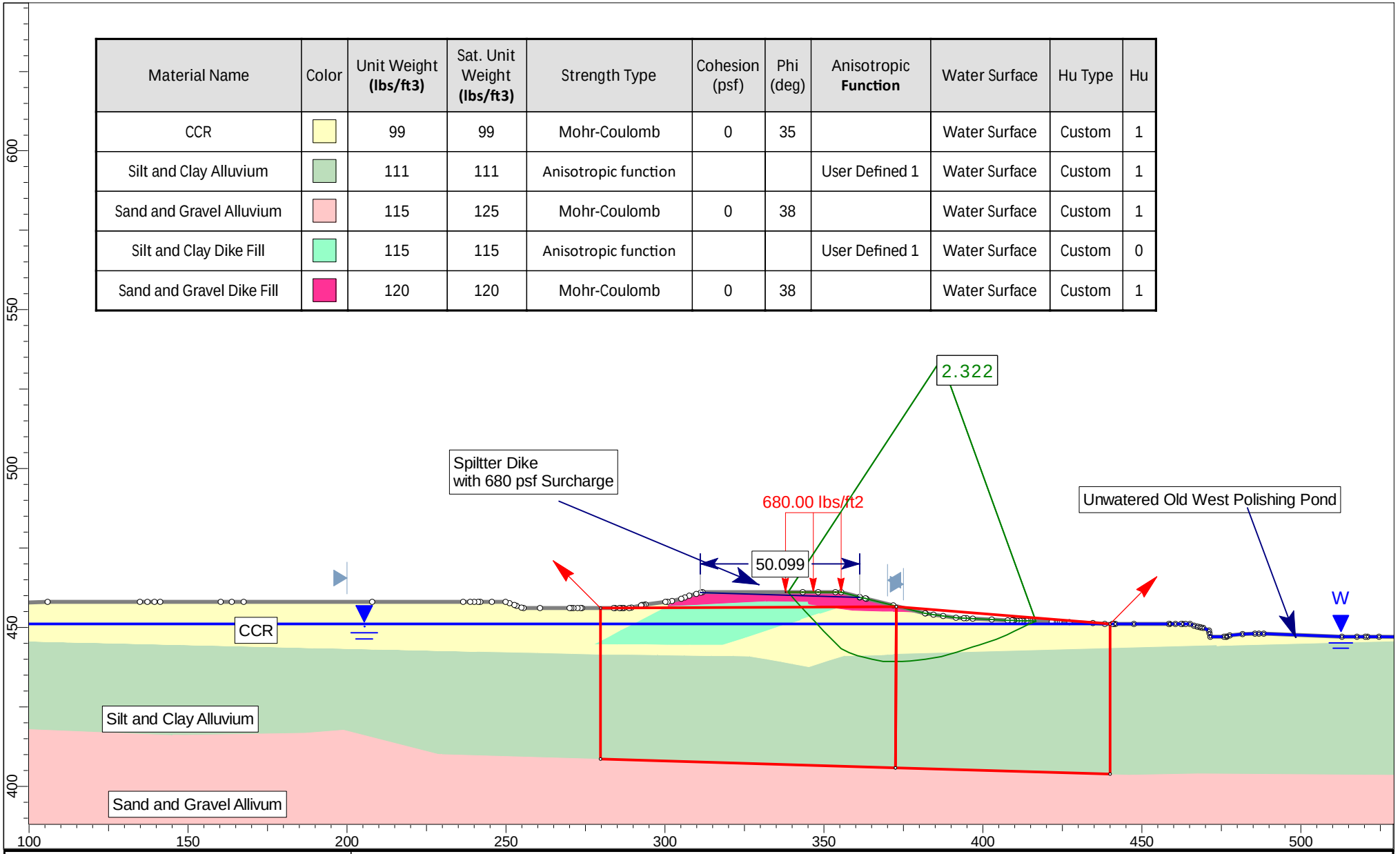
SLIDEINTERPRET 8.028

Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Construction Surcharge - Undrained Conditions - Circular Mechanism		
Drawn By	LPC	Scale 1:500	Company Dynegy
Date	6/12/2018		File Name _Const_Surcharge_Extended_Drained_Circle_Mats_LPC_20190905.sli

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	35		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			User Defined 1	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			User Defined 1	Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1



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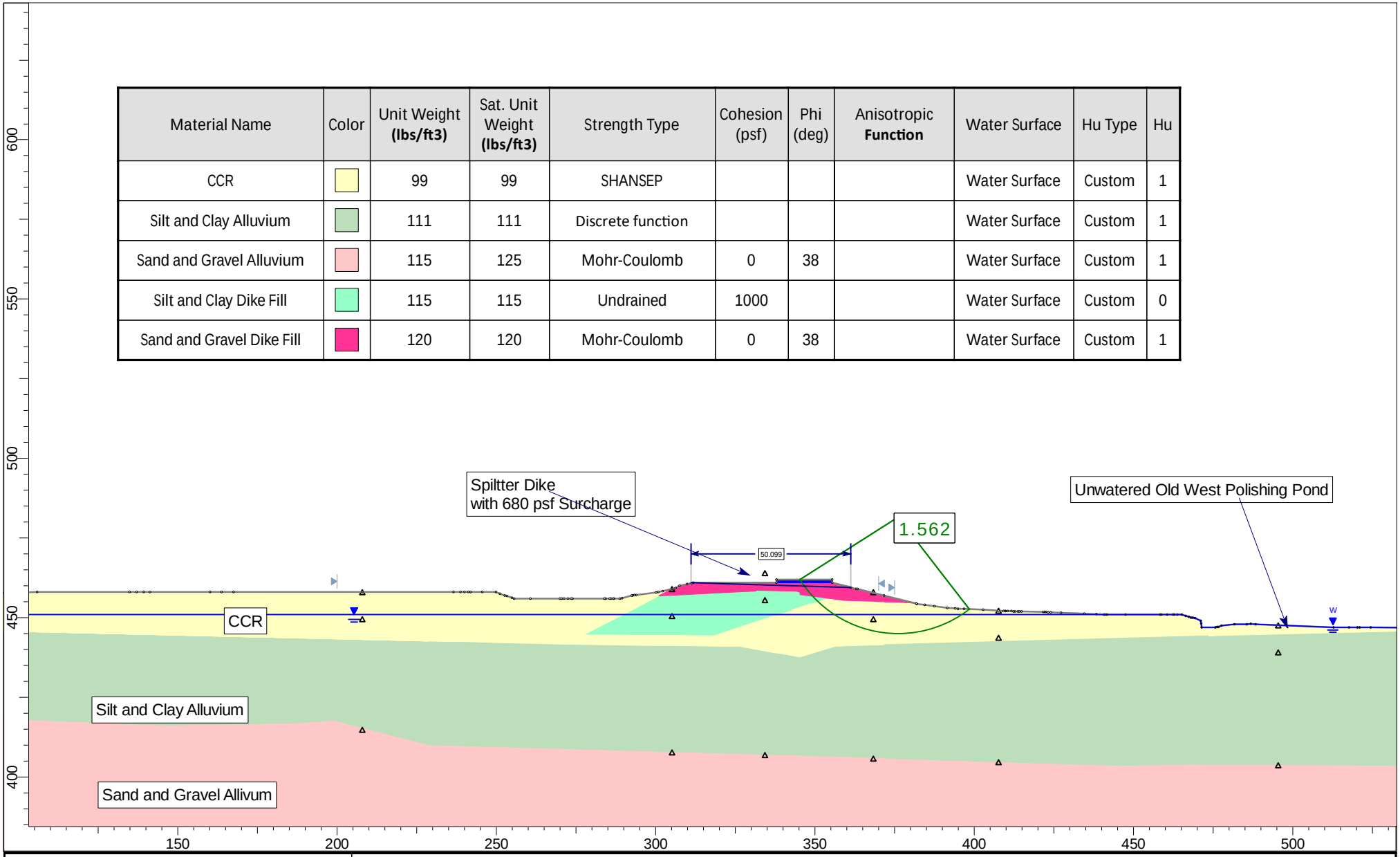
SLIDEINTERPRET 8.028

Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Construction Surcharge - Undrained Conditions - Circular Mechanism		
Drawn By	LPC	Scale 1:500	Company Dynegy
Date	6/12/2018	File Name	Const_Surcharge_Extended_Drained_Wedge_Mats_LPC_20190905.sli

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	SHANSEP				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1



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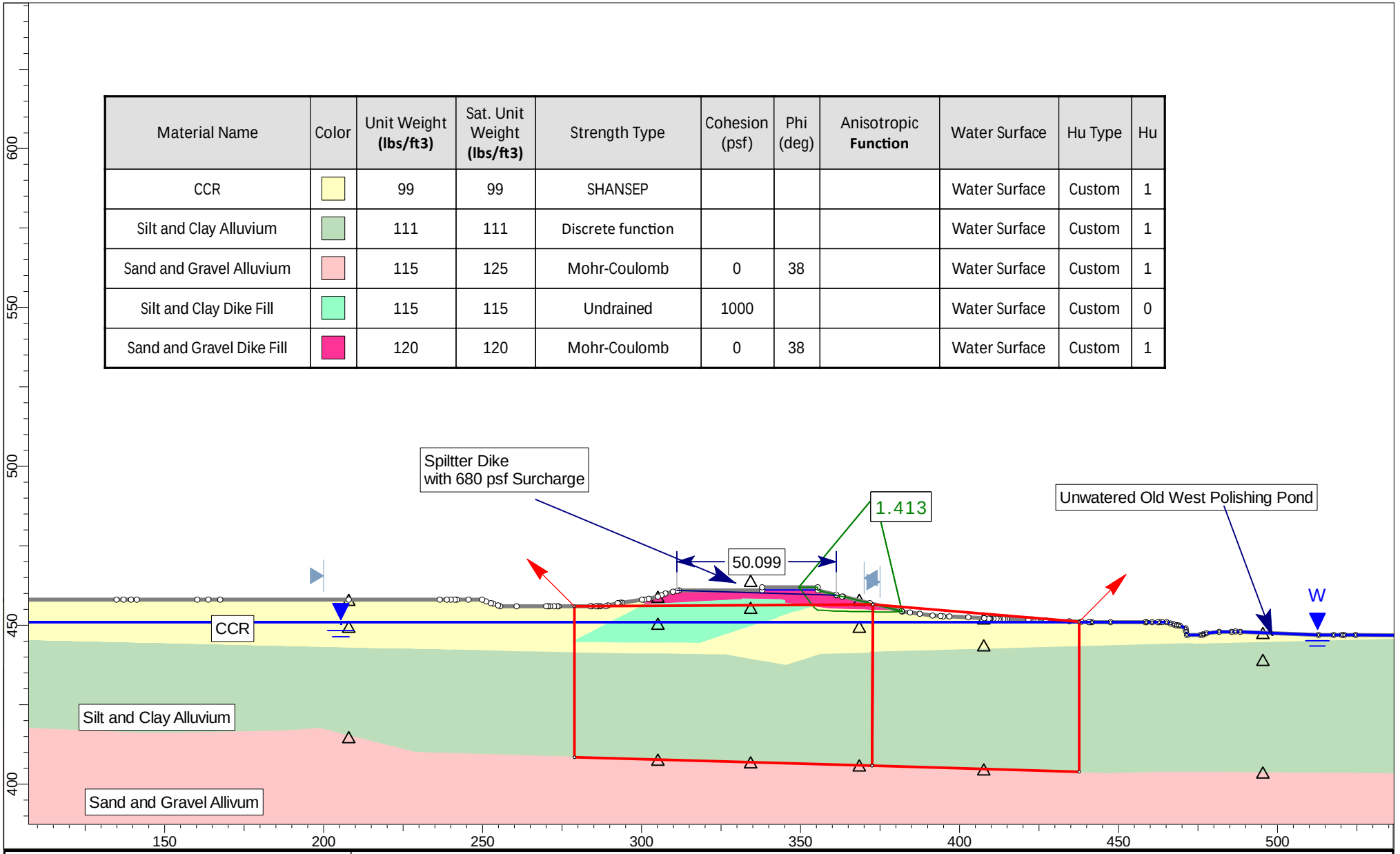
SLIDEINTERPRET 8.028

Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Construction Surcharge - Undrained Conditions - Circular Mechanism		
Drawn By	LPC	Scale 1:500	Company Dynegy
Date	6/12/2018		File Name Const_Surcharge_Extended_Undrained_Circle_Mats_LPC_20190905.sl

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	SHANSEP				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1



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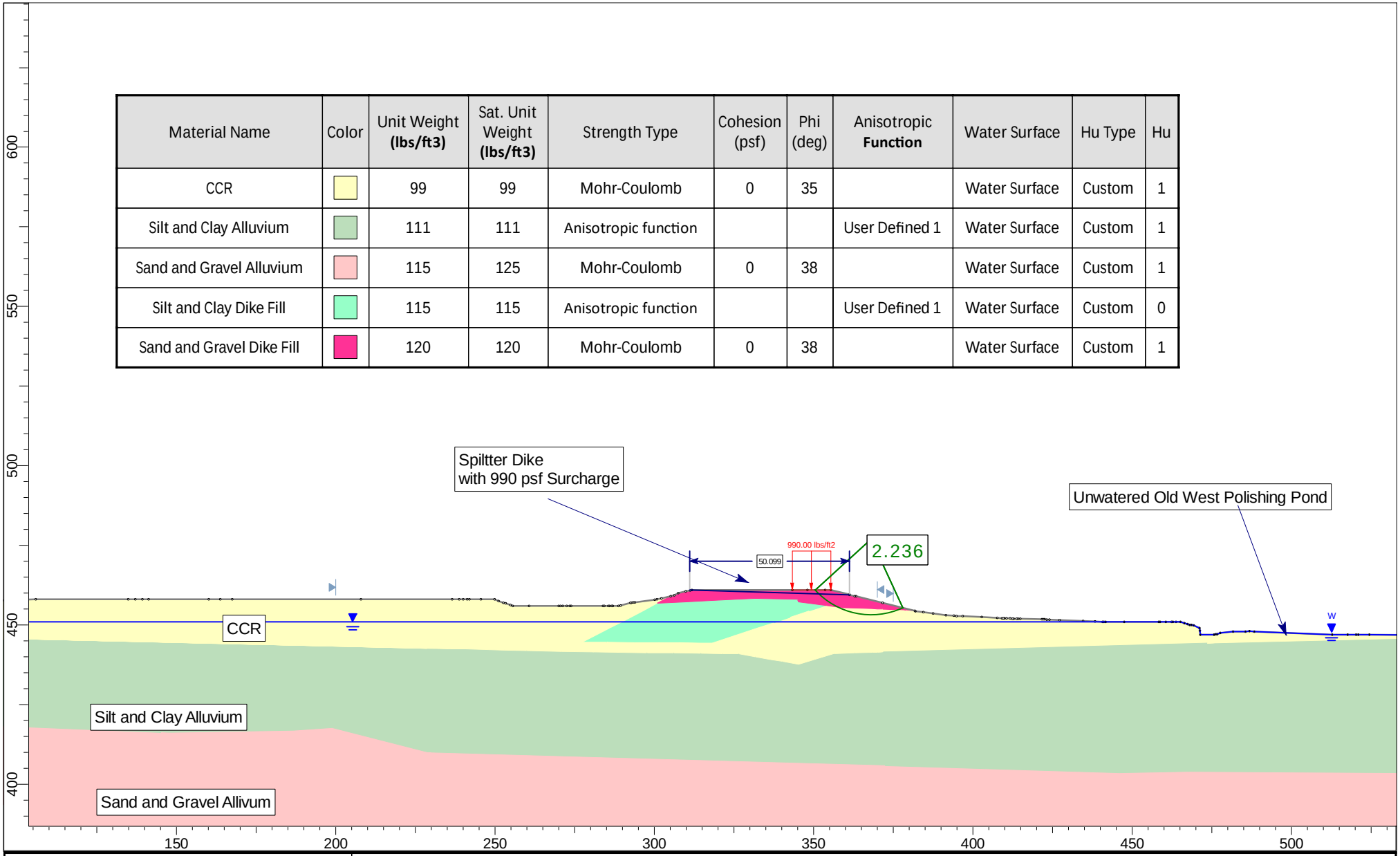
Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Construction Surcharge - Undrained Conditions - Circular Mechanism		
Drawn By	LPC	Scale 1:500	Company Dynegy
Date	6/12/2018	File Name	Const_Surcharge_Extended_Undrained_Wedge_Mats_LPC_20190905.s

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	35		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			User Defined 1	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			User Defined 1	Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1



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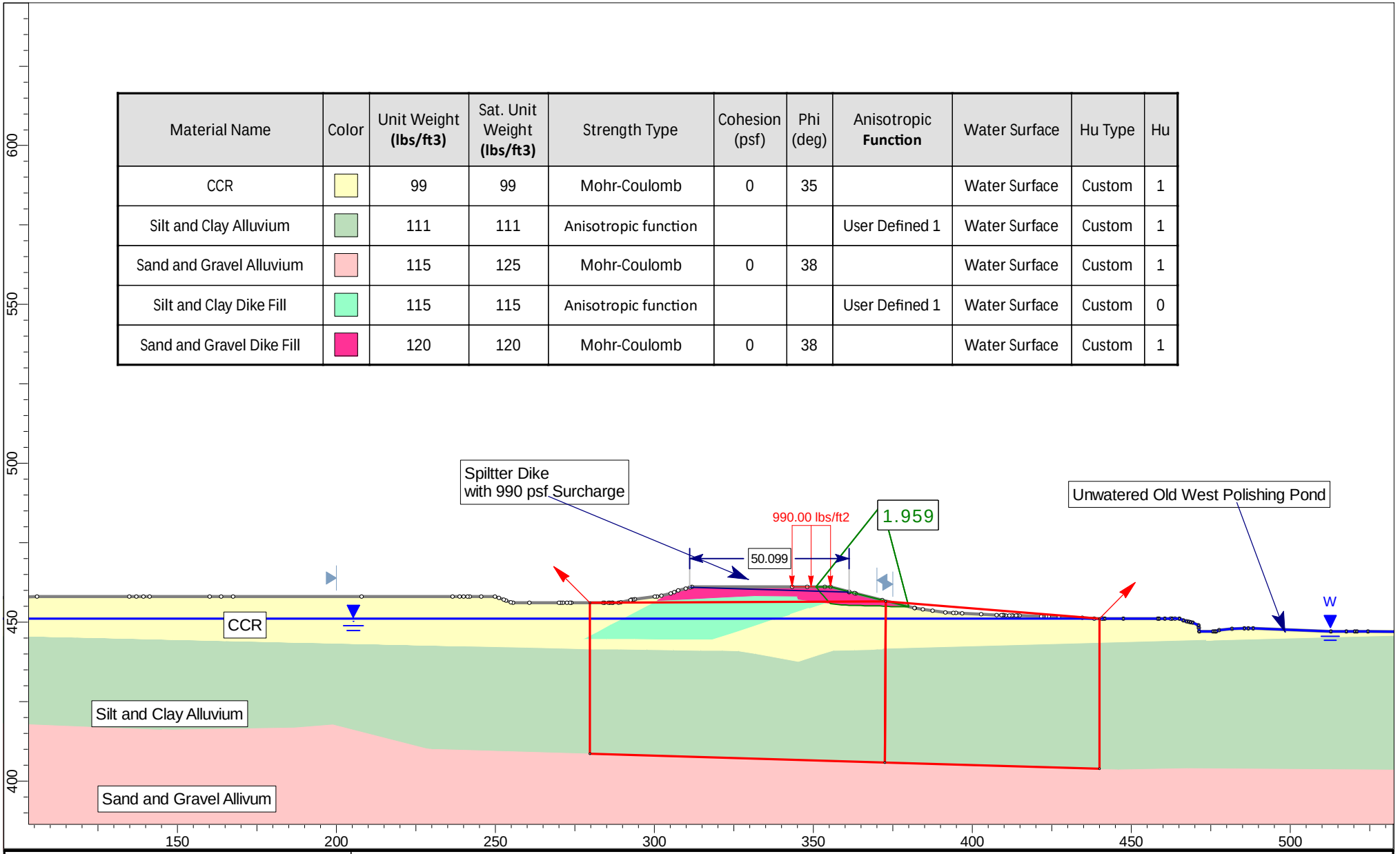
Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Construction Surcharge - Undrained Conditions - Circular Mechanism		
Drawn By	LPC	Scale 1:500	Company Dynegy
Date	6/12/2018	File Name	_Const_Surcharge_Retracted_Drained_Circle_Mats_LPC_20190904.sli

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	Mohr-Coulomb	0	35		Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Anisotropic function			User Defined 1	Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Anisotropic function			User Defined 1	Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1



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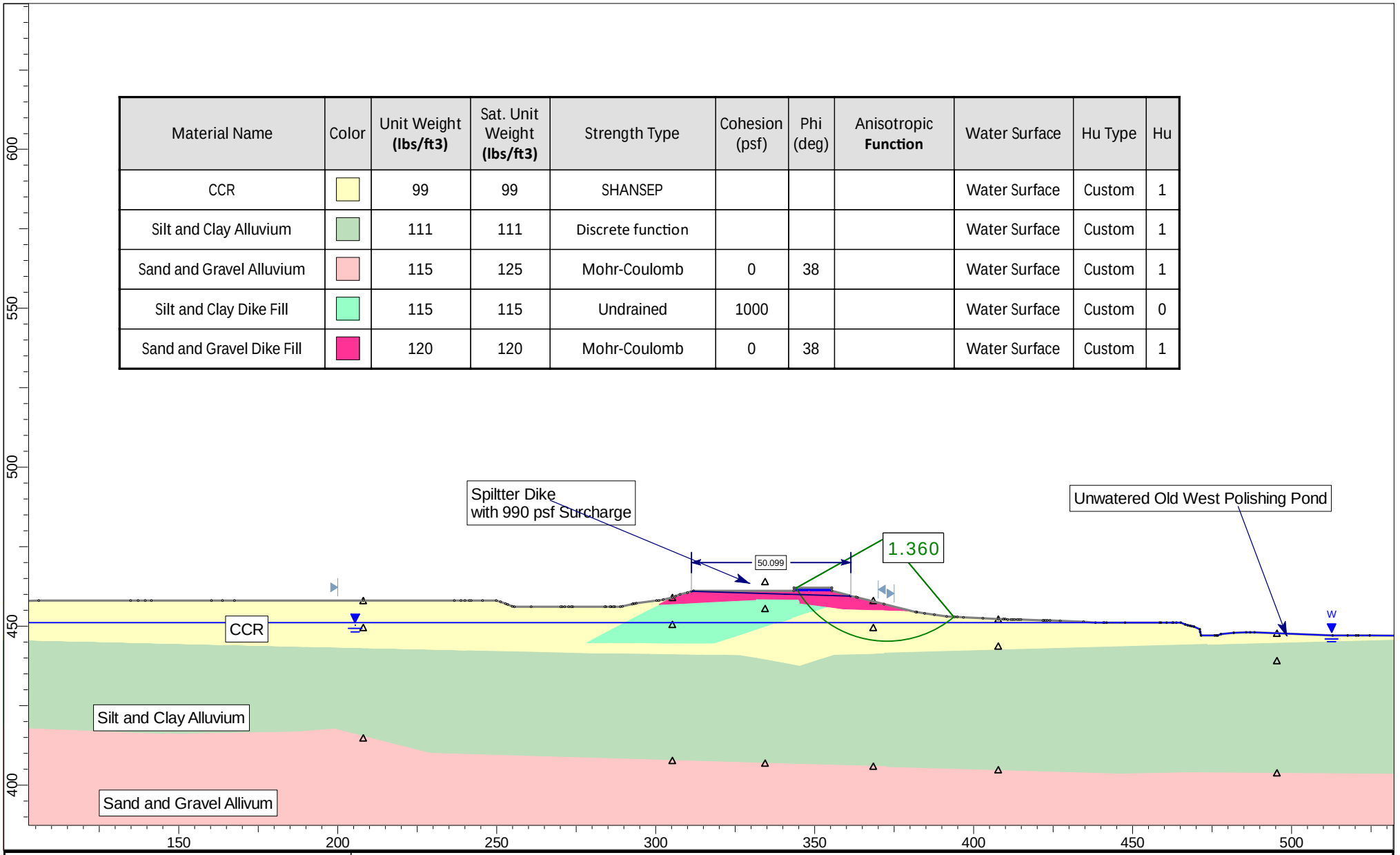
Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Construction Surcharge - Undrained Conditions - Circular Mechanism		
Drawn By	LPC	Scale 1:500	Company Dynegy
Date	6/12/2018		File Name Const_Surcharge_Retracted_Drained_Wedge_Mats_LPC_20190904.sl

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	SHANSEP				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1



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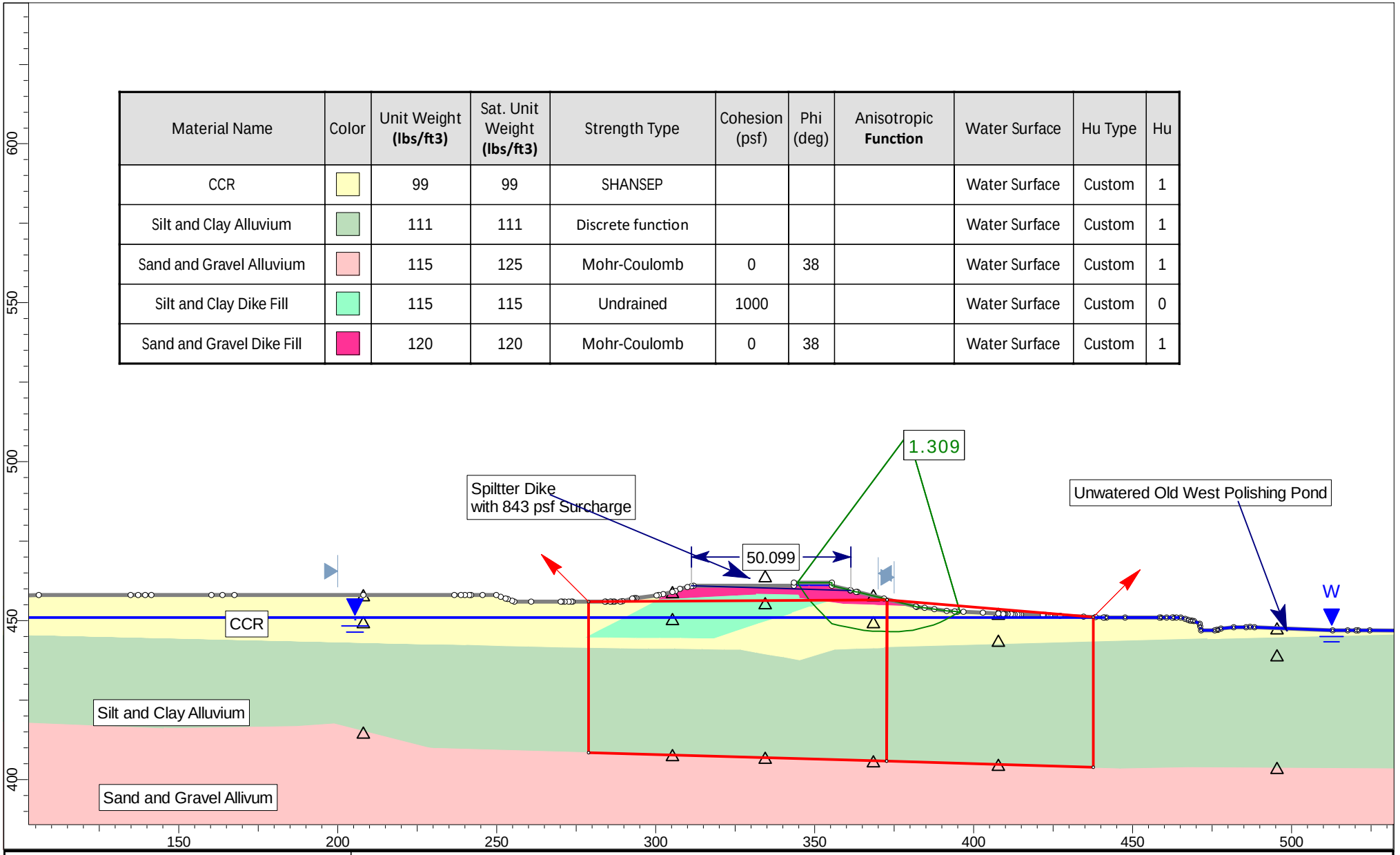
Project	Hennepin West Ash Pond System		
Analysis Description	Section A-A' - Construction Surcharge - Undrained Conditions - Circular Mechanism		
Drawn By	LPC	Scale 1:500	Company Dynegy
Date	6/12/2018	File Name	Const_Surcharge_Retracted_Undrained_Circle_Mats_LPC_20190904.s

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface	Hu Type	Hu
CCR		99	99	SHANSEP				Water Surface	Custom	1
Silt and Clay Alluvium		111	111	Discrete function				Water Surface	Custom	1
Sand and Gravel Alluvium		115	125	Mohr-Coulomb	0	38		Water Surface	Custom	1
Silt and Clay Dike Fill		115	115	Undrained	1000			Water Surface	Custom	0
Sand and Gravel Dike Fill		120	120	Mohr-Coulomb	0	38		Water Surface	Custom	1



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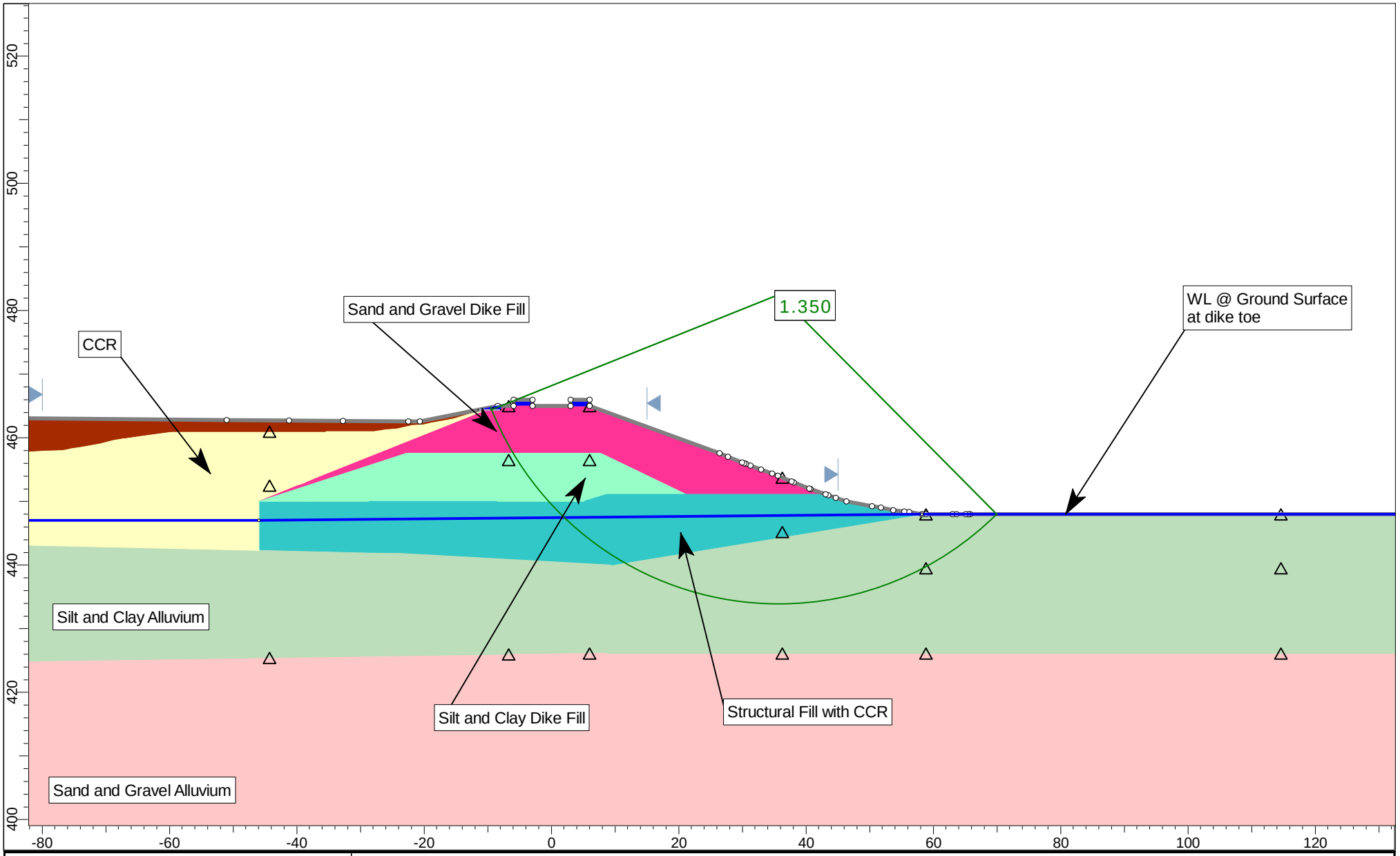
Project	Hennepin West Ash Pond System
Analysis Description	Section A-A' - Construction Surcharge - Undrained Conditions - Circular Mechanism
Drawn By	LPC
Scale	1:500
Company	Dynegy
Date	6/12/2018
File Name	Const_Surcharge_Retracted_Undrained_Wedge_Mats_LPC_20190904.s



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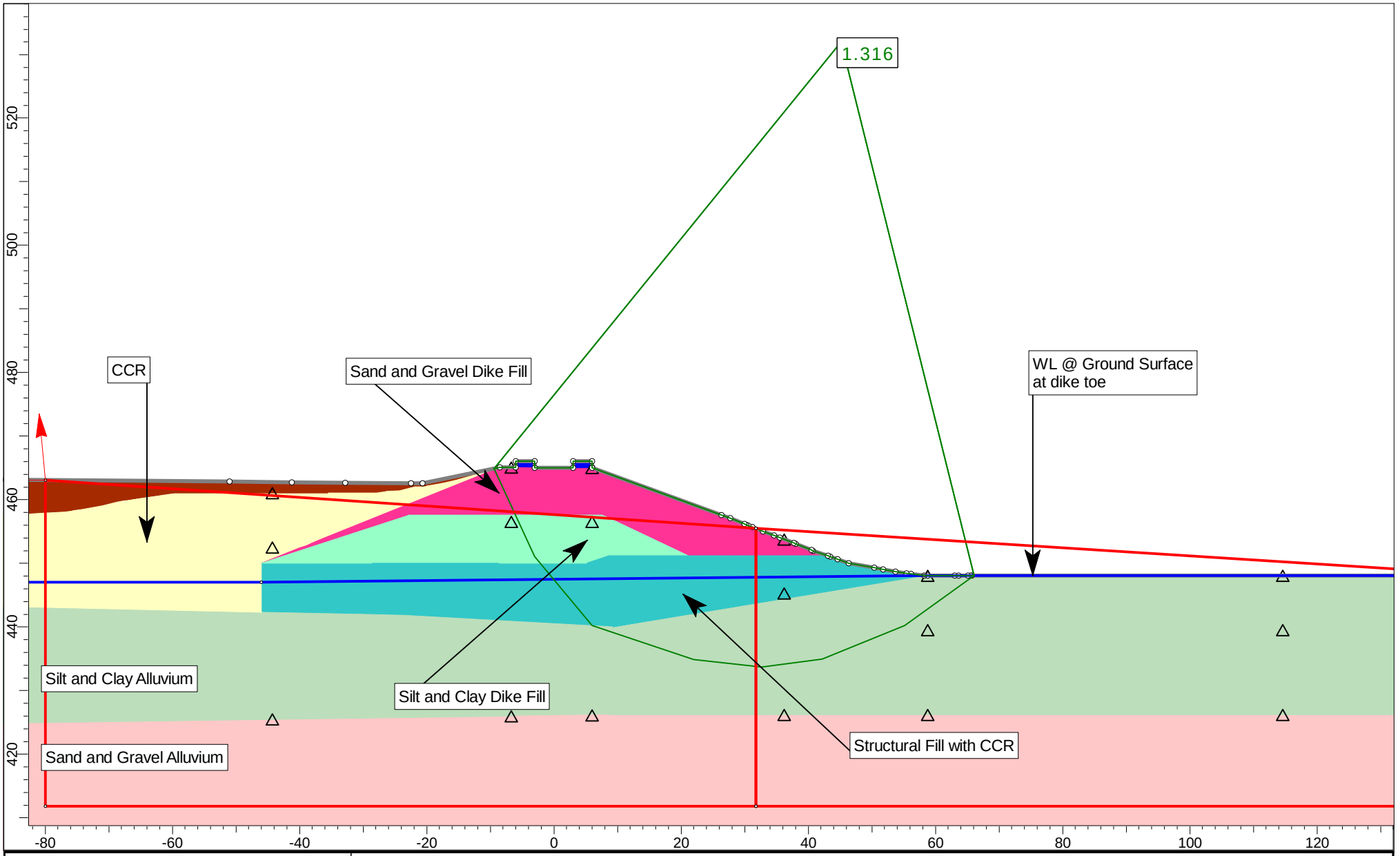
SLIDEINTERPRET 8.028

Project	Hennepin West Ash Pond System		
Analysis Description	Section F-F' - Construction Surcharge - Undrained Condition - Circular Mechanism		
Drawn By	ZJF	*Scale* 1:250	*Company* Dynegy
Date		*File Name*	F-F'_Crane Loading_ZJF_20190916_rev0.slmd



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SLIDEINTERPRET 8.028

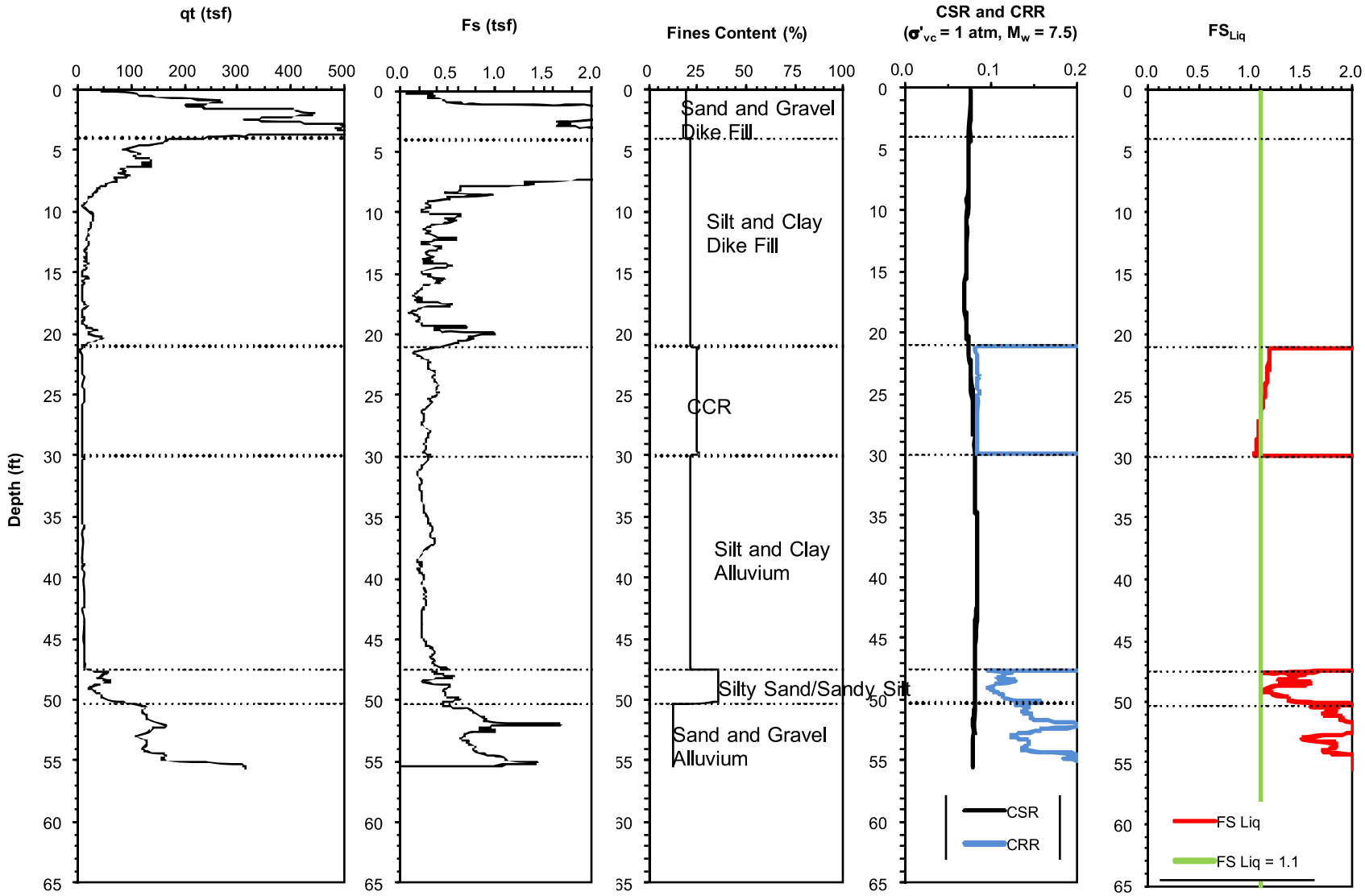
Project	Hennepin West Ash Pond System		
Analysis Description	Section F-F' - Construction Surcharge - Undrained Condition - Non-circular Wedge Mechanism		
Drawn By	ZJF	Scale 1:250	Company Dynegy
Date			File Name F-F'_Crane Loading_ZJF_20190916_rev0.slmd

APPENDIX C

Liquefaction Analyses

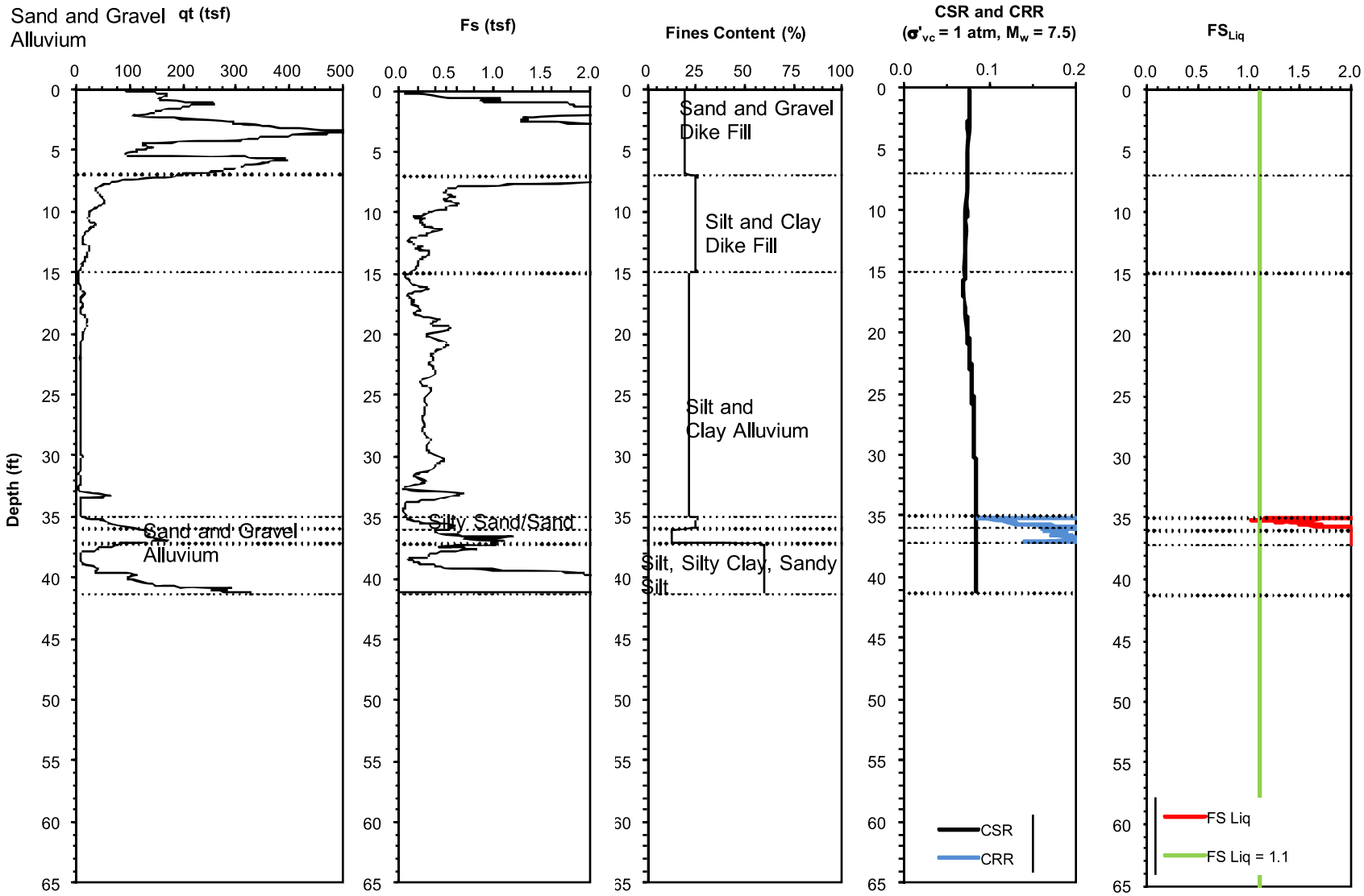
3/19/2018 5:37 PM

Project Name: Dynegy - Hennepin West Ash Pond Complex Closure Design
Location: Hennepin, IL
Test Number: HEN-C002
Type of Sounding: CPTu
CPT Operator: ConeTec Inc.



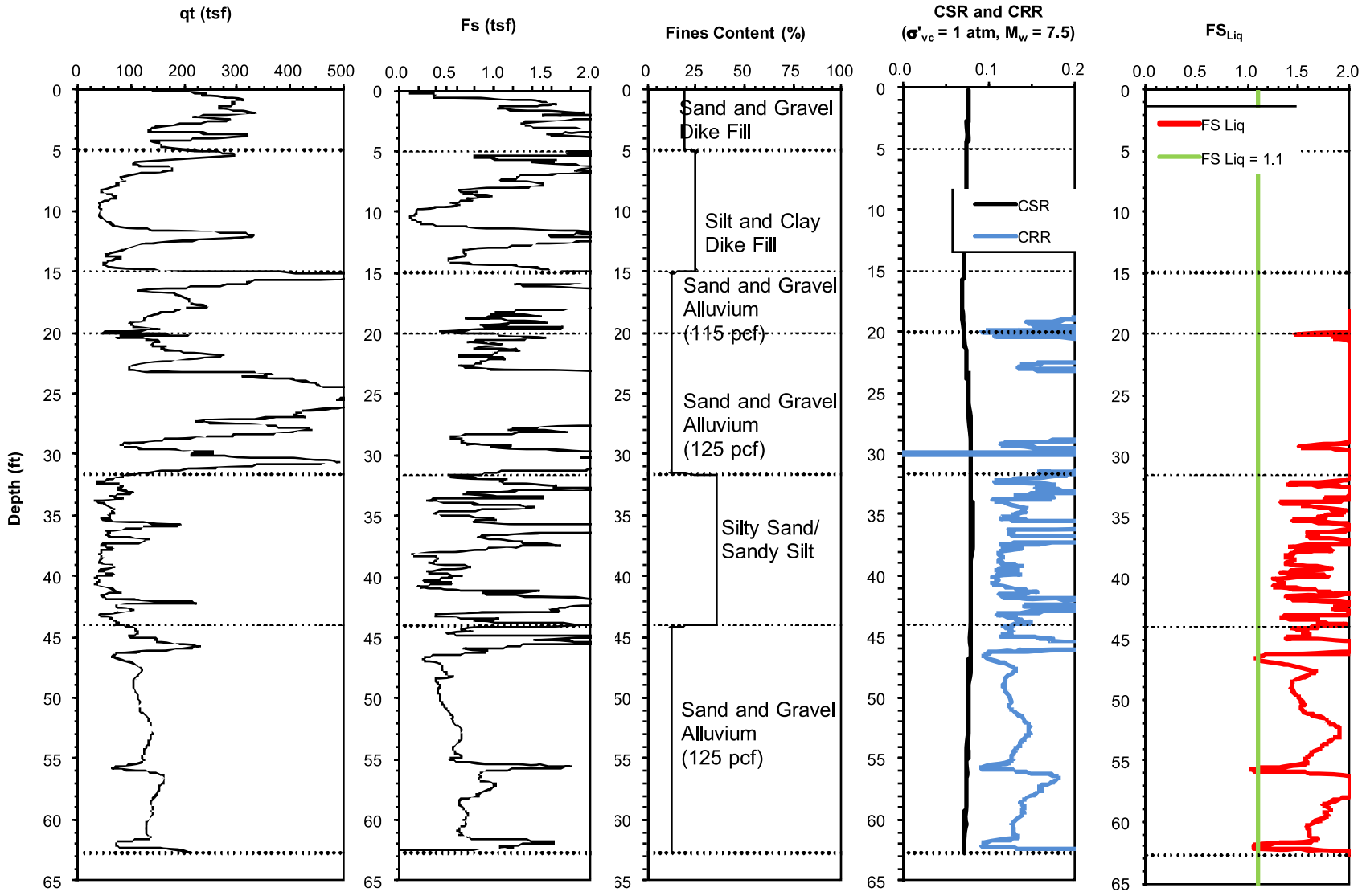
3/19/2018 5:54 PM

Project Name: Dynegy - Hennepin West Ash Pond Complex Closure Design
Location: Hennepin, IL
Test Number: HEN-C004
Type of Sounding: CPTu
CPT Operator: ConeTec Inc.



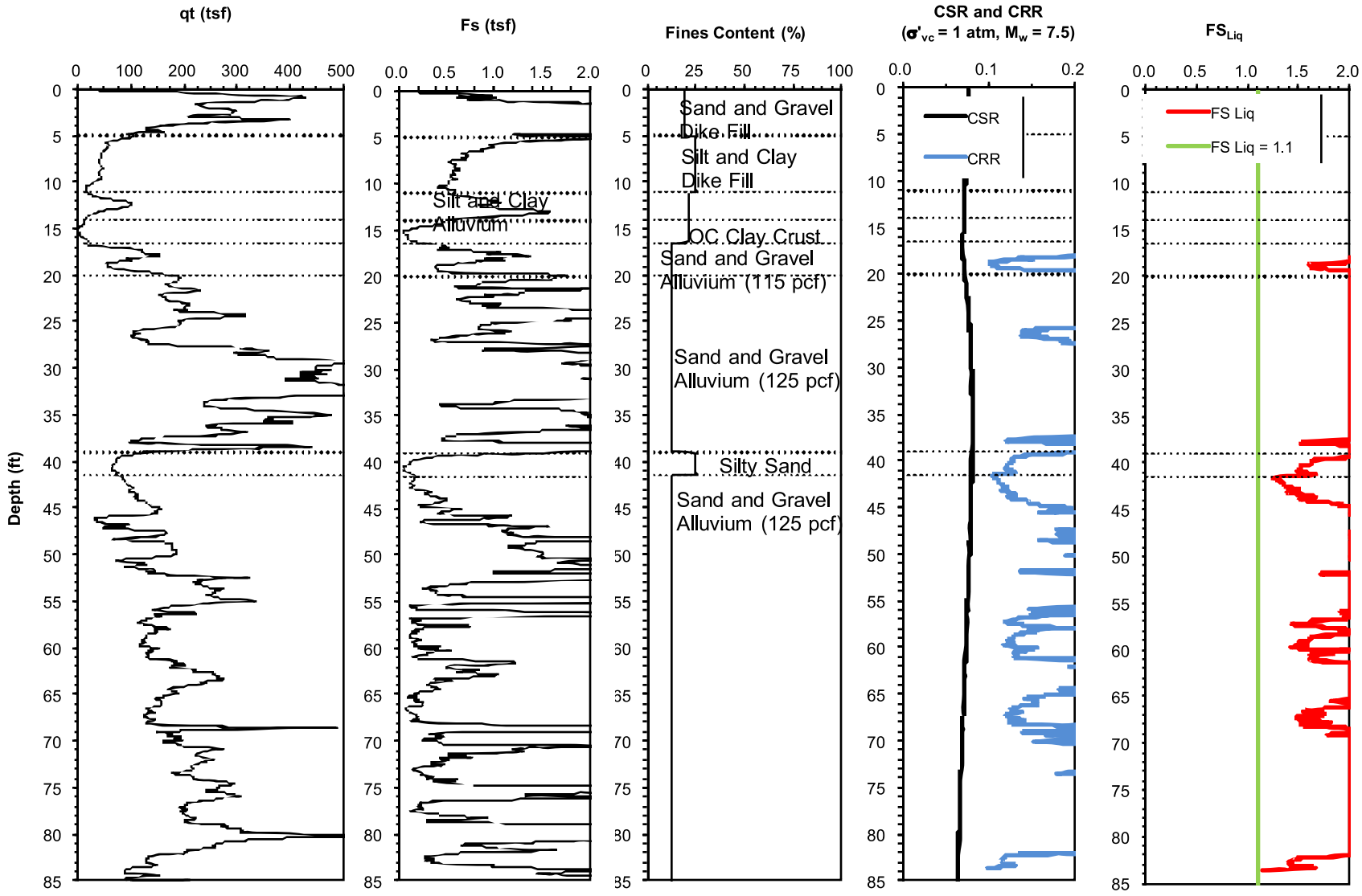
3/19/2018 5:50 PM

Project Name: Dynegy - Hennepin West Ash Pond Complex Closure Design
Location: Hennepin, IL
Test Number: HEN-C005A
Type of Sounding: CPTu
CPT Operator: ConeTec Inc.



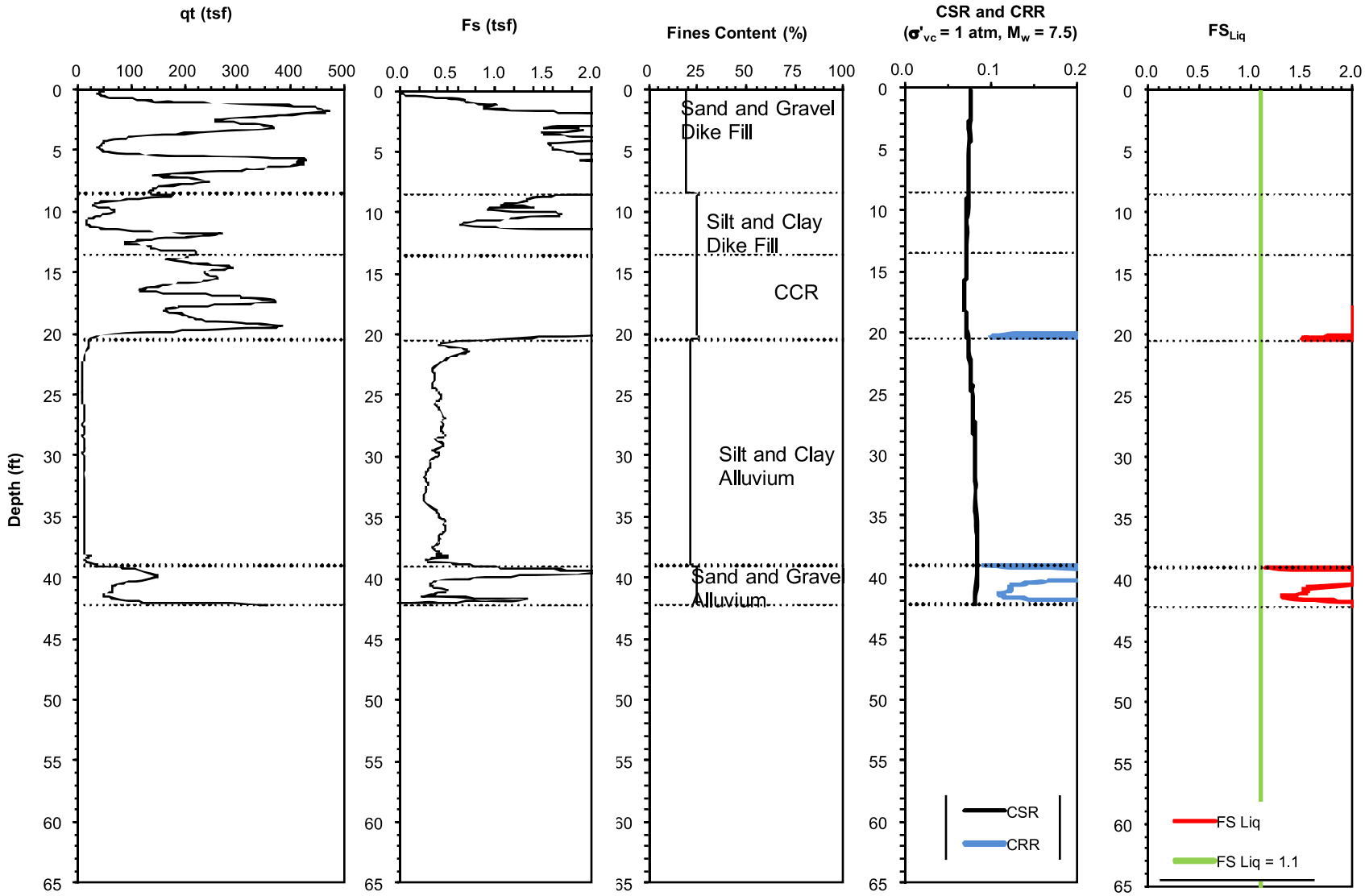
3/19/2018 5:48 PM

Project Name: Dynegy - Hennepin West Ash Pond Complex Closure Design
Location: Hennepin, IL
Test Number: HEN-C008B
Type of Sounding: CPTu
CPT Operator: ConeTec Inc.



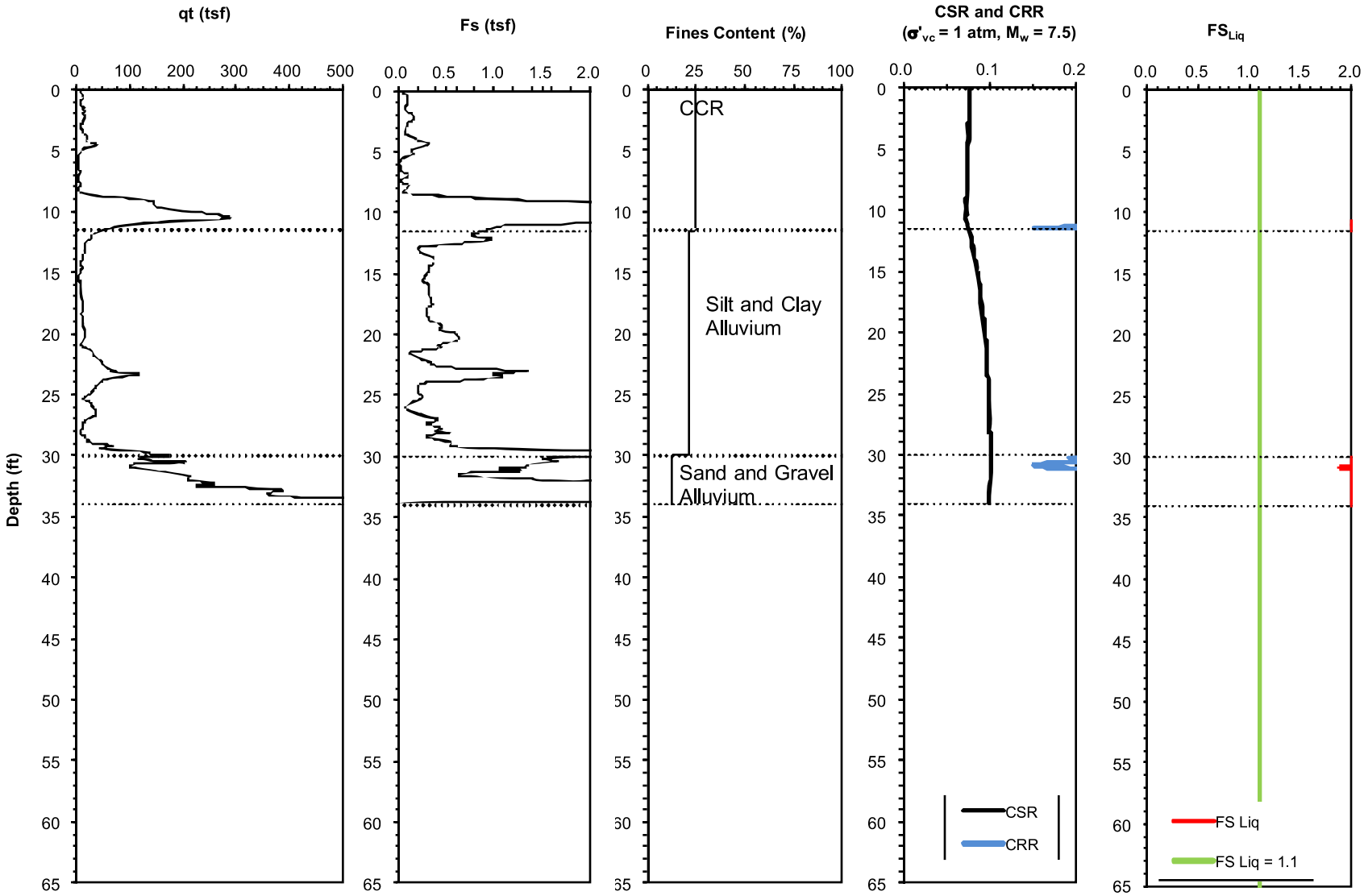
3/19/2018 5:44 PM

Project Name: Dynegy - Hennepin West Ash Pond Complex Closure Design
Location: Hennepin, IL
Test Number: HEN-C010
Type of Sounding: CPTu
CPT Operator: ConeTec Inc.



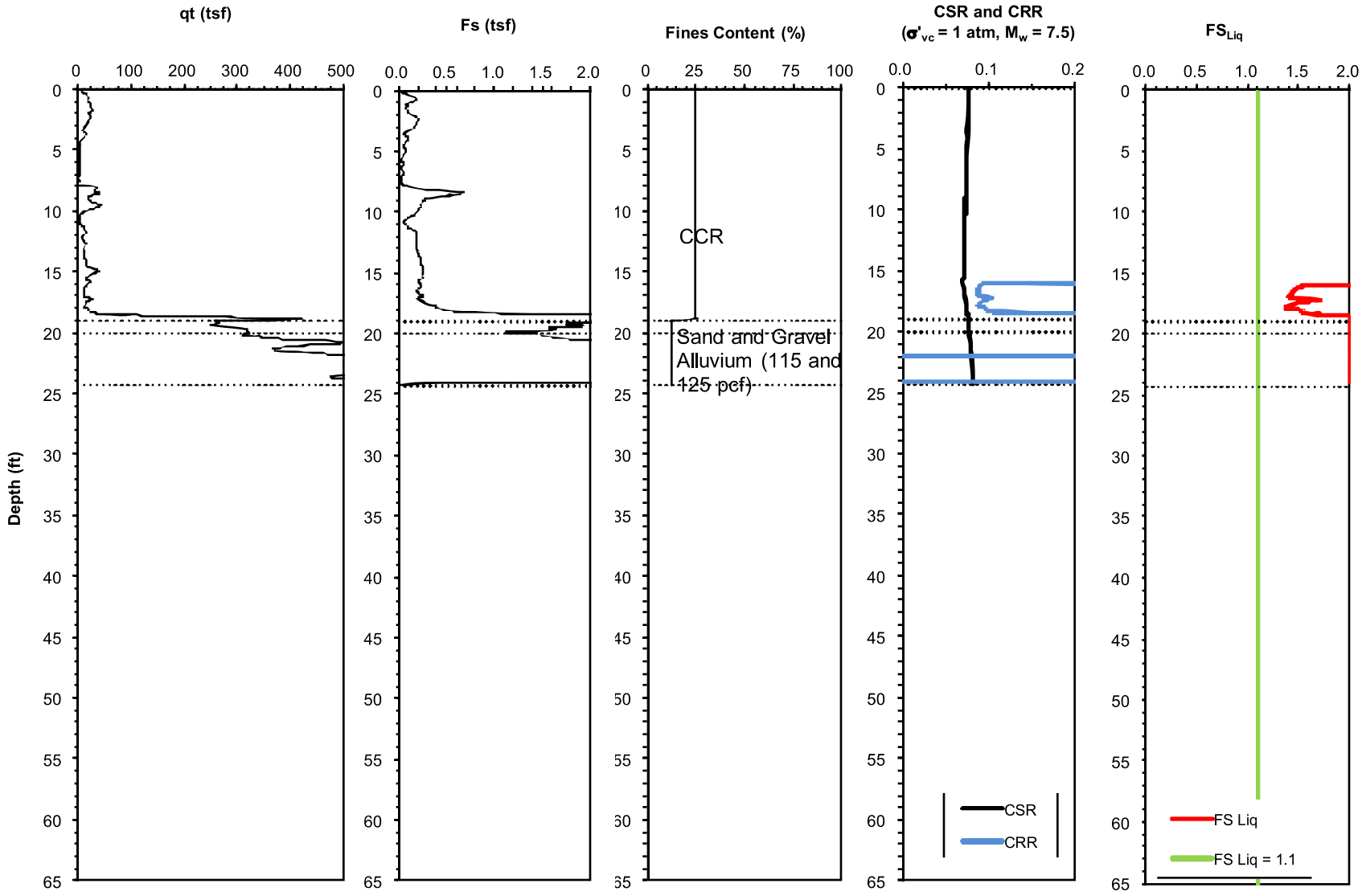
3/19/2018 5:41 PM

Project Name: Dynegy - Hennepin West Ash Pond Complex Closure Design
Location: Hennepin, IL
Test Number: HEN-C012
Type of Sounding: CPTu
CPT Operator: ConeTec Inc.

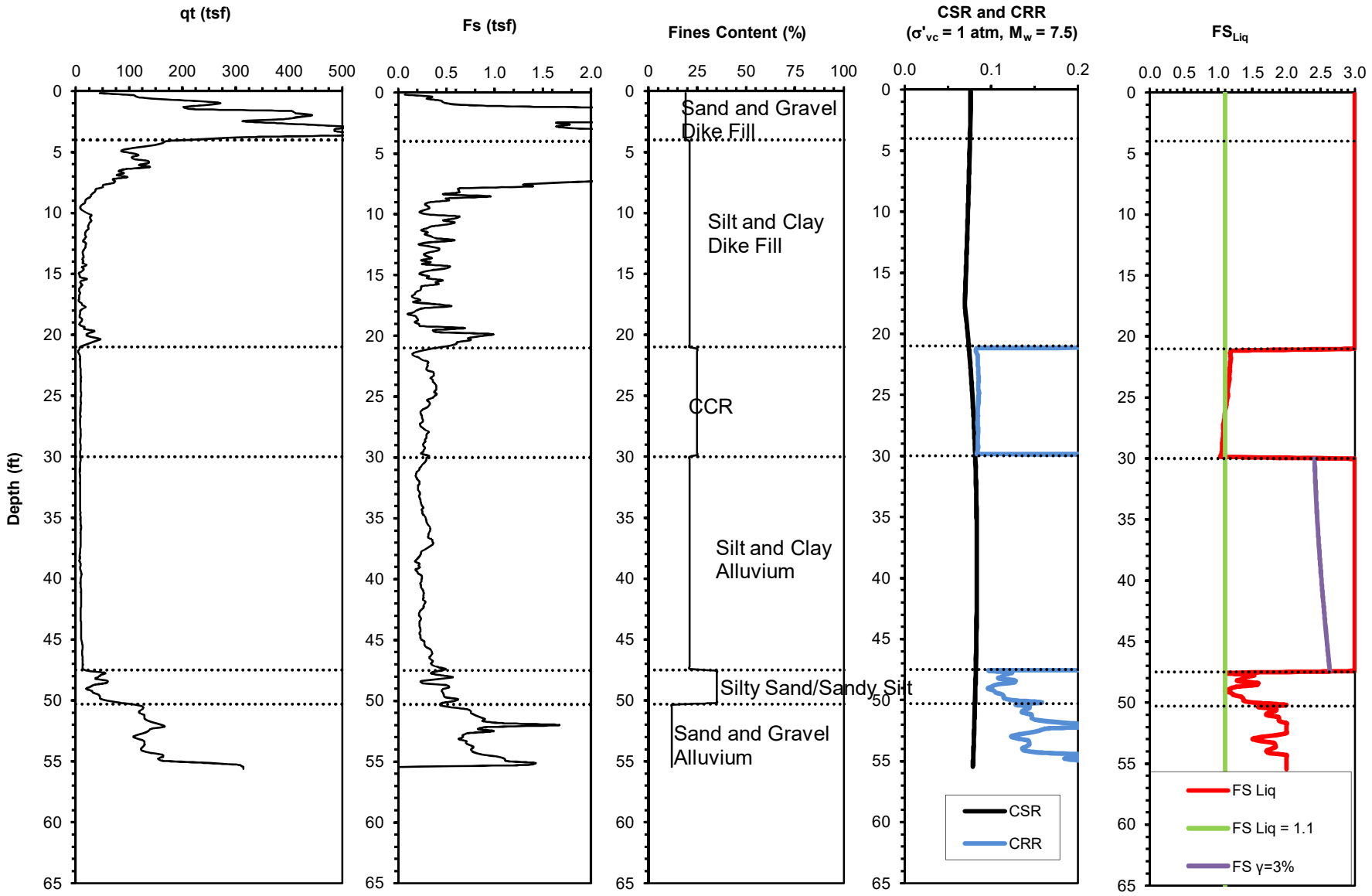


3/19/2018 5:38 PM

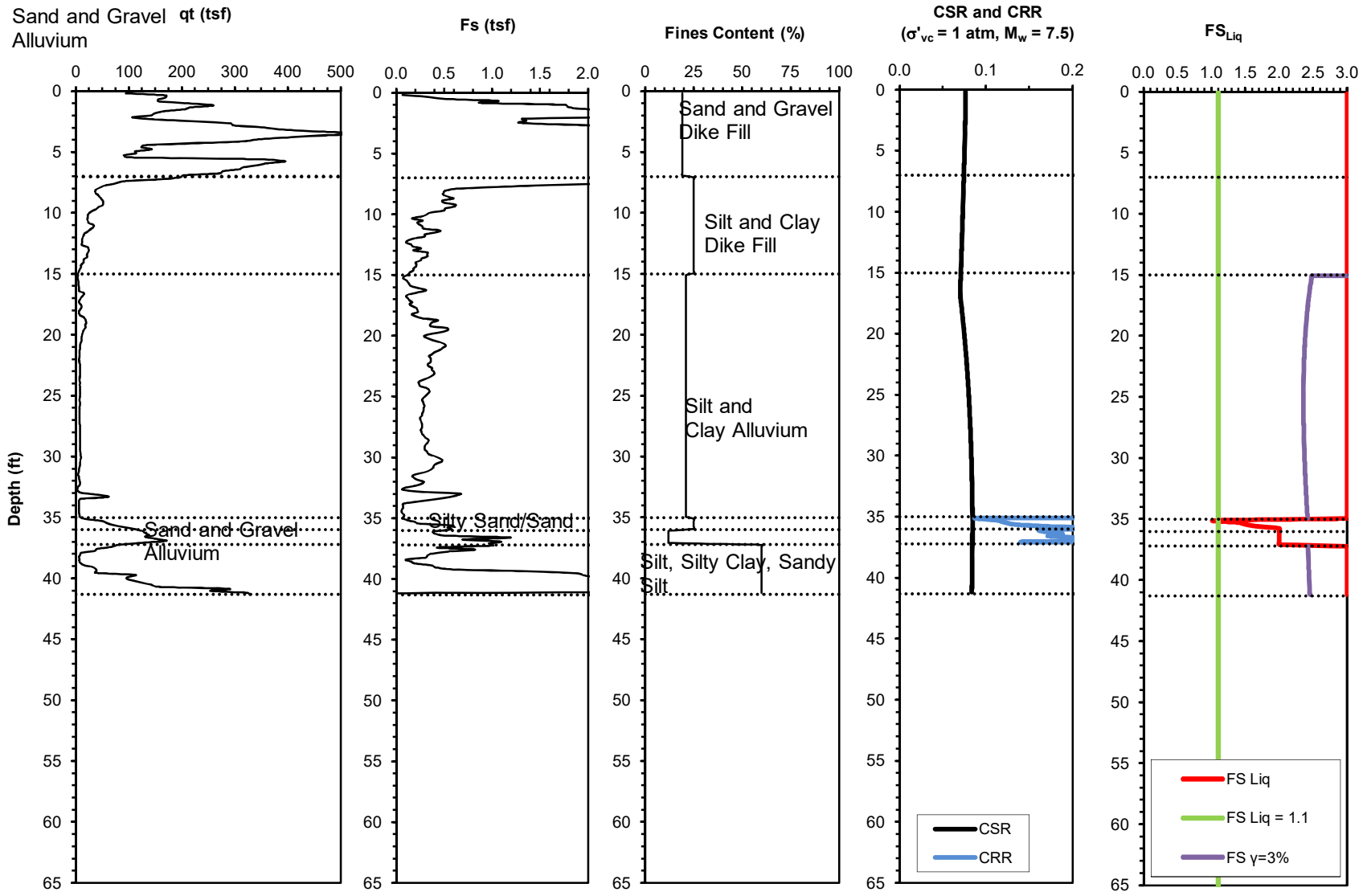
Project Name: Dynegy - Hennepin West Ash Pond Complex Closure Design
Location: Hennepin, IL
Test Number: HEN-C014
Type of Sounding: CPTu
CPT Operator: ConeTec Inc.



Project Name: Dynegy - Hennepin West Ash Pond Complex Closure Design
Location: Hennepin, IL
Test Number: HEN-C002
Type of Sounding: CPTu
CPT Operator: ConeTec Inc.



Project Name: Dynegy - Hennepin West Ash Pond Complex Closure Design
Location: Hennepin, IL
Test Number: HEN-C004
Type of Sounding: CPTu
CPT Operator: ConeTec Inc.

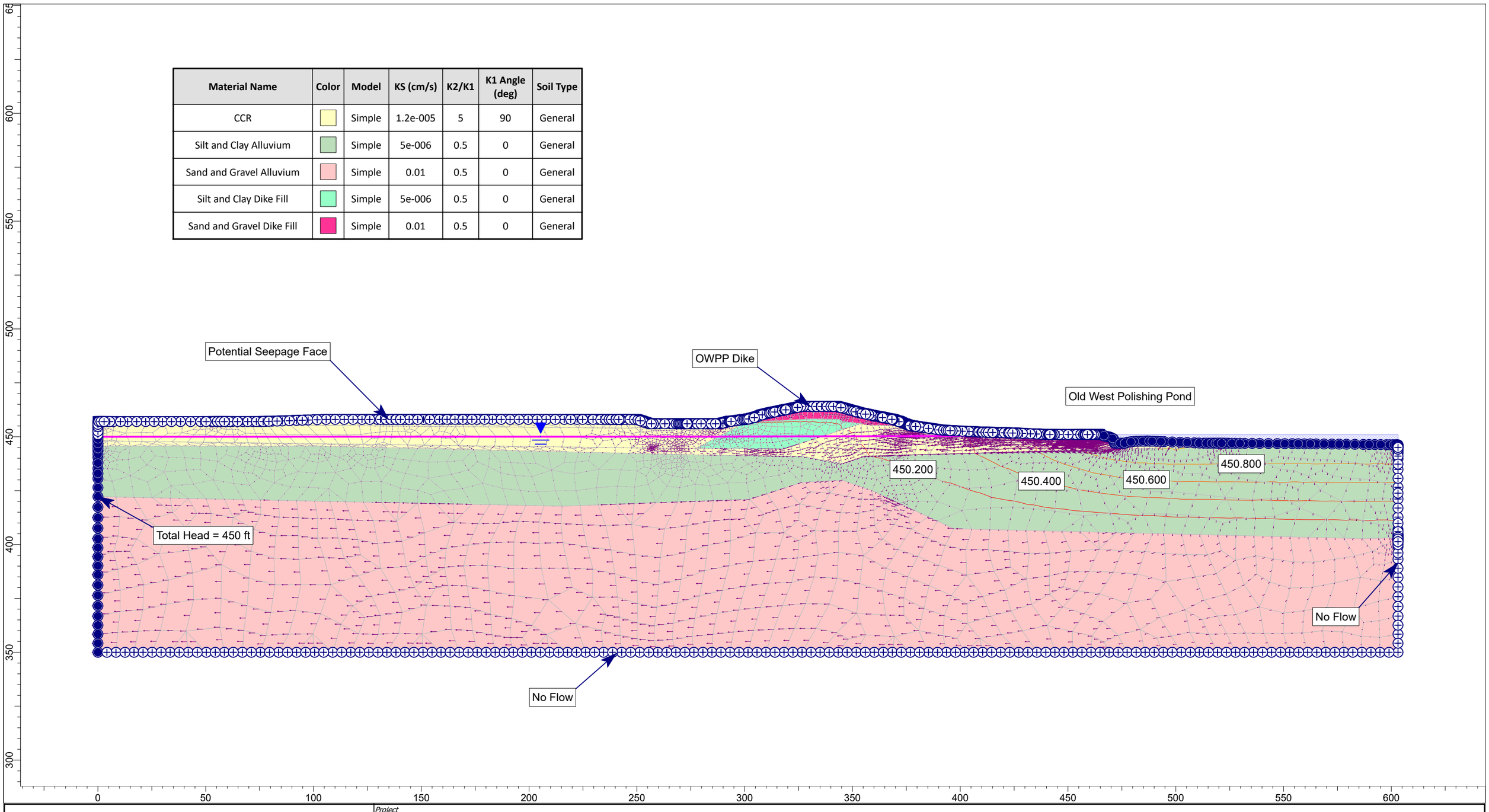


APPENDIX D

Seepage Analyses

Section A Seepage Analyses

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	1.2e-005	5	90	General
Silt and Clay Alluvium		Simple	5e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Silt and Clay Dike Fill		Simple	5e-006	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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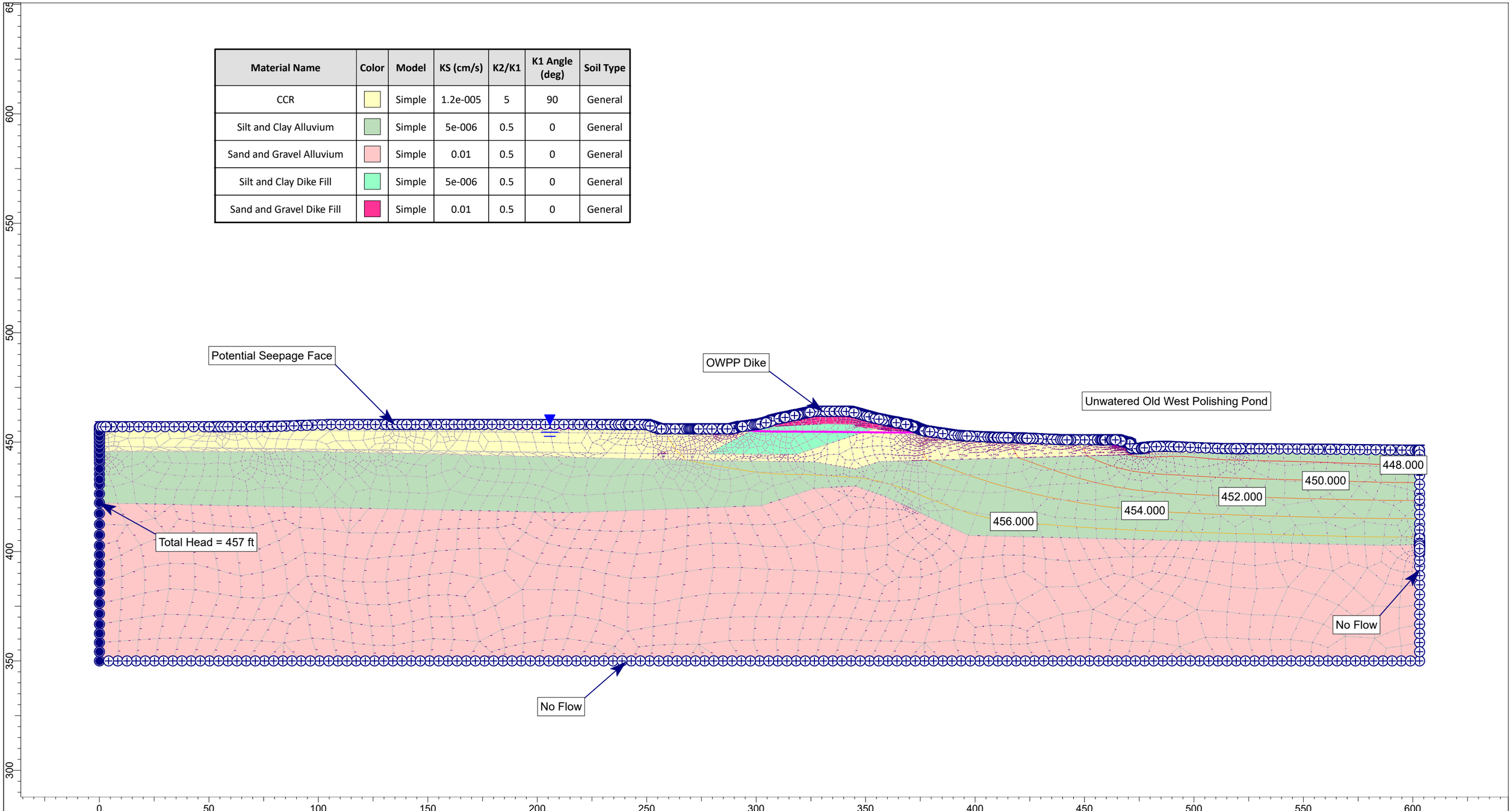
SLIDEINTERPRET 7.031

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section A Calibrated		
Analysis By	DJR		Client: Dynegy
Date: 2/21/2018, 8:28:48 AM	Scale: 1:500		File Name: section_a_calibrated_existing_djr_20180221.slim

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	1.2e-005	5	90	General
Silt and Clay Alluvium		Simple	5e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Silt and Clay Dike Fill		Simple	5e-006	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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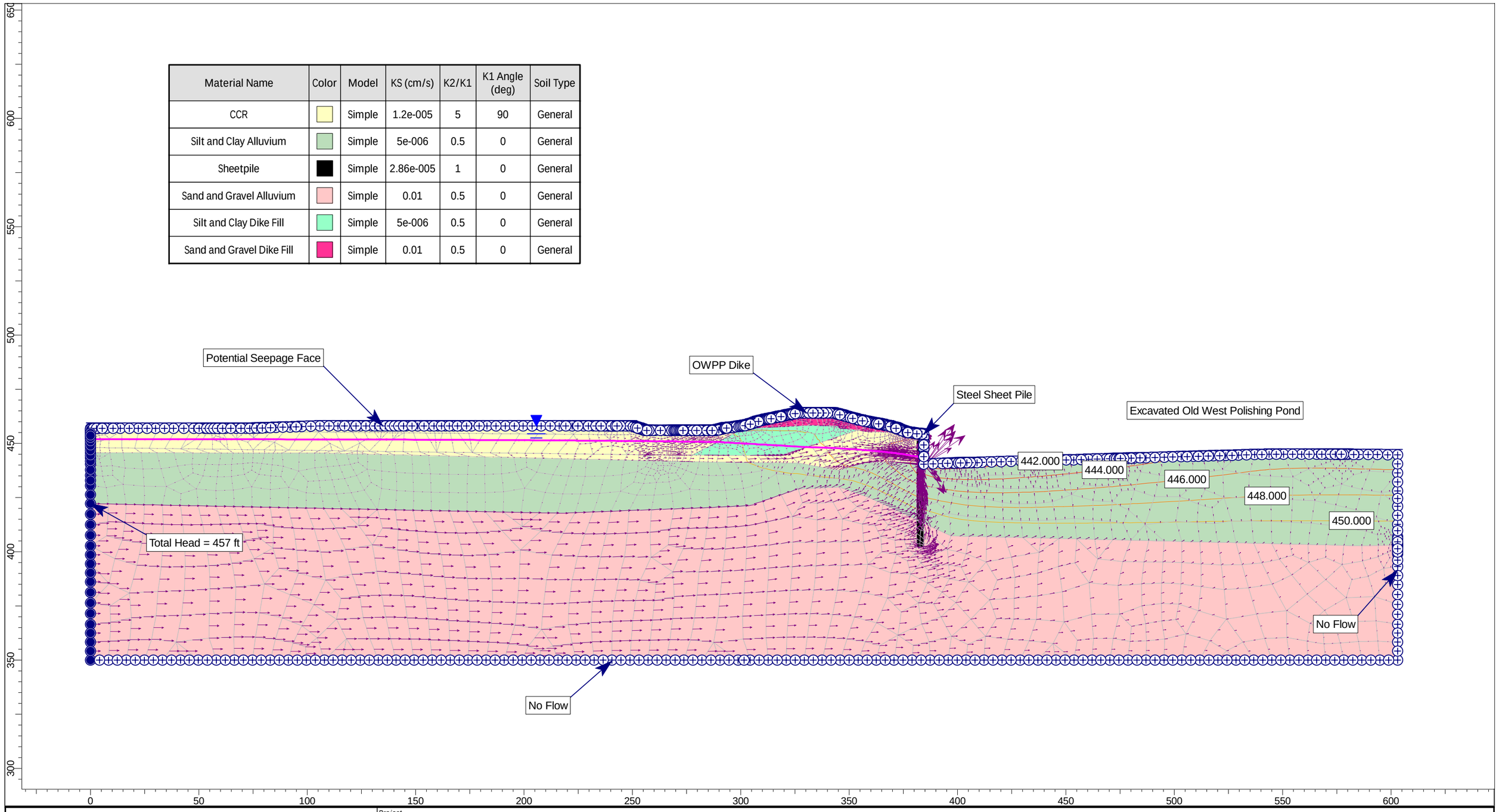
Project	Hennepin West Ash Pond System		
Analysis Description	Section A Unwatered		
Analysis By	DJR	*Client*	Dynegy
Date 2/21/2018, 8:28:48 AM	*Scale* 1:500	*File Name*	Section_a_Calibrated_Unwatered_DJR_20180221.slim

SLIDEINTERPRET 7.031

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	1.2e-005	5	90	General
Silt and Clay Alluvium		Simple	5e-006	0.5	0	General
Sheetpile		Simple	2.86e-005	1	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Silt and Clay Dike Fill		Simple	5e-006	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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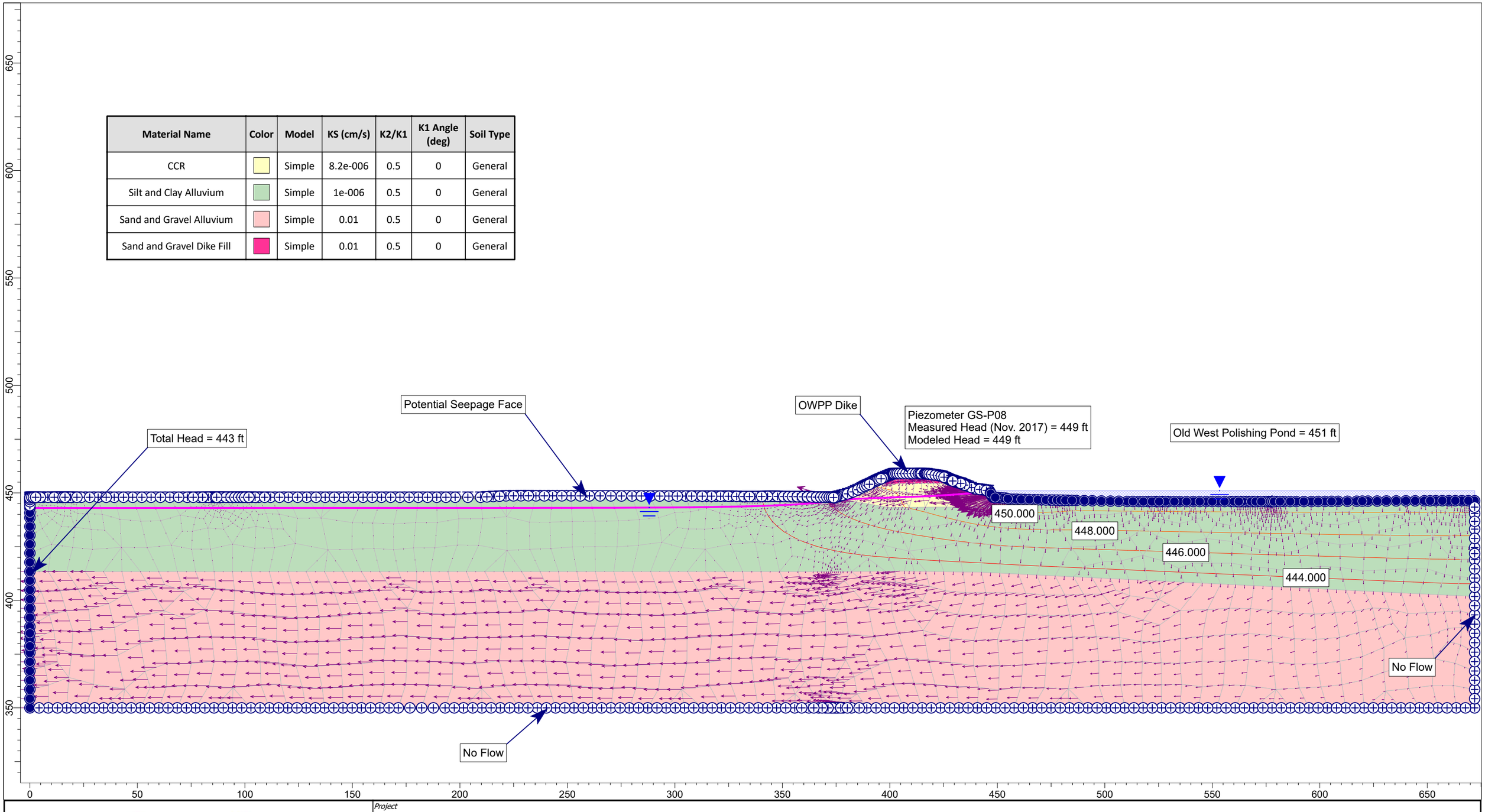
SLIDEINTERPRET 7.030

Project	Hennepin West Ash Pond System		
Analysis Description	Section A Excavation		
Analysis By	DJR		Client: Dynegy
Date: 3/16/2018	Scale: 1:500		File Name: section_a_calibrated_excavation_LPC_20180418.slim

Section G Seepage Analyses

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	1e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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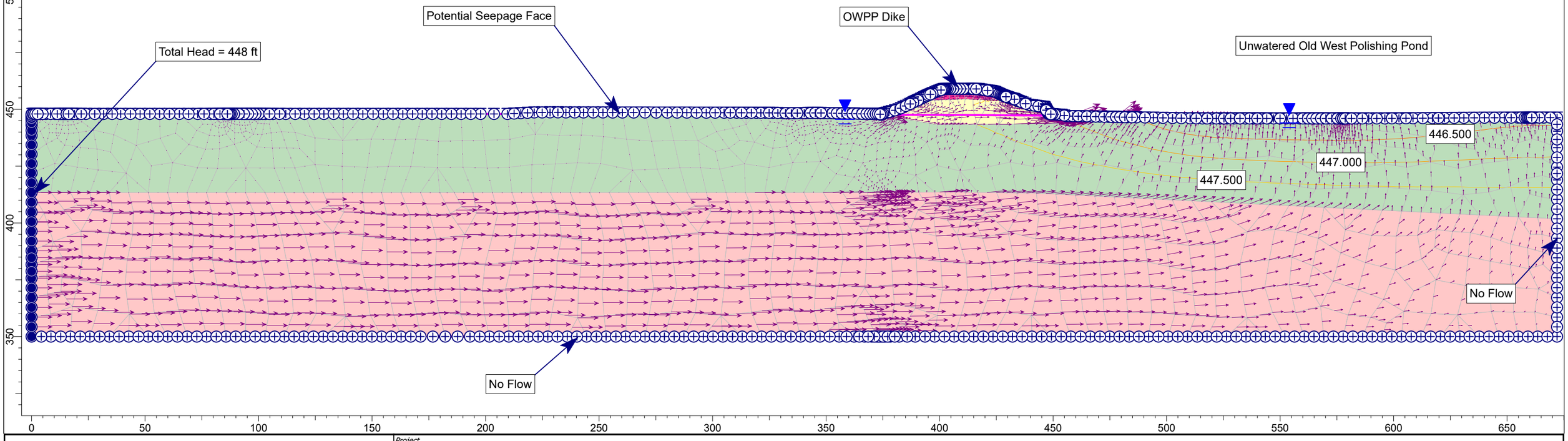
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Section G Calibrated		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 1:40:35 PM	Scale	1:500
File Name	section_g_seepage_calibrated_existing_djr_20180221.slim		

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	1e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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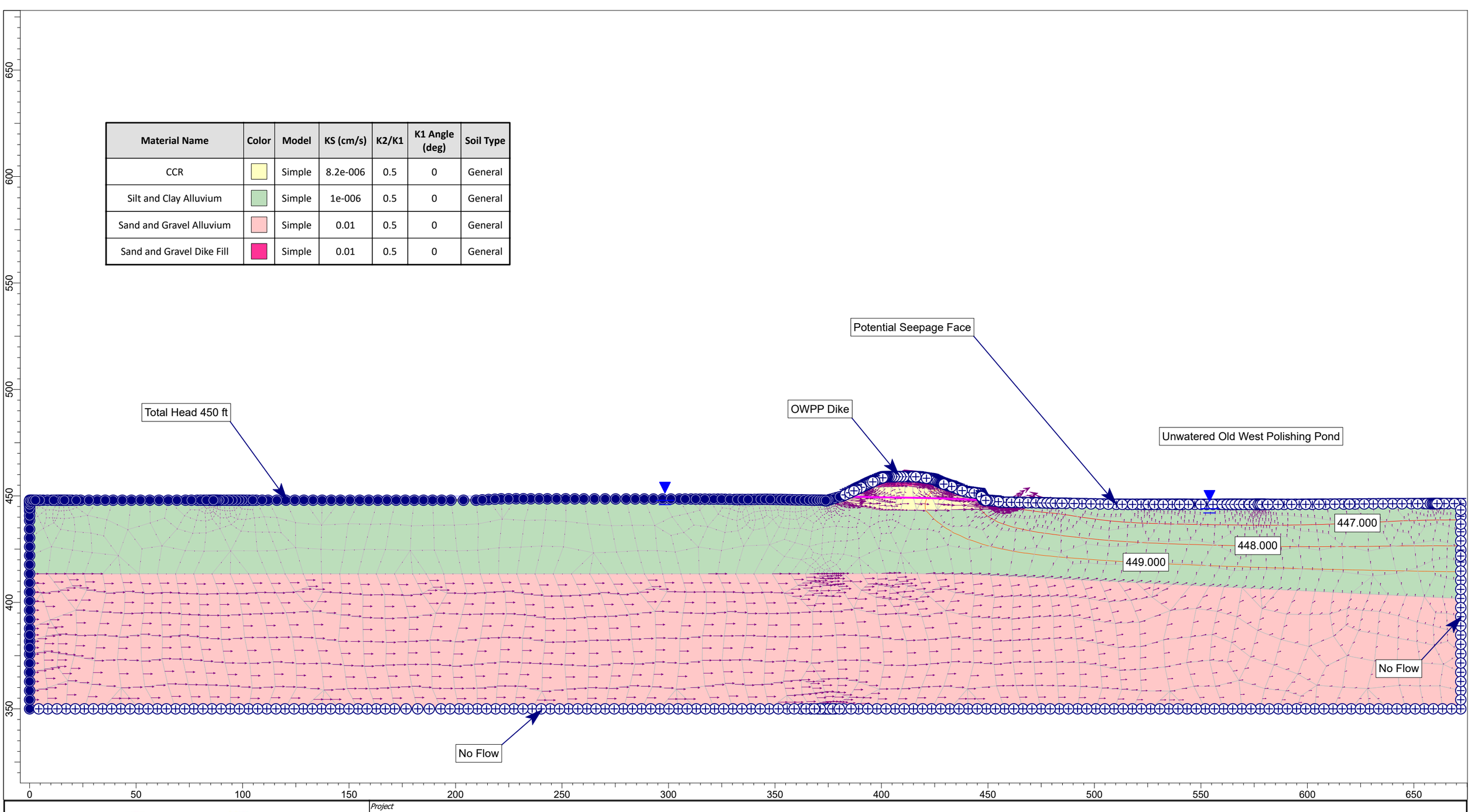
Project	Hennepin West Ash Pond System		
Analysis Description	Section G Unwatered		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 1:40:35 PM	Scale	1:500
File Name	section_g_seepage_calibrated_unwatered_djr_20180221.slim		

SLIDEINTERPRET 7.031

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	1e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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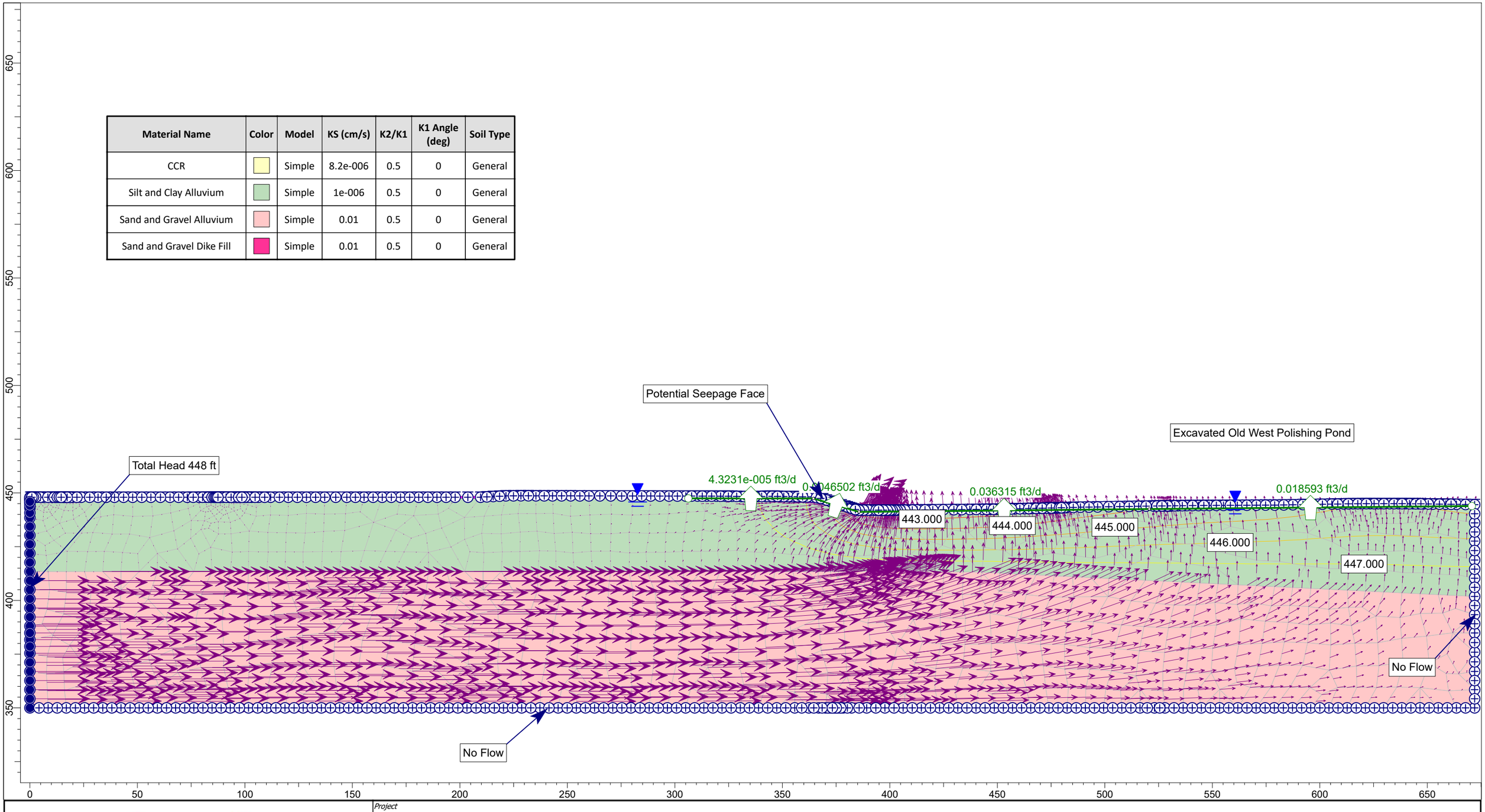
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Section G Unwatered - Flood		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 1:40:35 PM	Scale	1:500
File Name	section_g_seepage_calibrated_unwatered_flood_djr_20180221.slim		

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	1e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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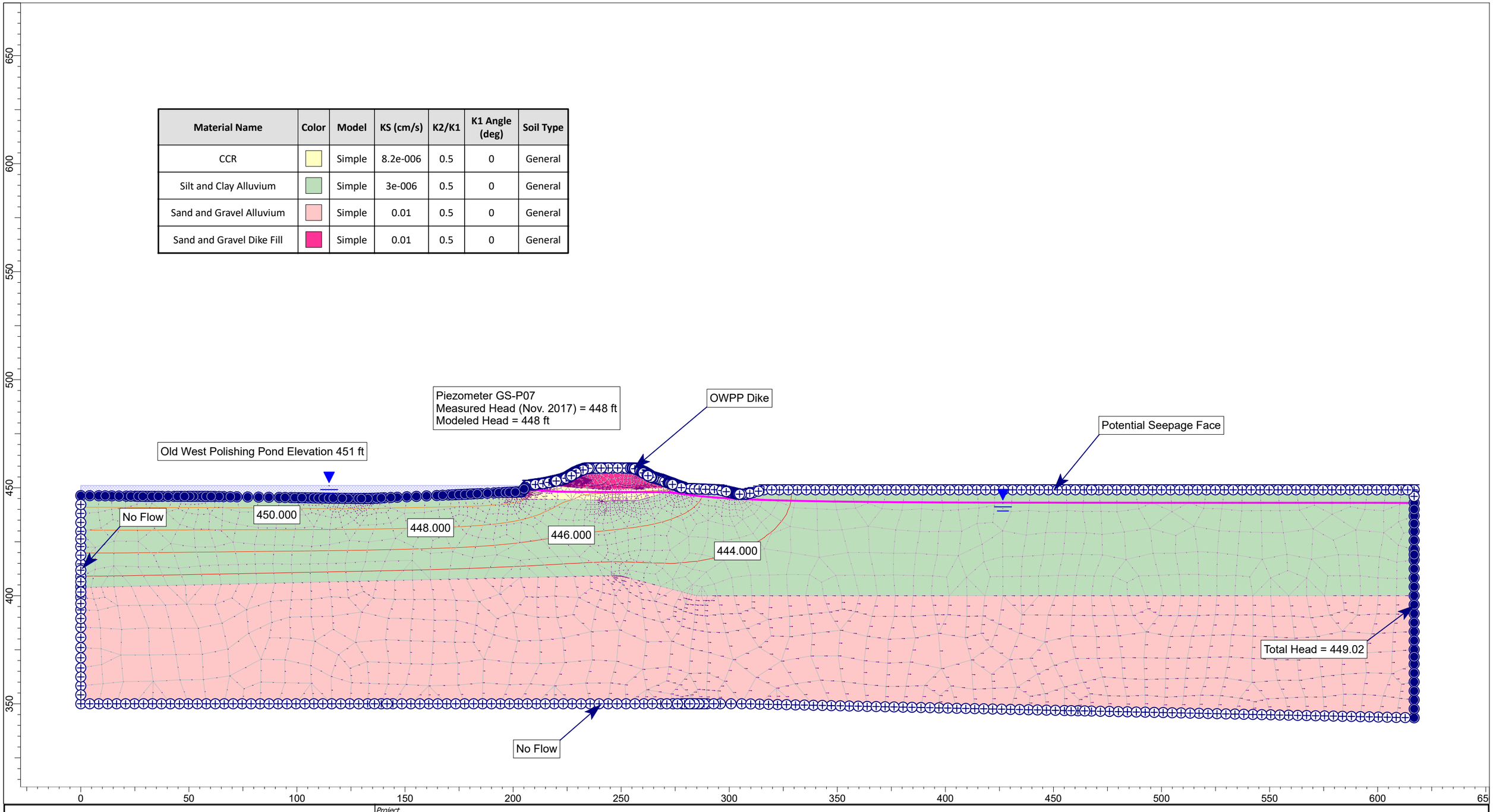
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Section G Excavation		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 1:40:35 PM	Scale	1:500
File Name	section_g_seepage_calibrated_excavation_djr_20180221.slim		

Section H Seepage Analyses

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	3e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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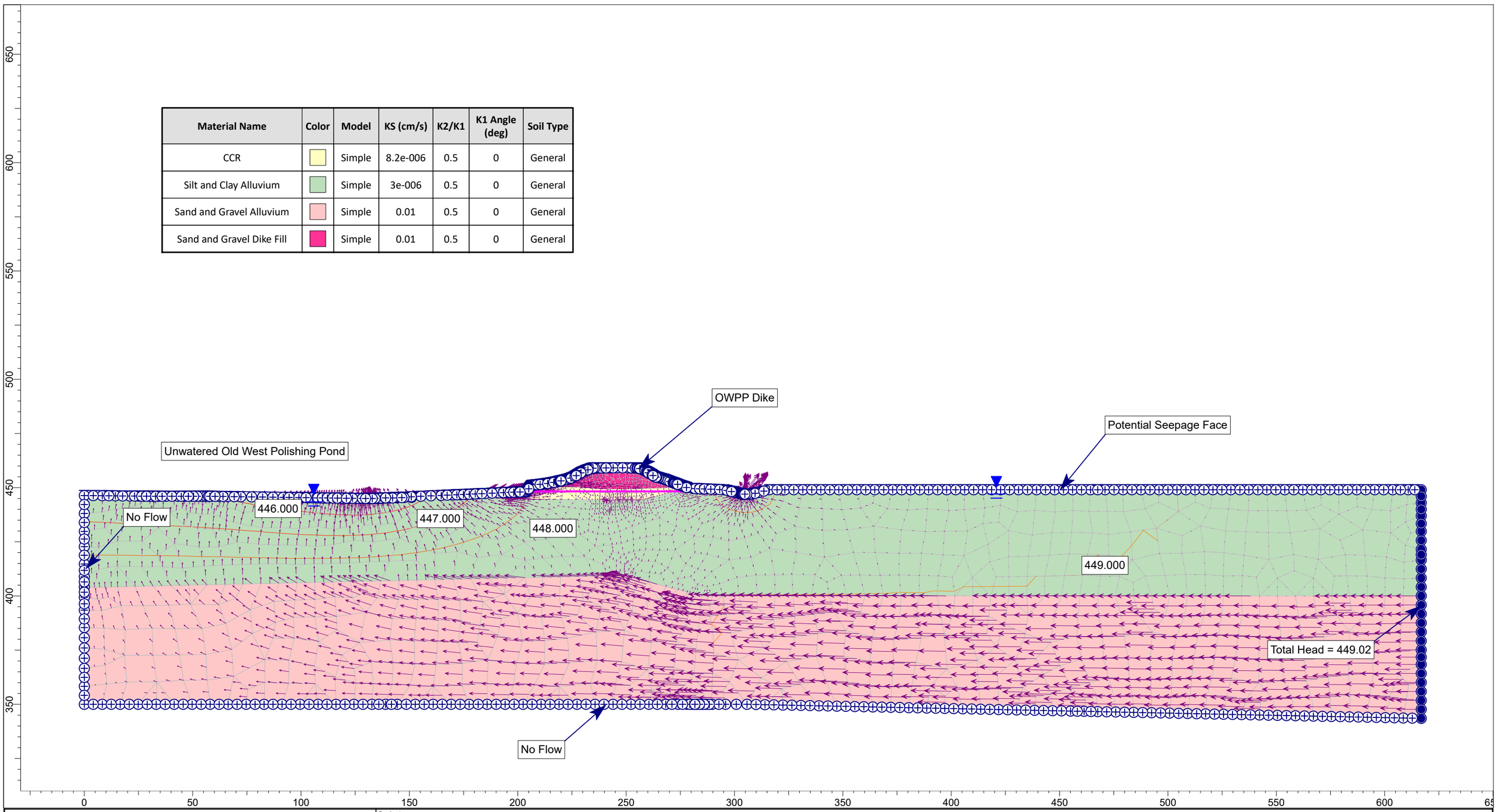
SLIDEINTERPRET 7.031

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section H Calibrated		
Analysis By	DJR		Client: Dynegy
Date: 2/15/2018, 2:50:06 PM	Scale: 1:500		File Name: Section_H_Seepage_Calibrated_Existing_DJR_20180221.slim

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	3e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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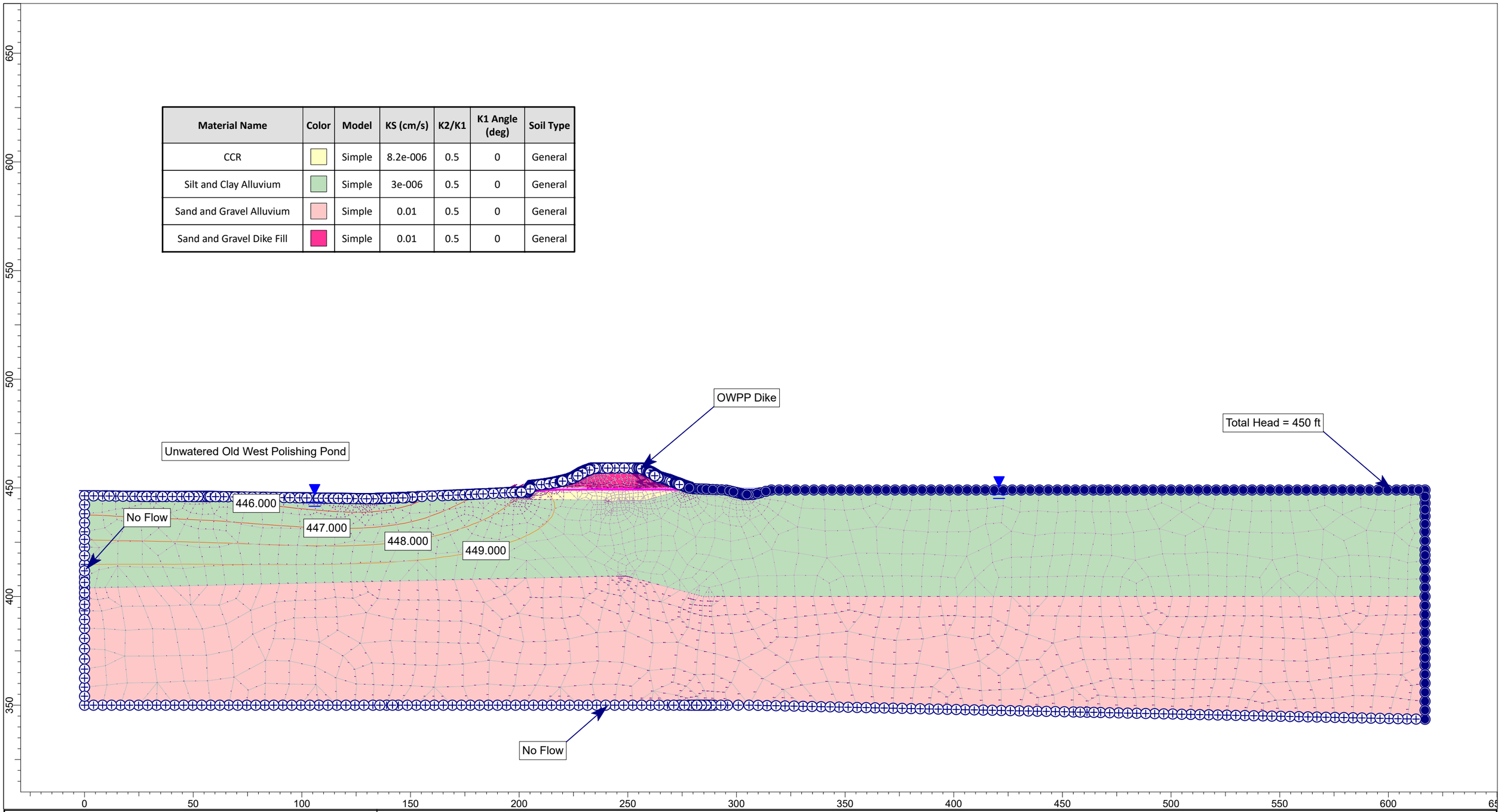
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Section H Unwatered		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 2:50:06 PM	Scale	1:500
File Name	section_h_seepage_calibrated_unwatered_djr_20180221.slim		

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	3e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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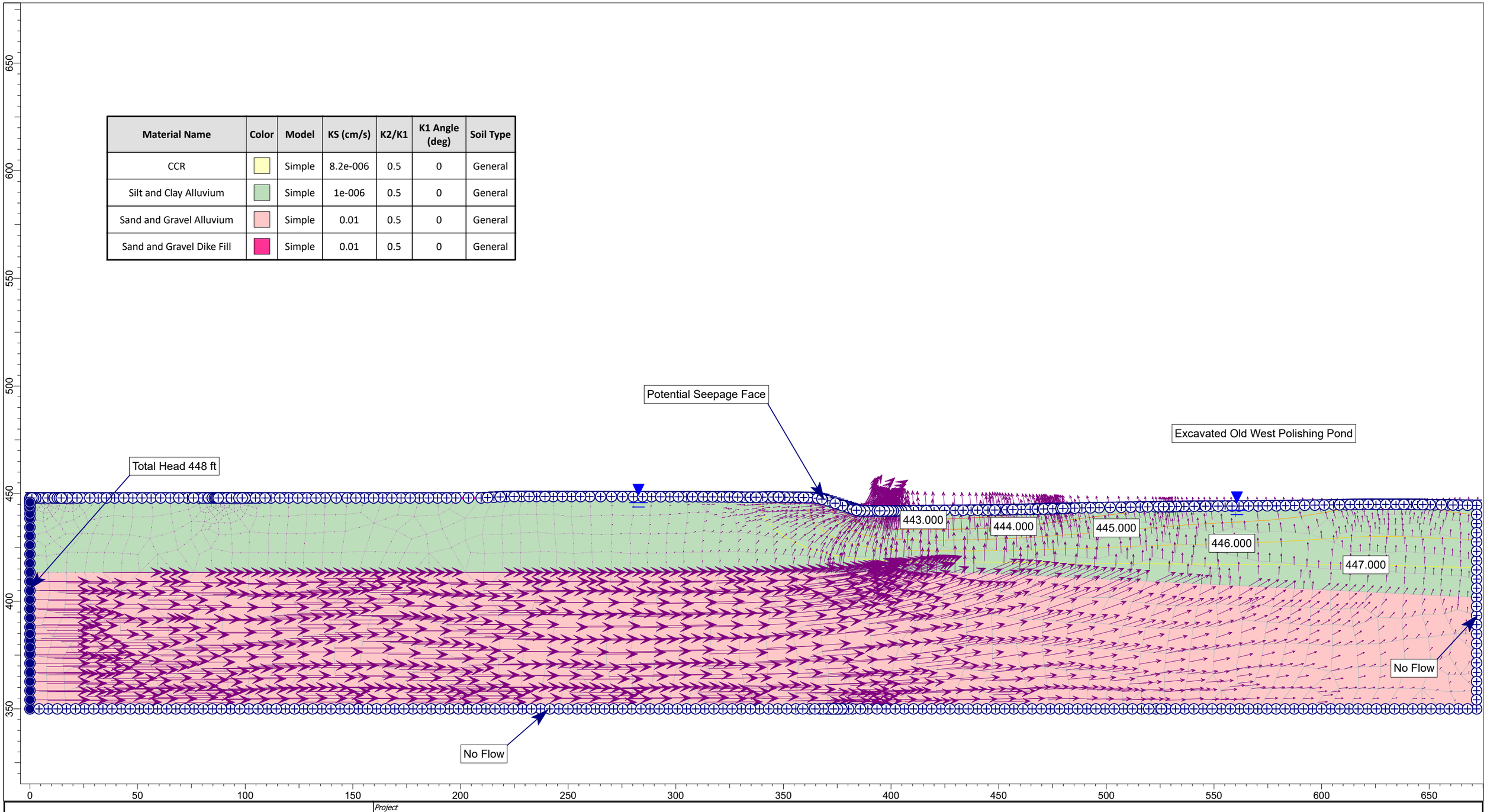
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Section H Unwatered - Flood		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 2:50:06 PM	Scale	1:500
File Name	Section_H_Seepage_Calibrated_Unwatered_Flood_DJR_20180221.slim		

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	1e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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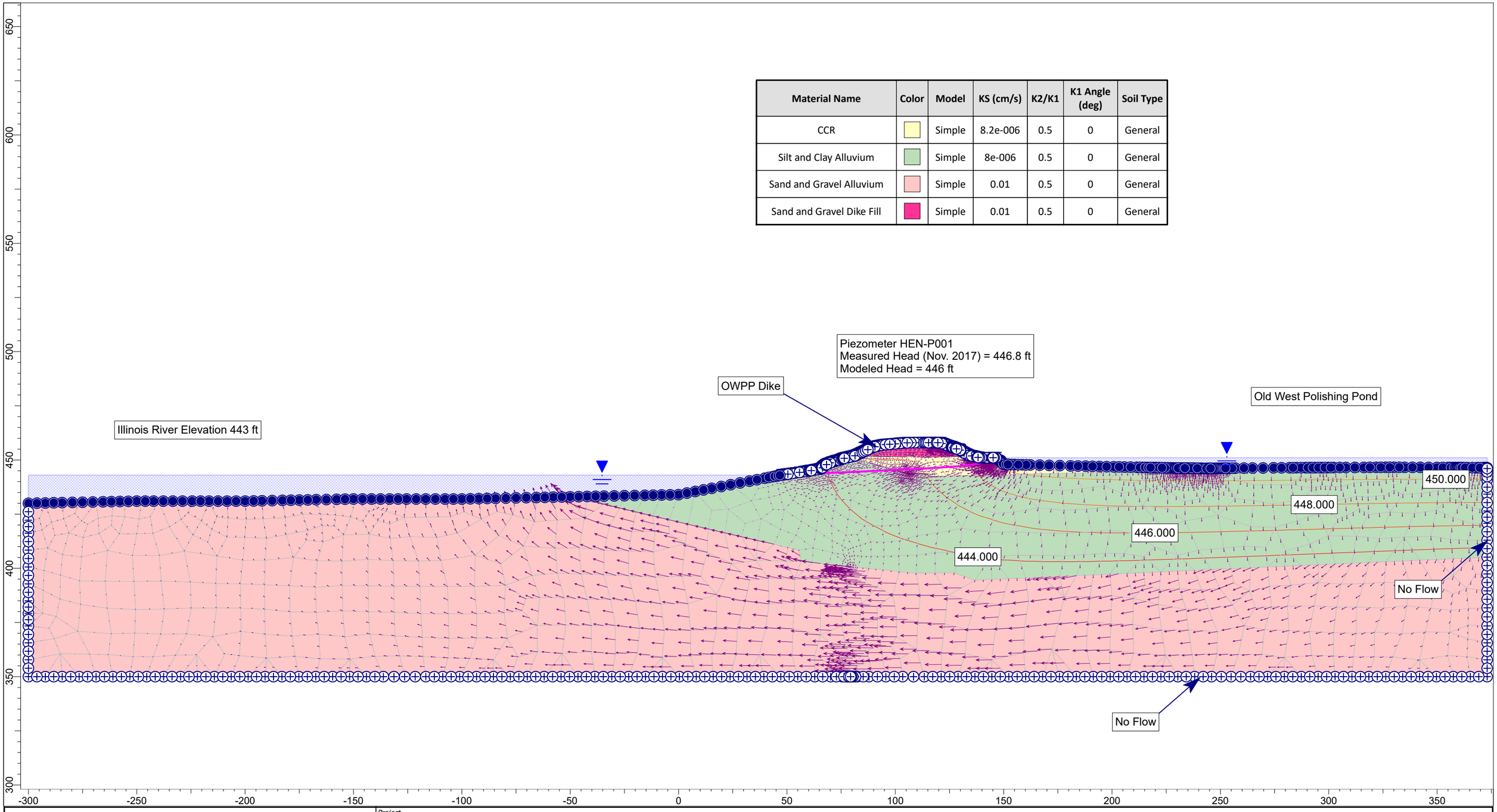
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Section G Excavation		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 1:40:35 PM	Scale	1:500
File Name	Section_G_Seepage_Calibrated_Excavation_DJR_20180221.slim		

Section I Seepage Analyses

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	8e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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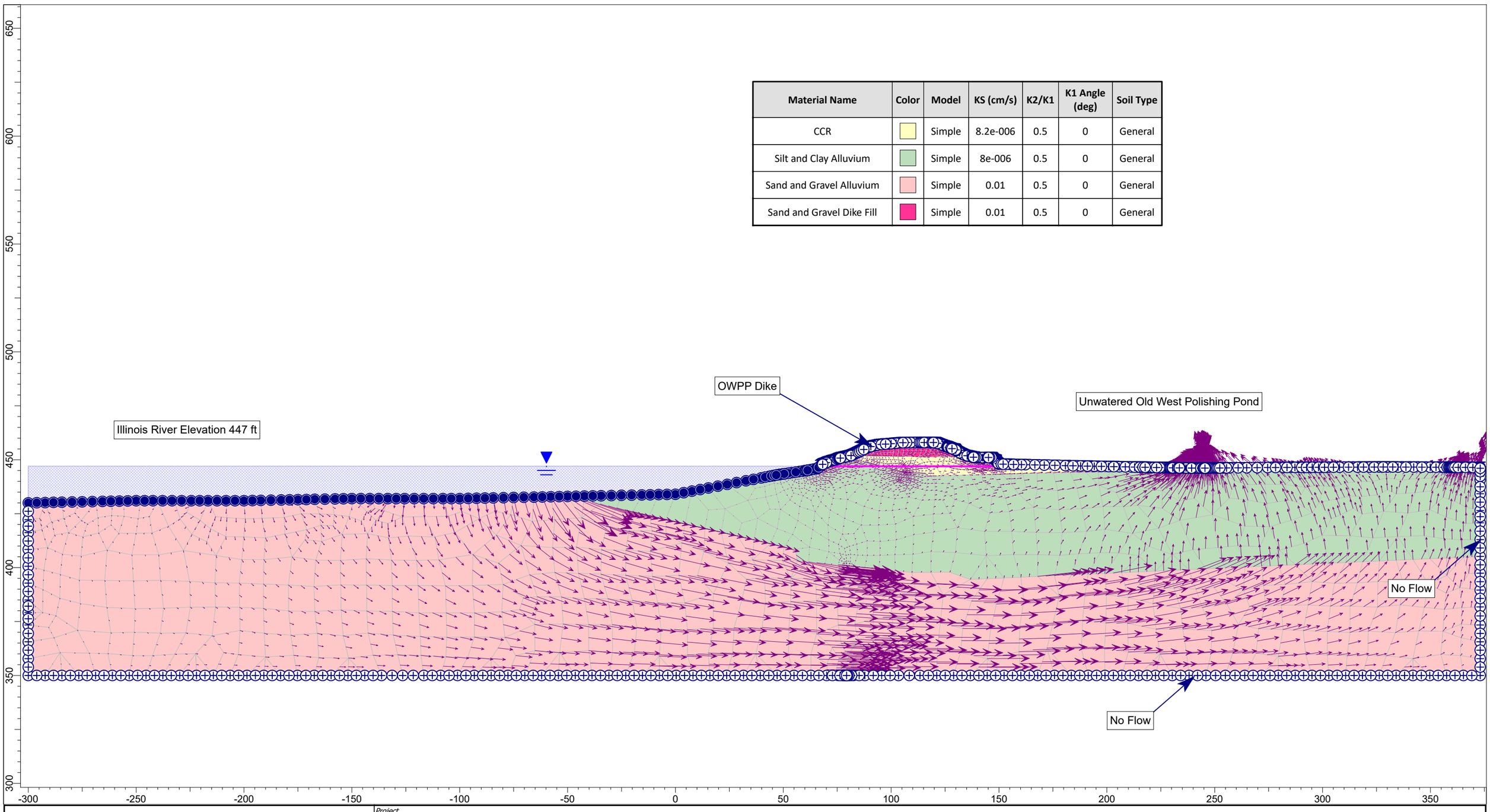
SLIDEINTERPRET 7.031

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section I Calibrated		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 3:18:17 PM	Scale	1:500
File Name	Section_I_Seepage_Calibrated_Existing_DJR_20180221.slim		

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	8e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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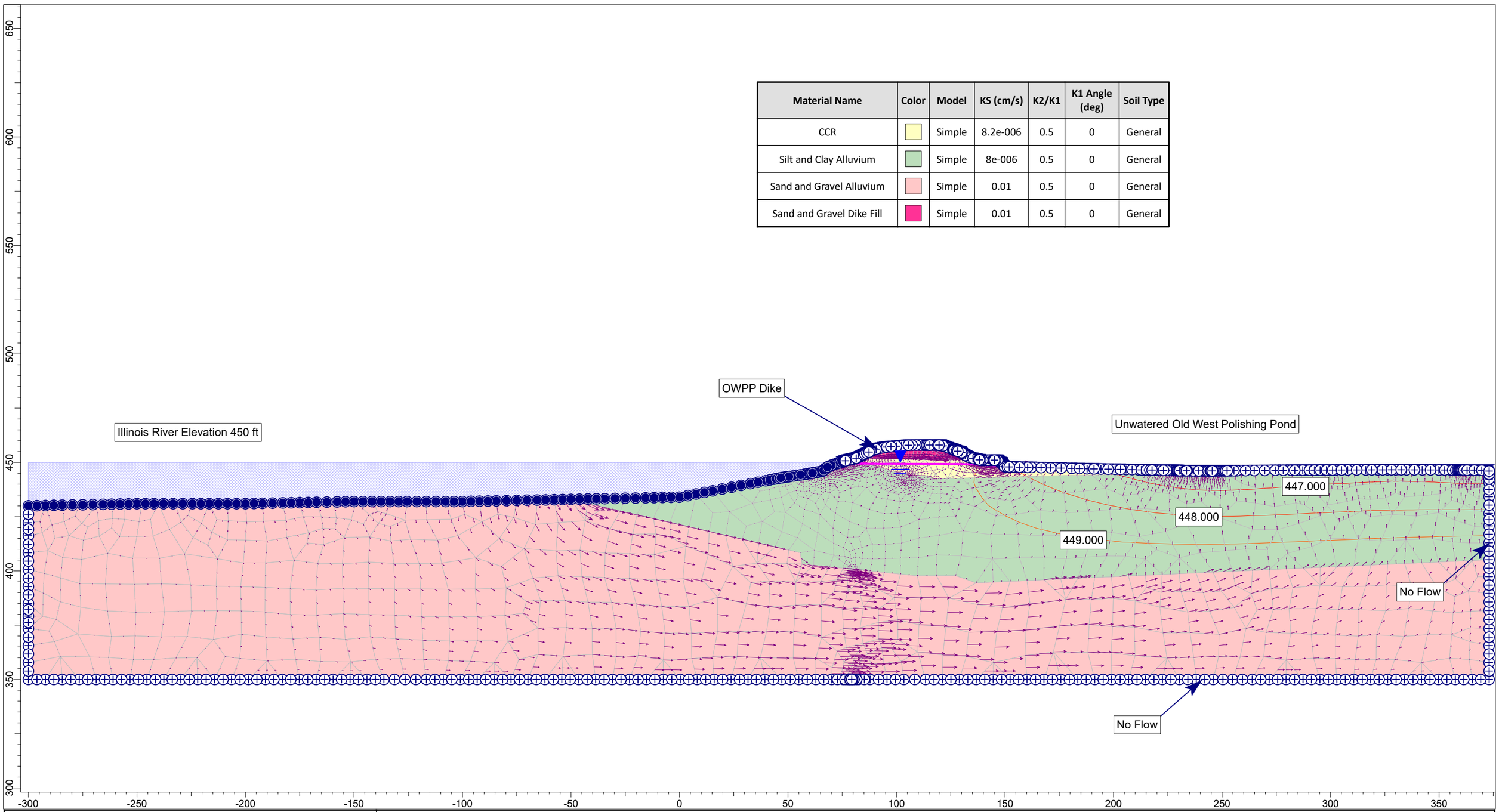
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Section I Unwatered		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 3:18:17 PM	Scale	1:500
File Name	Section_I_Seepage_Calibrated_Unwatered_DJR_20180221.slim		

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	8e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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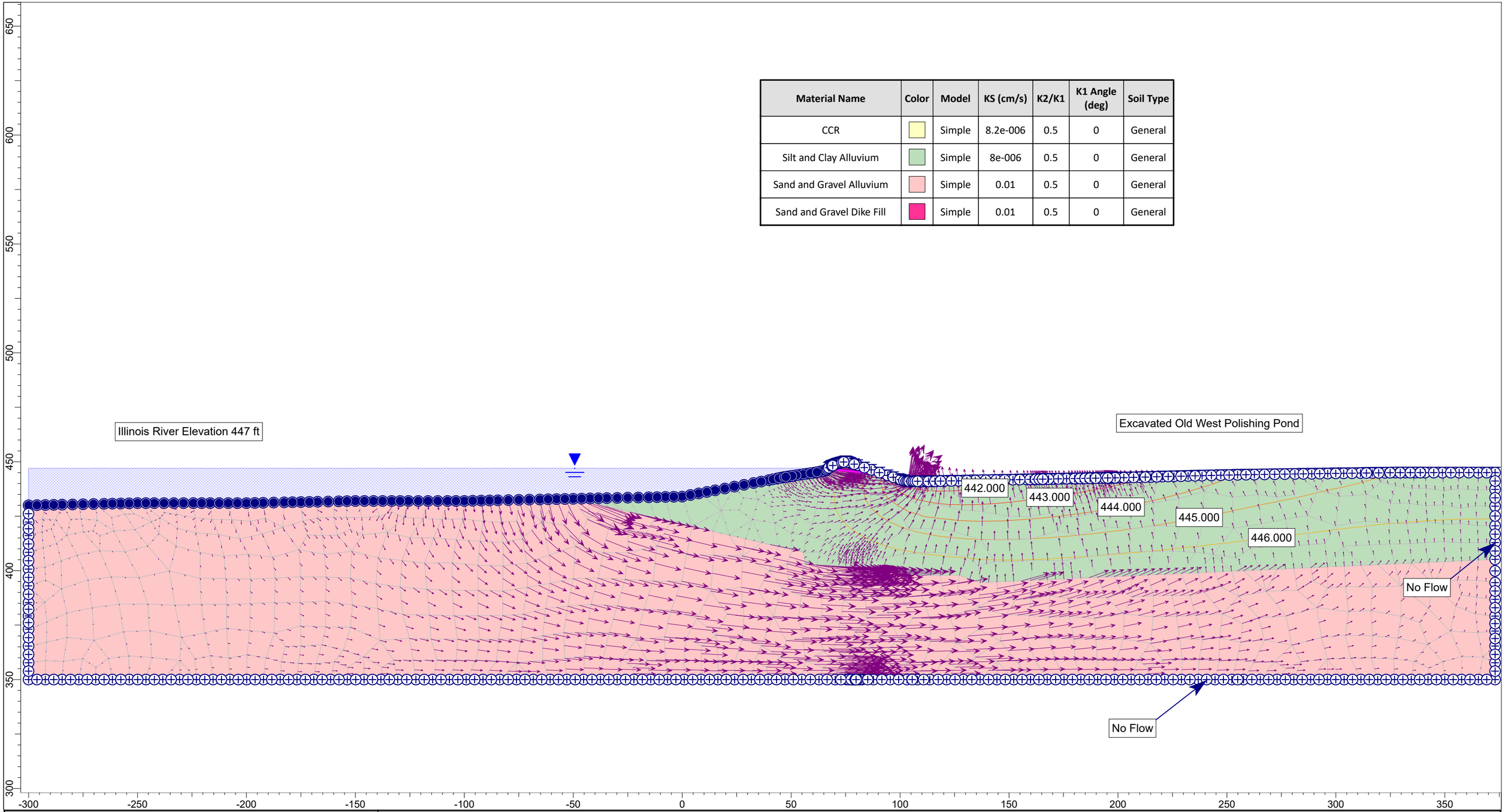
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Section I Unwatered - Flood		
Analysis By	DJR	*Client*	Dynegy
Date	2/15/2018, 3:18:17 PM	*Scale*	1:500
File Name	Section_I_Seepage_Calibrated_Unwatered_Flood_DJR_20180221.slim		

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	8e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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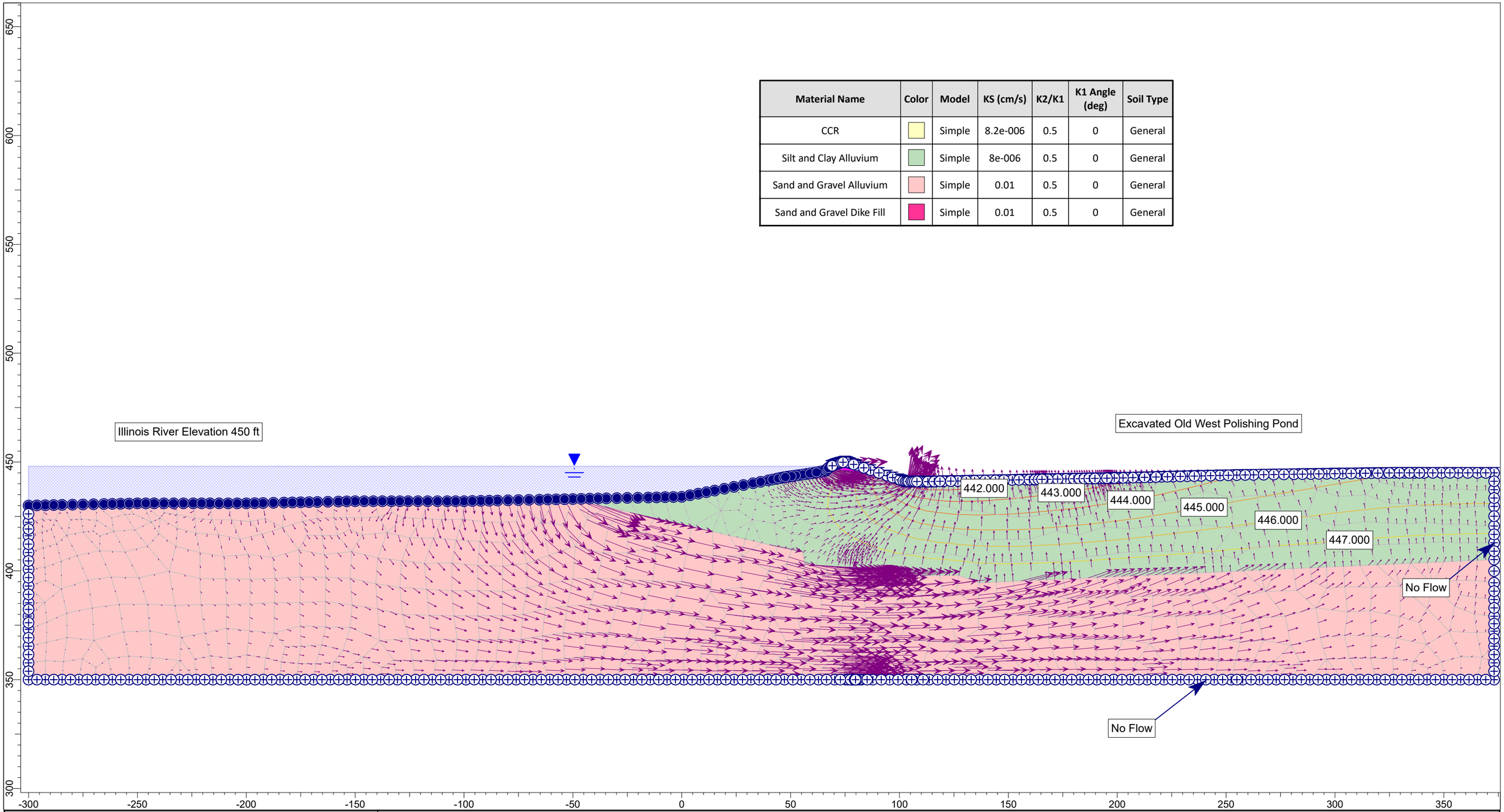
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Section I Excavation		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 3:18:17 PM	Scale	1:500
File Name	section_i_seepage_calibrated_excavation_djr_20180221.slim		

Material Name	Color	Model	KS (cm/s)	K2/K1	K1 Angle (deg)	Soil Type
CCR		Simple	8.2e-006	0.5	0	General
Silt and Clay Alluvium		Simple	8e-006	0.5	0	General
Sand and Gravel Alluvium		Simple	0.01	0.5	0	General
Sand and Gravel Dike Fill		Simple	0.01	0.5	0	General



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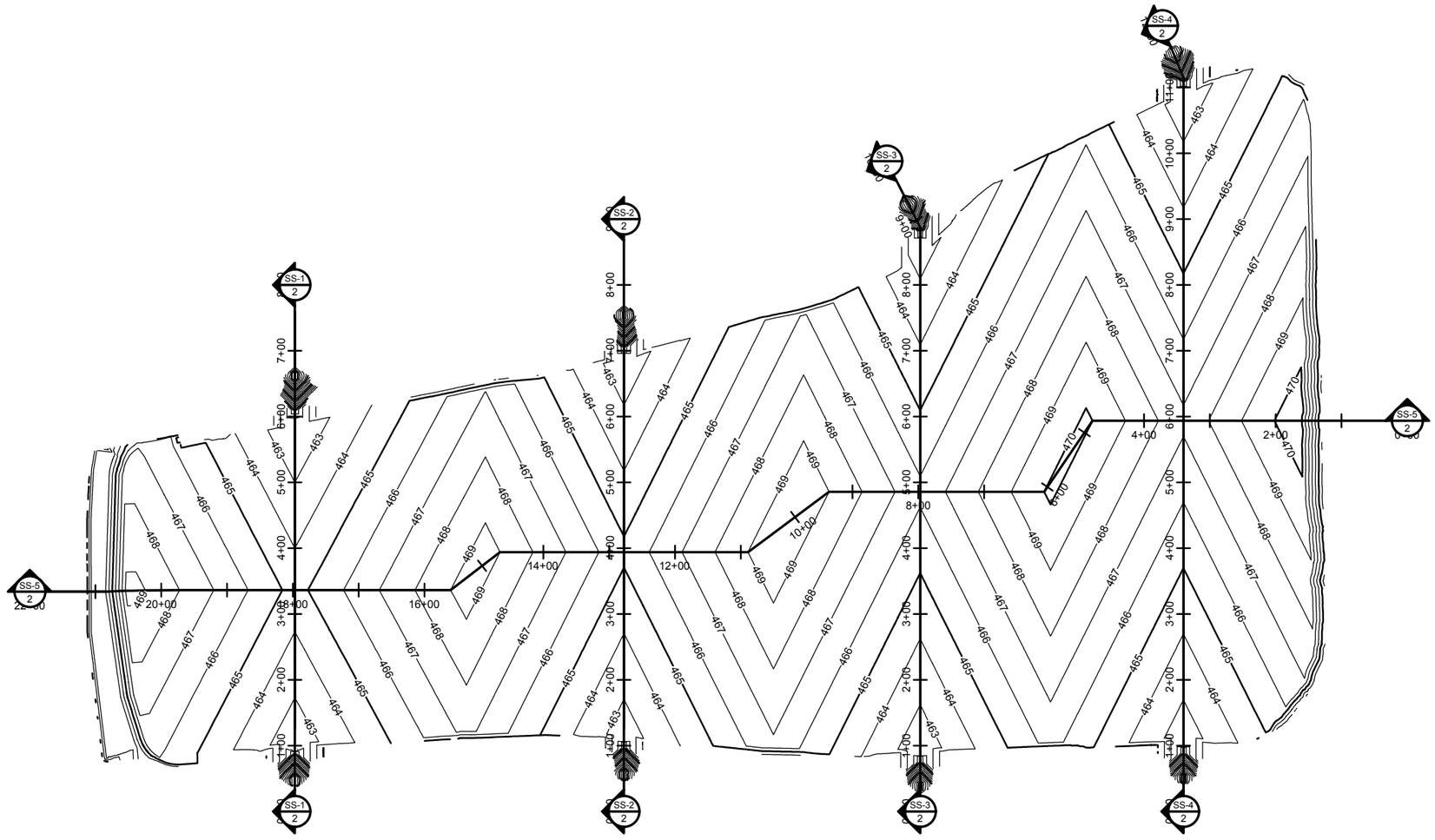
SLIDEINTERPRET 7.031

Project	Hennepin West Ash Pond System		
Analysis Description	Section I Excavation - High River Level (448 ft)		
Analysis By	DJR	Client	Dynegy
Date	2/15/2018, 3:18:17 PM	Scale	1:500
File Name	section_i_seepage_calibrated_excavation_flood_djr_20180221.slim		

APPENDIX E

Settlement Analyses



0 200

SCALE IN FEET

FINAL COVER PLAN VIEW
HENNEPIN POWER STATION

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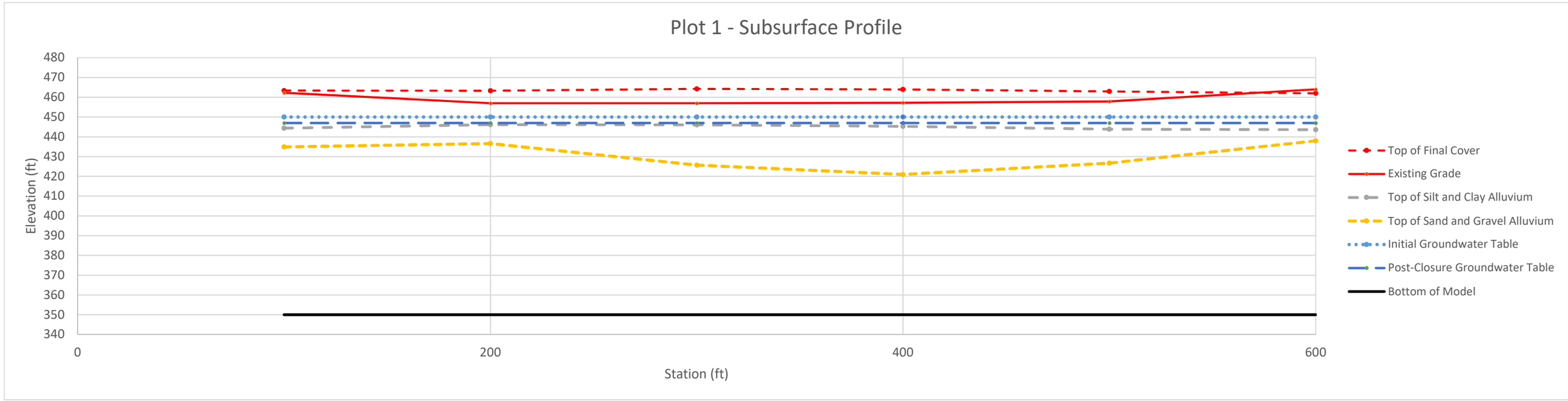
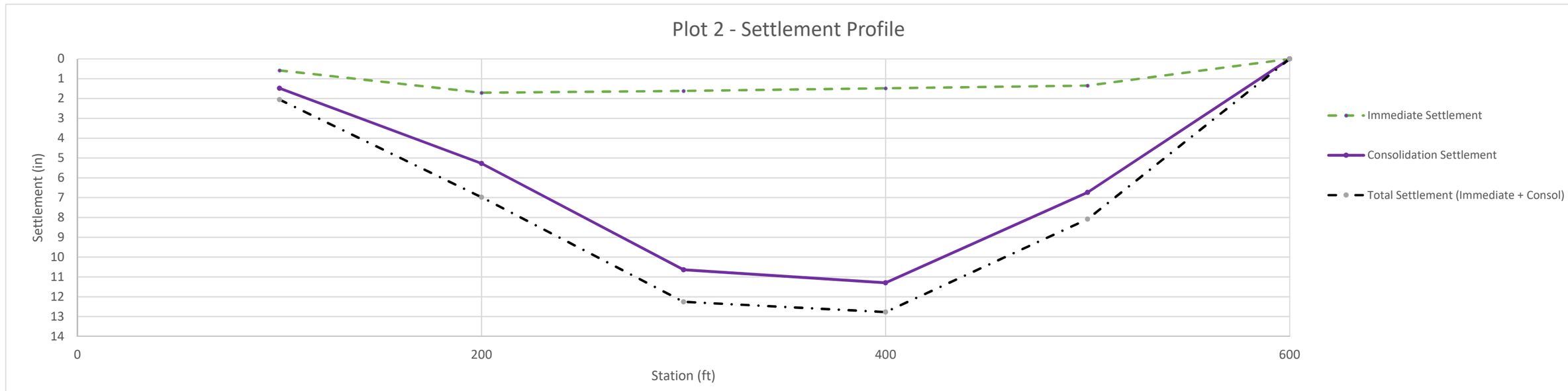
PROJECT NO: CHE8400 | MAY 2020

FIGURE 1

L:\CADD\DYNEGY\HENNEPIN\CLOSURE DESIGN - CHE8356B\FIGURES\8356B-F002 - Last Saved by: SNichols on 5/31/20





Notes:
1. Subsurface profiles and settlement values are interpolated between analysis points using straight lines. Actual profiles may vary slightly.
2. Immediate settlements refer to recompression settlement of the CCR, alluvial foundation soils, and elastic settlement of the underlying sand. Immediate settlement is expected to occur concurrently with the placement of fill.
3. Consolidation settlement refers to virgin compression of the alluvial clay and is expected to occur over several months to several years.

Settlement Section SS-1 Results

Dynegy - Hennepin Power Station
West Ash Pond System Closure

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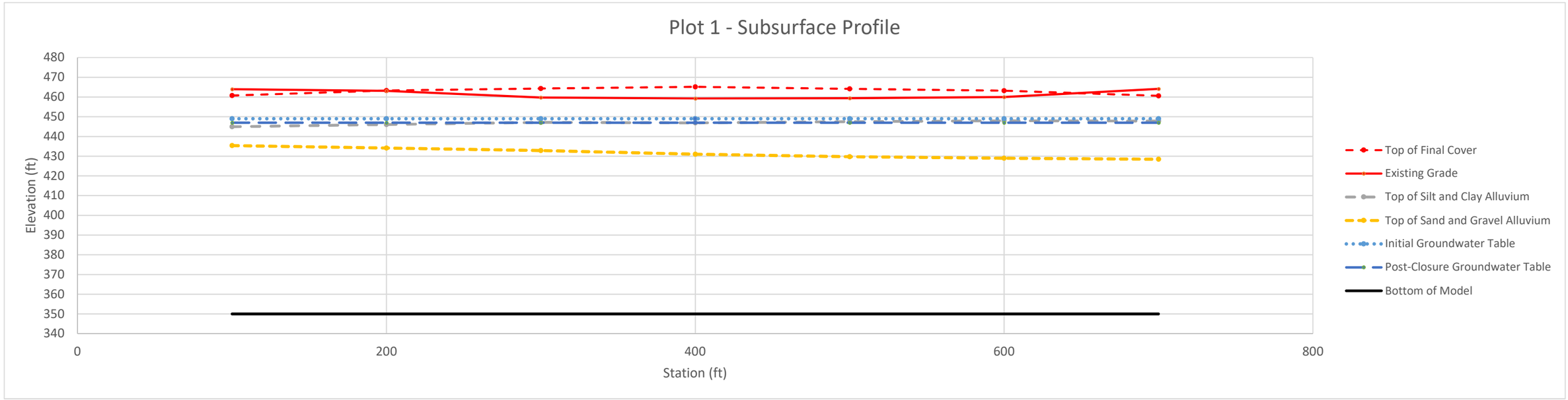
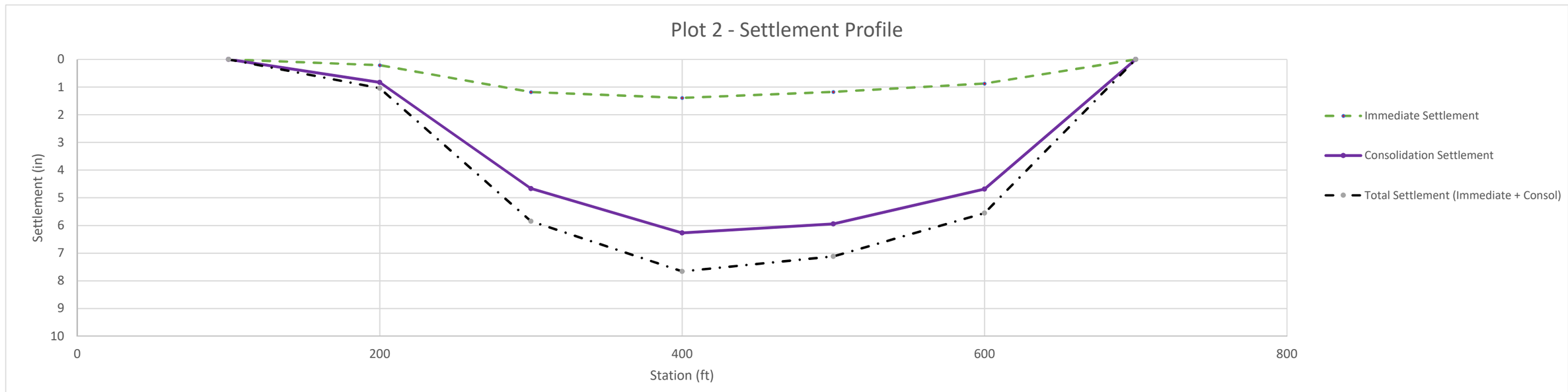
Figure SS-1





Notes:
1. Subsurface profiles and settlement values are interpolated between analysis points using straight lines. Actual profiles may vary slightly.
2. Immediate settlements refer to recompression settlement of the CCR, alluvial foundation soils, and elastic settlement of the underlying sand. Immediate settlement is expected to occur concurrently with the placement of fill.
3. Consolidation settlement refers to virgin compression of the alluvial clay and is expected to occur over several months to several years.

Settlement Section SS-2 Results

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West Ash Pond System Closure

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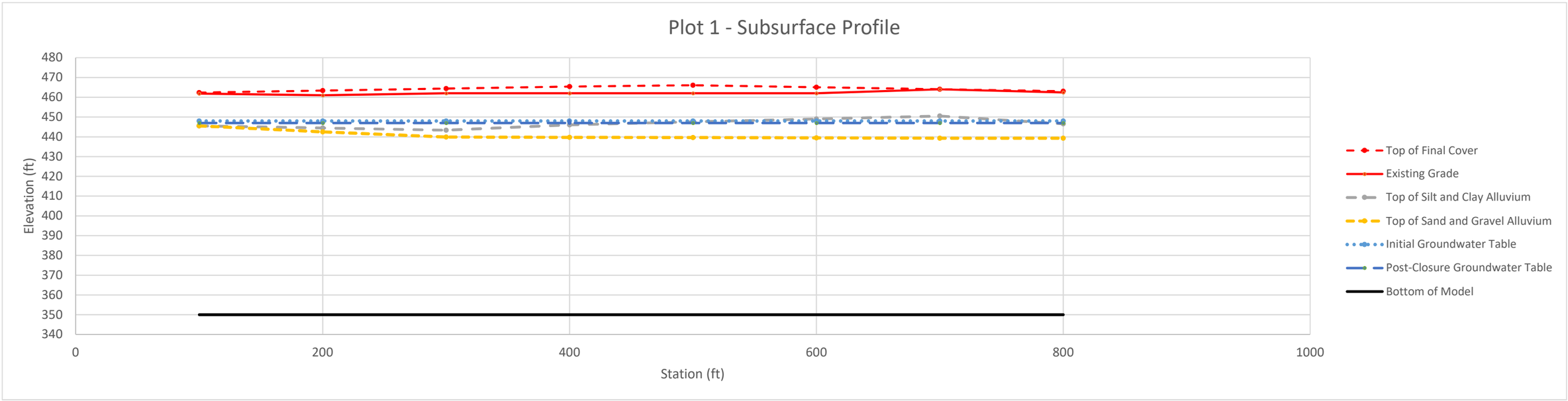
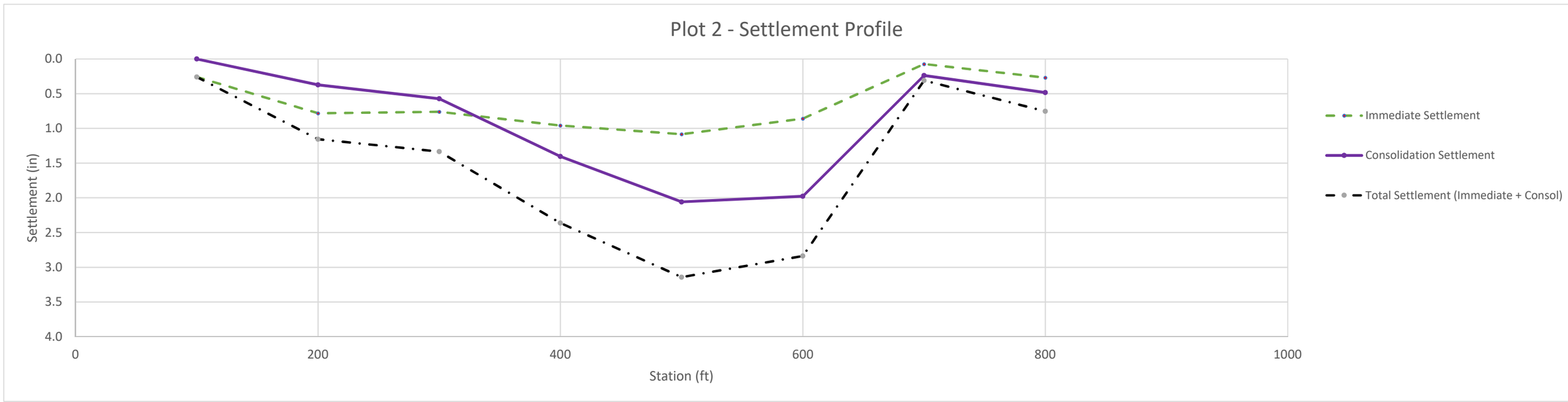
Figure SS-2





Notes:
1. Subsurface profiles and settlement values are interpolated between analysis points using straight lines. Actual profiles may vary slightly.
2. Immediate settlements refer to recompression settlement of the CCR, alluvial foundation soils, and elastic settlement of the underlying sand. Immediate settlement is expected to occur concurrently with the placement of fill.
3. Consolidation settlement refers to virgin compression of the alluvial clay and is expected to occur over several months to several years.

Settlement Section SS-3 Results

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West Ash Pond System Closure

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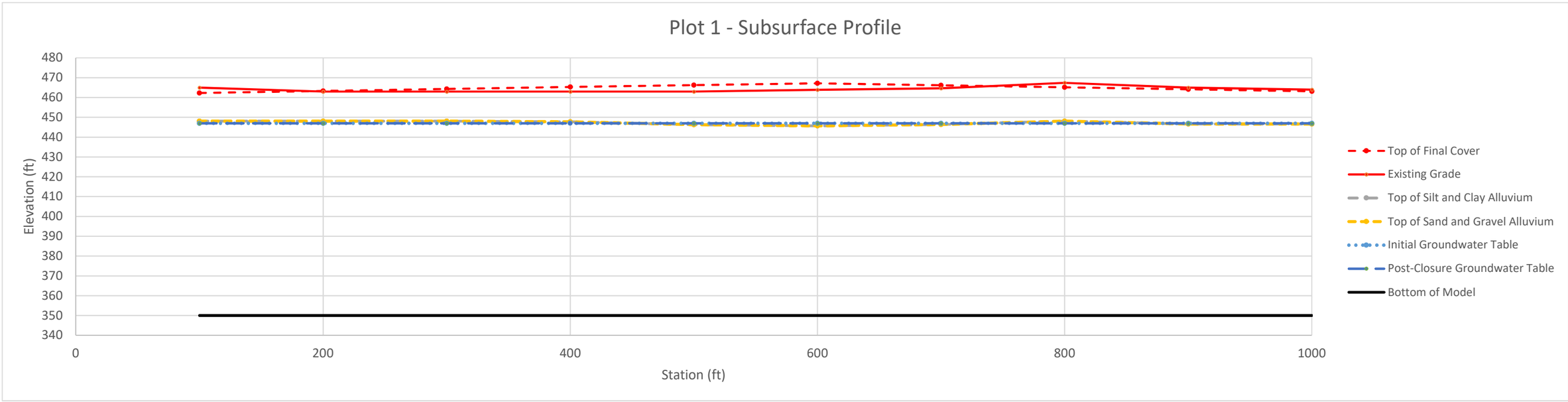
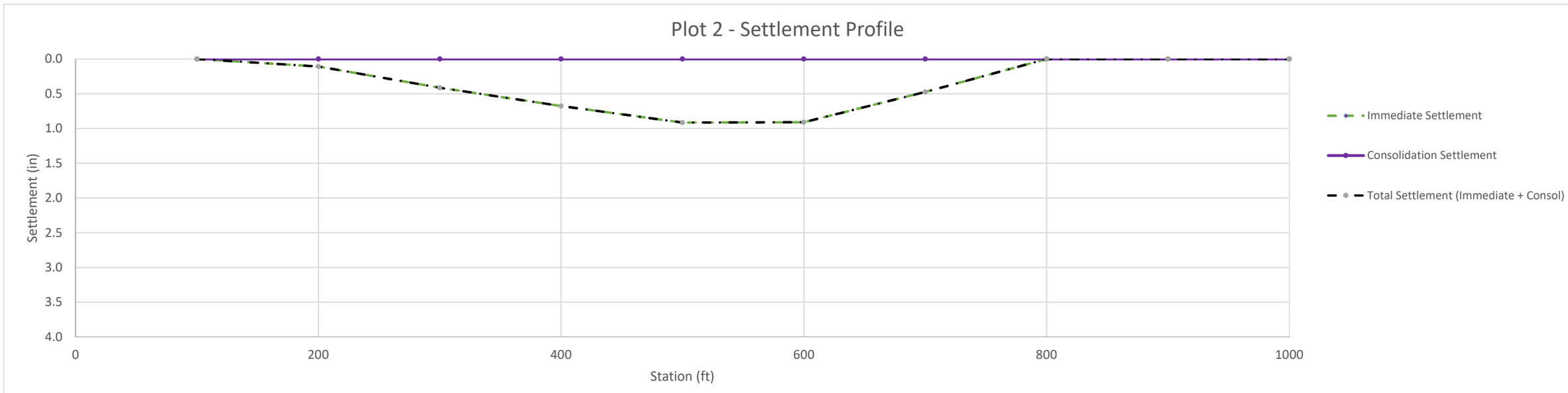
Figure SS-3





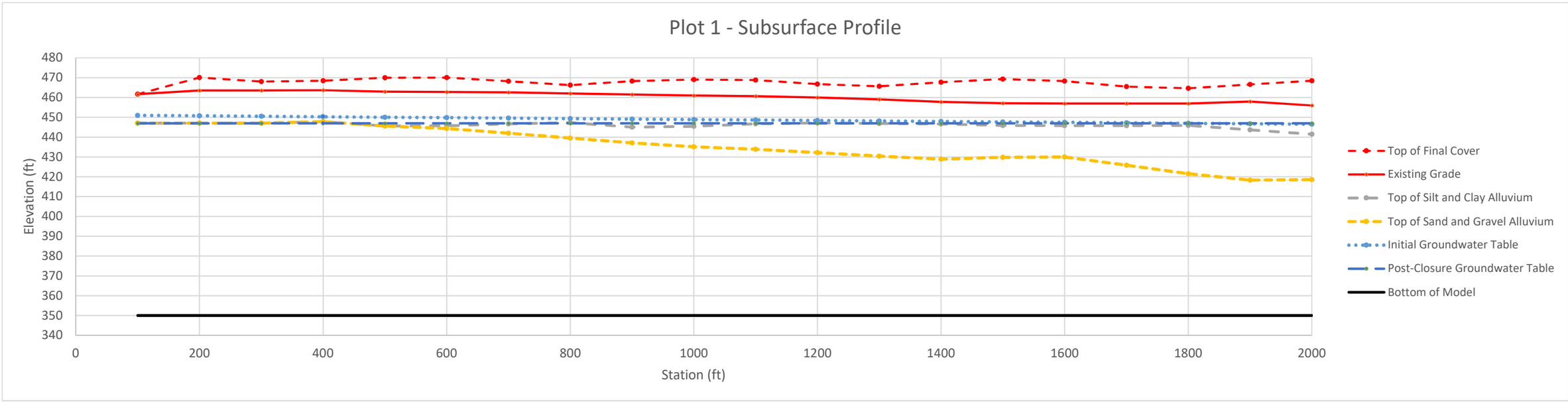
Notes:
1. Subsurface profiles and settlement values are interpolated between analysis points using straight lines. Actual profiles may vary slightly.
2. Immediate settlements refer to recompression settlement of the CCR, alluvial foundation soils, and elastic settlement of the underlying sand. Immediate settlement is expected to occur concurrently with the placement of fill.
3. Consolidation settlement refers to virgin compression of the alluvial clay and is expected to occur over several months to several years.

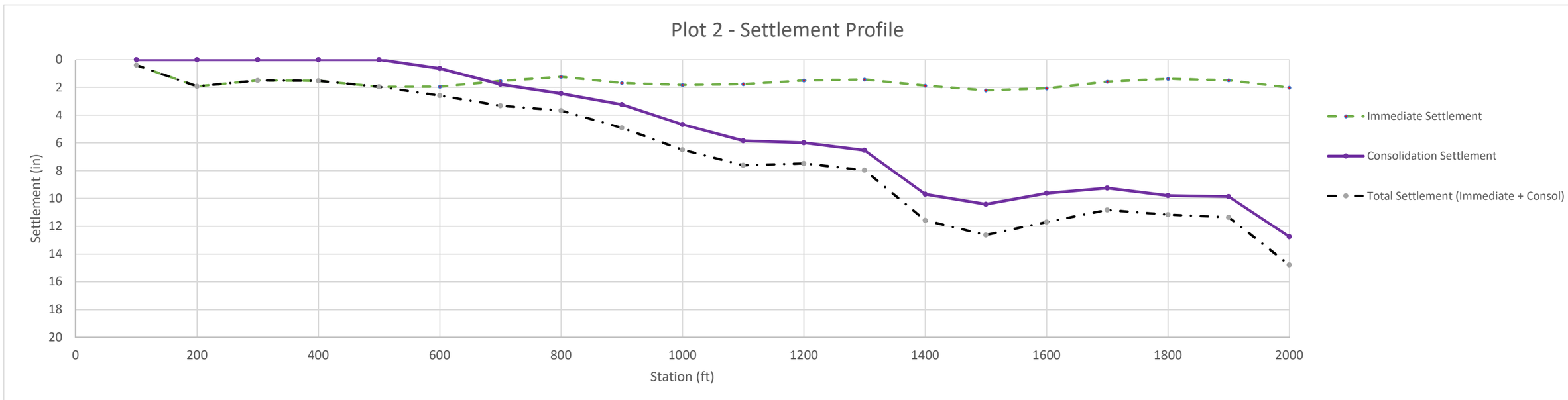
Settlement Section SS-4 Results

Dynegy - Hennepin Power Station
West Ash Pond System Closure

Geosyntec consultants

CHE8356B	July 2020	**Figure SS-4**





Notes:
1. Subsurface profiles and settlement values are interpolated between analysis points using straight lines. Actual profiles may vary slightly.
2. Immediate settlements refer to recompression settlement of the CCR, alluvial foundation soils, and elastic settlement of the underlying sand. Immediate settlement is expected to occur concurrently with the placement of fill.
3. Consolidation settlement refers to virgin compression of the alluvial clay and is expected to occur over several months to several years.

Settlement Section SS-5 Results

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West Ash Pond System Closure

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Figure SS-5

APPENDIX F

Puncture Analysis

Calculation of Actual Pressure on Geosynthetic Liner		
Parameter	Value	Notes
Cover Soil Thickness (ft)	2	per sheet C-410 of WAPS Closure Design Drawings
Cover Soil Unit Weight (pcf)	125	assumed typical total unit weight of soil
Ground pressure from Wheel loading (pcf)	2880	20 psi used per WAPS Closure Specificiations (maximum pressure over 24 inch thick cover)
Actual Pressure, p_{act} (psf)	3130	

Calculation of Allowable Pressure on SKAPS GE116 Geotextile		
Parameter	Value	Notes
Geotextile Mass per Unit Area, M (g/m^2)	543	per geotextile MQC Certs submitted by Chesapeake on March 5, 2020
Protrusion Height, H (m)	0.0599	per lab submittal by Shannon and Wilson (S&W) dated 4/29/2020
Modification Factor for Protrusion Shape, MF_s	0.25	per Table 1 of GRI White Paper #14 (2008) and S&W 4/29/2020 submittal
Modification Factor for Packing Density, MF_{PD}	1	per Table 1 of GRI White Paper #14 (2008)
Modification Factor for Arching in Solids, MF_A	0.75	per Table 1 of GRI White Paper #14 (2008)
Reduction Factor for Long-Term Chemical/Biological Degradation, RF_{CBD}	1.1	per Table 1 of GRI White Paper #14 (2008)
Reduction Factor for Long-Term Creep, RF_{CR}	1	per Table 1 of GRI White Paper #14 (2008)
Allowable Pressure, p_{allow} (kPa)	573	
Allowable Pressure, p_{allow} (psf)	11962	

Factor of Safety against Puncture, FS	4

Hennepin WAPS Closure	
Geotextile Puncture Resistance	
Vistra	Geosyntec consultants
CHE8400	
Created By: Zachary Fallert	
Checked By: David Kein/Jesse Varsho	
Date: 4/30/2020	

Calculation of Actual Pressure on Geosynthetic Liner		
Parameter	Value	Notes
Cover Soil Thickness (ft)	2	per sheet C-410 of WAPS Closure Design Drawings
Cover Soil Unit Weight (pcf)	125	assumed typical total unit weight of soil
Ground pressure from Wheel loading (pcf)	2880	20 psi used per WAPS Closure Specificiations (maximum pressure over 24 inch thick cover)
Actual Pressure, p_{act} (psf)	3130	

Calculation of Allowable Pressure on SKAPS GE116 Geotextile		
Parameter	Value	Notes
Geotextile Mass per Unit Area, M (g/m^2)	543	per geotextile MQC Certs submitted by Chesapeake on March 5, 2020
Protrusion Height, H (m)	0.0762	Assumed 3 inch maximum rock size.
Modification Factor for Protrusion Shape, MF_s	0.25	per Table 1 of GRI White Paper #14 (2008) and S&W 4/29/2020 submittal
Modification Factor for Packing Density, MF_{PD}	1	per Table 1 of GRI White Paper #14 (2008)
Modification Factor for Arching in Solids, MF_A	0.75	per Table 1 of GRI White Paper #14 (2008)
Reduction Factor for Long-Term Chemical/Biological Degradation, RF_{CBD}	1.1	per Table 1 of GRI White Paper #14 (2008)
Reduction Factor for Long-Term Creep, RF_{CR}	1	per Table 1 of GRI White Paper #14 (2008)
Allowable Pressure, p_{allow} (kPa)	446	
Allowable Pressure, p_{allow} (psf)	9327	

Factor of Safety against Puncture, FS	3

Hennepin WAPS Closure	
Geotextile Puncture Resistance	
Vistra	Geosyntec consultants
CHE8400	
Created By: Zachary Fallert	
Checked By: David Kein/Jesse Varsho	
Date: 4/30/2020	

APPENDIX G

Steel Sheet Pile Design Memo

CIORBA GROUP | Consulting Engineers

PROJECT MEMO

TO: Lucas Carr PE, Geosyntec Consultants
Project Engineer

FROM: William Bakos, EI / Alex Durbak PE, SE

CHECKED BY: Brett Sauter PE, SE, Structural Group Manager

DATE: 6/28/2018

REFERENCE: Hennepin Sheet Pile Wall Design

PROJECT NO.: 20890.01

Ciorba Group engineers performed an independent calculation to verify the design of the sheet pile wall along the west side of the Old West Ash Pond which will be installed to allow for closure-by-removal of the Old West Polishing Pond as shown in the plans dated April 13, 2018.

DESIGN ASSUMPTIONS

Ciorba Group engineers take no exception to the assumptions which were used to develop earth pressures. The summary of parameters (attached) as provided by Geosyntec Consultants on June 15th, 2018 was utilized in the verification calculations. In the independent calculation, the upper 1-foot of soil embedment was neglected for passive resistance.

INDEPENDENT CALCULATION METHOD AND RESULTS

Ciorba Group engineers performed independent spreadsheet calculations to verify the validity of the designed embedment depth and sheet pile section for the wall using Coulomb theory and the free earth support method. The wall was analyzed for both the drained and undrained condition. The sheet pile wall has a safety factor for overturning of 1.3 for a temporary wall which was applied by dividing the passive pressure by 1.3. The allowable steel stress was taken as 30 ksi.

The independent calculation resulted in similar calculated pressures and maximum moment, embedment depth requirement, and required section modulus of sheet pile as that prepared by Geosyntec, however the independent calculated deflections were higher than those prepared by Geosyntec. The free earth support method typically overestimates deflection calculations and the deflections that Geosyntec calculated using the CivilTech Shoring program, which uses an empirical method, are considered more reasonable. The results of the independent calculations confirm that the sheet pile section NZ 26 and the embedment as shown on the prefinal plans prepared by Geosyntec are adequate.

5507 N. Cumberland Avenue Chicago, Illinois 60656 Tel 773.775.4009 Fax 773.775.4014 www.ciorba.com

William Bakos

From: Brett W. Sauter, PE, SE
Sent: Tuesday, June 19, 2018 8:00 AM
To: William Bakos
Cc: Alexander P. Durbak, PE, SE
Subject: FW: Hennepin Earth and Hydrostatic Pressures for Sheet Pile Wall Design
Attachments: Attachment A - Cross Section A'.pdf

This is the information for project 20890.01.

Will send you another email as well with information.

Brett

CIORBA GROUP | Consulting Engineers
(773) 355-2936

From: Panos Andonyadis <PAndonyadis@Geosyntec.com>
Sent: Friday, June 15, 2018 4:43 PM
To: Brett W. Sauter, PE, SE <bsauter@ciorba.com>
Cc: Lucas Carr <LCarr@Geosyntec.com>; John Seymour <JSeymour@Geosyntec.com>
Subject: Hennepin Earth and Hydrostatic Pressures for Sheet Pile Wall Design

Brett,

Below is a detailed summary of how we developed the earth pressures used for design and tables with the earth and hydrostatic pressures to be used for your design. All of this was pulled from the package Lucas provided to you earlier. Please feel free to reach out to me with questions.

Cross-section Section A-A' (Attachment A) was used for design. This is considered the critical cross section because it has the largest unsupported wall height and a relatively thick zone of alluvial silts and clays within the subsurface. The same subsurface stratigraphy, soil properties, and groundwater conditions used for the slope stability analyses at Section A-A' were used for the steel sheet pile (SSP) wall design. The groundwater table behind the wall was assumed to be at El. 451 ft; this is the elevation measured by existing piezometers and the approximate normal pool elevation in the Old West Polishing Pond (OWPP) and was used because the sheet pile wall was assumed to be impermeable. The groundwater table in front of the wall as assumed equal to the closure-by-removal ground surface in the OWPP (El. 440.4 ft), resulting in 10.6 ft of hydrostatic imbalance. The proposed buttress at Section A-A' was not included in the analysis, as this buttress will not be constructed until after closure-by-removal of the OWPP is complete.

All loads were assumed static, and both drained and undrained loading conditions were considered for the temporary scenario.

Assumptions used to develop earth pressures

- For undrained analyses (ϕ=0, c=su), it is possible to calculate negative active earth pressures using classic earth pressure theory equations (e.g., Coulomb). For these analyses, negative active earth pressures were resolved to zero;
- The sheet piles will be free to deflect normal to the plane of the wall and thus active earth pressures will develop;
- Lateral earth pressures were calculated following Coulomb theory;

- A wall-to-soil interface friction angle of 10° was applied for all interfaces;
- There is a 14° slope immediately upslope of the wall;
- For the silt and clay alluvium, a drained friction angle of 30°, representing the shear strength determined from CIU triaxial tests, was used for earth pressure calculations instead of the friction angle calculated from direct shear strength tests. This is because the base angle of the active and passive wedges will be non-horizontal and oriented in a manner similar to a triaxial compression test, rather than a direct shear test;
- Seepage below the sheet pile tip was neglected because the sheet piling extends through the low permeability silt and clay alluvium unit and the sheet pile is assumed to act as a hydraulic cutoff;
- For undrained analyses, it was assumed that the CCR material would behave drained. Excess pore pressures that may develop within the CCR are expected to dissipate more rapidly than the native materials and thus behave drained relative to the native materials. Furthermore, assuming the CCR behaves drained imposes a greater load on the SSP wall which conservatively models the CCR loading on the SSP; and
- Calculated active and passive earth pressures are unfactored.

Summary of Parameters

Strata	**Unit Weight**		**Active Side Top Elev.**	**Passive Side Top Elev.**	**ϕ'**	**c'**	**δ**	**K_a**	**K_p**
	γ_{moist}	**γ_{sat}**							
	(pcf)	**(pcf)**	**(ft)**	**(ft)**	**(°)**	**(psf)**	**(°)**		
CCR-Unsat	99	99	454.2		33	0	10.0	0.33	4.80
CCR-Sat	99	99	450.9		33	0	0.0	0.35	3.39
Silt and Clay 1 (SCA1)	111	111	440.3	440.3	0	407	0.0	1.00	1.00
Silt and Clay 2 (SCA2)	111	111	428.3	428.3	0	678	0.0	1.00	1.00
Sand and Gravel (SGA)	125	125	405.8	405.8	38	0	10.0	0.26	6.22

Drained Condition Earth and Hydrostatic Pressures

Active		
Layer	Elevation (ft)	Pressure (psf)
CCR-Unsat	454.2	0
CCR-Sat	450.9	97
CCR-Sat	440.4	230
SCA1	440.3	272
SCA1	428.4	480
SCA2	428.3	489
SCA2	405.9	887
SGA	405.8	624
SGA	375	1117

Hydrostatic		
Layer	Elevation (ft)	Pressure (psf)
CCR-Unsat	454.2	0
CCR-Sat	450.8	6
SCA1	440.2	661
SGA	375	661

Passive		
Layer	Elevation (ft)	Pressure (psf)
SCA1	440.3	0
SCA1	428.4	2546
SCA2	405.9	7076
SGA	375	22693

Undrained condition Earth and Hydrostatic Pressures

Active		
Layer	Elevation (ft)	Pressure (psf)
CCR-Unsat	454.2	0
CCR-Sat	450.9	97

Hydrostatic		
Layer	Elevation (ft)	Pressure (psf)
CCR-Unsat	454.2	0
CCR-Sat	450.9	0

Passive		
Layer	Elevation (ft)	Pressure (psf)
SCA1	440.3	870
SCA1	428.4	1428

CCR-Sat	440.4	230
SCA1	440.3	0
SCA1	428.4	475
SCA2	428.3	0
SCA2	405.9	1027
SGA	405.8	624
SGA	375	1117

CCR-Sat	440.4	630
SCA1	440.3	661
SGA	375	661

SCA2	428.3	1995
SCA2	405.9	3064
SGA	405.8	10817
SGA	375	22693

Regards,

Panos Andonyadis, P.E.
Project Engineer
(licensed PE in IL)

---
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APPENDIX H.4
2018 GEOSYNTEC GEOTECHNICAL INVESTIGATION REPORT

Prepared for

Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

OLD WEST ASH POND AND OLD WEST POLISHING POND GEOTECHNICAL INVESTIGATION SUMMARY REPORT

at

Dynegy Midwest Generation, LLC

Hennepin Power Station

13498 East 800th Street
Hennepin, Illinois, 63127

Prepared by

Geosyntec consultants

engineers | scientists | innovators

134 N. LaSalle Street, Suite 300
Chicago, Illinois 60602

Project Number: CHE8356

February 2, 2018

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1. EXECUTIVE SUMMARY

A geotechnical investigation was performed for the Old West Ash Pond (OWAP) and Old West Polishing Pond (OWPP) at the Hennepin Power Station, located in Hennepin, Illinois. The Power Station is owned and operated by Dynegy Midwest Generation, LLC.

The geotechnical investigation results suggest that construction dewatering is unlikely to be required for excavation of CCR during closure construction of the OWAP. Subsurface conditions encountered during test pit excavations were favorable, and unsaturated CCR was encountered within and at least five feet below the bottom of proposed excavations. However, phreatic levels within the CCR may vary and potentially increase seasonally, based on local precipitation, changes in the pool level in the Illinois River, and/or other factors. Stormwater should be carefully managed during closure construction to prevent ponding in excavations, which may lead to saturation of the CCR.

Fill placement in the western portions of the OWAP will occur over CCR that becomes saturated at approximately three feet below grade. Temporary subgrade stabilization measures, such as haul road construction or bridging lifts, may be required to provide equipment access in this area. However, construction dewatering is not anticipated to be required in this area as stormwater and subgrade stabilization measures will be specified to be carefully managed.

For the OWPP, the dewatering study found that the perimeter dikes and foundation soils have relatively low permeabilities. This suggests that groundwater inflows during closure-by-removal construction will be relatively low and can likely be managed using a system of shallow trenches and pumped sumps for dewatering. Haul roads and/or work platforms may be needed to facilitate equipment access into the OWPP during excavation.

Closure construction for both the OWAP and OWPP may be affected by flooding events on the adjacent Illinois River. If a flood event were to occur during construction, it may cause an increase in groundwater levels within the OWAP and OWPP and promote increased seepage or surface water inflows. This may require work stoppages until the flood event recedes.

Geotechnical information was also collected to support the final design of the sheet pile wall and support closure-induced settlement analyses. The data collected from these investigations is expected to be sufficient for final design. Deep borings to estimate the depth to and type of bedrock at the site were not successful due to difficult drilling conditions. However, a publicly-available log for a water well drilled approximately one-half mile from the site indicates shale bedrock at a depth of approximately 100 feet below the crest of the OWAP.

2. PROJECT BACKGROUND

The purpose of this geotechnical investigation was to collect geotechnical data to support the final closure design of the OWAP and OWPP at the Hennepin Power Station. The geotechnical investigation included:

- Test pits and piezometers to evaluate the need for construction dewatering and the feasibility of trenches for construction dewatering of CCR within the OWAP;
- Piezometers and pumping tests to estimate in-situ hydraulic conductivity of soils at the OWPP, for use in calculating excavation inflows;
- Borings to confirm subsurface stratigraphy along the sheet pile wall between the OWAP and OWPP, for completing final wall design;
- Deep borings to estimate the depth to and type of bedrock beneath the OWAP, for evaluating the cost and feasibility of a deep cutoff wall for groundwater remediation; and
- Laboratory testing to estimate the index properties, compressibility, and permeability of CCR and soil for estimating post closure settlements and excavation inflows; and
- Laboratory testing to estimate the undrained shear strength of foundation soils along the proposed sheet pile wall, for completing final wall design.

The methods, results, and general conclusions from the geotechnical investigation are discussed in **Section 3**.

3. GEOTECHNICAL INVESTIGATION

The geotechnical investigation included a field investigation (**Section 3.1**) and laboratory investigation (**Section 3.2**). Summarized subsurface conditions are provided in **Section 3.3** and the results of limited engineering analyses of pumping and recovery tests are provided in **Section 3.4**.

3.1 Field Investigation

3.1.1 Old West Ash Pond Dewatering Investigation

The goal of the test pits was to evaluate the feasibility of dewatering saturated CCR using open trenches. This type of dewatering can be simulated using test pits. The instrumented test pits were intended to allow for the evaluation of drawdown of the phreatic surface adjacent to the test pits.

Instrumented test pit locations were selected to evaluate subsurface conditions at areas of greatest proposed cut where CCR was expected to potentially be saturated during closure construction. The non-instrumented test pit locations were selected to evaluate the spatial variability of CCR conditions across the OWAP.

The field investigation for the OWAP included digging nine test pits (GS-T01 through GS-T09). Three of the test pits (GS-T01 through GS-T03) were instrumented with two temporary standpipe piezometers each, located 5 and 30 feet from the edge of the test pit (GS-P01 through GS-P06).

3.1.1.1 Piezometers

The piezometers were installed using a hollow-stem auger drill rig owned and operated by Roberts Environmental Drilling, Incorporated (REDI Drill) of Millstadt, Illinois on November 7, 2017. Geosyntec supervised the piezometer installation and logged the subsurface materials at each piezometer by examining drill cuttings.

The bottom of each piezometer was installed approximately 10 feet below grade. The piezometers were entirely within CCR materials. Each piezometer included a five-foot long 0.010-inch slotted polyvinyl chloride (PVC) screen, FilterSil® No. 1 sand pack, and hydrated bentonite chip seal. Each piezometer included a temporary surface completion consisting of a two-inch solid PVC riser with approximately three feet of stickup above grade. A vented well cap was installed on each piezometer, and groundwater in the piezometers was allowed to reach hydrostatic equilibrium with the surrounding CCR over an eight-day period prior to advancing test pits. Piezometer construction details are

provided in **Table 1**, piezometer locations are provided in **Figure 1** and piezometer construction logs are provided in **Appendix B**.

Table 1 – Old West Ash Pond Piezometer Construction Details

Piezometer ID	Northing[1] (ft)	Easting[1] (ft)	Surface Elevation[1] (ft)	Total Depth (ft)	Screen Depths (ft)	Filter Pack Depth (ft)	Seal Depth (ft)	Casing Stick-Up (ft)
GS-P01A	1689162	2528812	464.2	10.1	4.8 - 9.8	4.0 - 10.1	0.0 - 4.0	3.0
GS-P02	1689147	2528823	464.4	10.4	5.1 - 10.1	3.8 - 10.4	0.0 - 3.8	3.0
GS-P03	1688339	2528457	464.6	10.1	4.8 - 9.8	9.0 - 10.1	0.0 - 4.0	3.0
GS-P04	1688335	2528482	464.7	10.3	5.0 - 10.0	4.0 - 10.3	0.0 - 4.0	3.0
GS-P05	1688361	2527512	460.5	10.3	5.0 - 10.0	4.0 - 10.3	0.0 - 4.0	3.0
GS-P06	1688360	2527539	460.5	10.3	5.0 - 10.0	4.0 - 10.3	0.0 - 4.0	3.0

[1]Piezometer locations were surveyed by IngenAE, LLC on January 17, 2018. Horizontal coordinates are in the NAD83 datum and elevations are in the NAVD88 datum.

3.1.1.2 Test Pits

The test pits were advanced by a trackhoe owned and operated by Gensini Excavation, Incorporated of Princeton, Illinois on November 15 and 16, 2017 under Geosyntec's supervision. Prior to excavating the instrumented test pits, the water levels in the adjacent piezometers, located 5- and 30 ft from each test pit, were checked and nearly all were found to be essentially dry.

Each of the instrumented test pits (GS-T01 through GS-T03) was excavated to approximately 10 feet below grade without encountering saturated CCR, groundwater inflows, or other unstable conditions. The sides of the test pit excavations stood vertically and did not cave during test pit excavation. The non-instrumented test pits were also successful and encountered similar subsurface conditions as the instrumented test pits, except for test pits GS-T07 and GS-T08; saturated CCR was encountered at depths of 3.0 and 5.8 ft, respectively. Test pit GS-T05 encountered several isolated pockets of CCR, but the pockets were not observed to be laterally or vertically continuous. Test pits GS-T05, GS-T07, and GS-T08 were located in areas of planned fill rather than excavation.

After excavation, the test pits were left open for 24 hours to hours to evaluate groundwater inflows. Eight of nine test pits were dry at 24 hours; GS-T07 accumulated approximately 8 inches of standing water. All test pits were backfilled on November 16, 2017. Test pit excavation details are provided in **Table 2**, test pit locations are provided in **Figure 1**, photographs of the test pits are provided in **Appendix A**, and test pit logs are provided in **Appendix C**.

Table 2 – Old West Ash Pond Test Pit Details

Test Pit ID	Northing[1] (ft)	Easting[1] (ft)	Surface Elevation[1] (ft)	Proposed Cut / Fill[2] (ft)	Total Depth (ft)	Depth to Saturated CCR[3] (ft)	Depth to Free Water after 24 Hours[3] (ft)
GS-T01	1689176	2528804	464.3	-3.0	10.0	NE	NE
GS-T02	1688346	2528447	464.9	-6.0	10.0	NE	NE
GS-T03	1688361	2527502	461.1	-3.0	10.0	NE	NE
GS-T04	1688934	2528886	464.7	-1.5	10.8	NE	NE
GS-T05	1688881	2528697	464.1	+2.0	10.4	NE	NE
GS-T06	1688590	2528822	463.0	-1.0	10.4	NE	NE
GS-T07	1688711	2527343	455.4	+4.0	5.0	3.0	4.8
GS-T08	1688422	2527538	456.4	+2.0	7.0	5.8	NE
GS-T09	1688411	2528388	461.3	-1.0	10.4	NE	NE

[1]Test pit locations were surveyed by IngenAE, LLC on January 17, 2018. Horizontal coordinates are in the NAD83 datum and elevations are in the NAVD88 datum.

[2]Fill is denoted with a "+" while cut is denoted with a "-"

[3]NE = Not Encountered

3.1.2 Old West Polishing Pond Permeability Investigation

The goal of the piezometer installation and testing was to collect data on soil types and permeability for use in estimating groundwater inflows during closure-by-removal excavation of the OWPP.

The field investigation for the OWPP included installing and sampling two piezometers (GS-P07 and GS-P08) down into foundation soils below the base of the proposed excavation. Instrumented pumping and recovery tests were performed on GS-P07, GS-P08, and existing piezometer HEN-P001.

3.1.2.1 Piezometers

The piezometers were installed on November 11, 2017 under Geosyntec supervision using the same hollow-stem auger drill rig and crew as the OWAP piezometers. The piezometers were continuously sampled during advancement, primarily using the Standard Penetration Test (SPT) (ASTM International, 2011) technique, although limited Shelby tube (ASTM International, 2015) samples were also collected for laboratory permeability testing of the foundation clay beneath the OWPP dikes.

The piezometer borings were advanced until native soils were encountered and then each piezometer was constructed using a 10-foot long 0.010-inch slotted PVC screen, FilterSil® No. 1 sand pack, and hydrated bentonite chip seal. Both piezometers included a temporary surface completion consisting of a two-inch diameter solid PVC riser with approximately three feet of stickup above grade. A vented well cap was installed on each piezometer and the piezometers were allowed to reach hydrostatic equilibrium with the surrounding soil for six days prior to performing the groundwater recovery tests.

Piezometer construction details are provided in **Table 3**, piezometer locations are provided in **Figure 1**, and piezometer construction logs are provided in **Appendix B**.

Table 3 – Old West Polishing Pond Piezometer Construction Details

Piezometer ID	Northing[1] (ft)	Easting[1] (ft)	Surface Elevation[1] (ft)	Total Depth (ft)	Screen Depths (ft)	Filter Pack Depth (ft)	Seal Depth (ft)	Casing Stick-Up (ft)
GS-P07	1688524	2526764	459.2	20.0	9.7 - 19.7	9.0 - 20.0	0.0 - 9.0	3.0
GS-P08	1688312	2527027	458.7	18.3	8.0 - 18.0	7.0 - 20.3	0.0 - 7.0	3.0

[1]Piezometer locations were surveyed by IngenAE, LLC on January 17, 2018. Horizontal coordinates are in the NAD83 datum and elevations are in the NAVD88 datum.

3.1.2.2 Pumping and Recovery Testing

Instrumented pumping and recovery tests were performed by Geosyntec on November 16, 2017. Tests were performed at piezometers GS-P07, GS-P08, and HEN-P001. The pumping piezometers were instrumented with stand-alone pressure transducers (In-Situ Level TROLLs 700®) and data loggers to collect water level measurements during the pumping tests. A Proactive Hurricane XL pump was placed at the bottom of each piezometer casing and a pressure transducer was placed approximately one foot above the pump. Manual groundwater level measurements were also collected during pumping to verify pressure transducer data.

Water level measurements were collected by the dataloggers at approximately one-minute time intervals during pumping and recovery. The piezometers were pumped at rates between 1.68 L/min (0.5 gallons per minute [gpm]) to 3.04 L/min (0.8 gpm) for durations between 3.5 and 21 minutes, as necessary to pump most water out of the piezometers. Measurements were collected during well recovery for durations between approximately 30 and 182 minutes, as necessary for the water level in the piezometer to rebounded to within 0.5 feet of the pre-pumping water level.

Photographs of the recovery testing setup are provided in **Appendix A**.

3.1.3 Old West Ash Pond Sheet Pile, Slurry Wall, and Soil Compressibility Investigation

The field investigation program for the OWAP included six borings. Two borings were drilled in the OWAP (GS-B01 and GS-B02) for collecting samples of CCR and alluvial clay for consolidation testing and for evaluating the depth and type of bedrock for potential design of a slurry containment wall. Four borings (GS-B03 through GS-B06) were drilled along the alignment of the sheet pile wall to assess subsurface conditions and support final design of the wall.

The geotechnical borings were advanced between November 7 and 11, 2017, using a drill rig owned and operated by REDI Drill of Millstadt, Illinois. Geosyntec supervised the drilling and logged the subsurface materials at each boring. The borings were advanced using hollow-stem augers and mud-rotary techniques.

Table 4 – Old West Ash Pond Boring Details

Boring ID	Northing[1] (ft)	Easting[1] (ft)	Surface Elevation[1] (ft)	Total Depth (ft)
GS-B01	1688362	2527555	460.9	31.0
GS-B02	1689138	2528829	464.6	9.0
GS-B03	1688617	2527230	460.1	55.5
GS-B04	1688435	2527245	459.1	45.5
GS-B05	1688777	2527235	459.2	20.5
GS-B06	1688347	2527250	458.4	21.0

[1]Boring locations were surveyed by IngenAE, LLC on January 17, 2018. Horizontal coordinates are in the NAD83 datum and elevations are in the NAVD88 datum.

Several problems were encountered in the drilling of boring GS-B01, including:

- Difficulties in reaching the boring location with the driller's service truck,
- Significant loss of drilling fluid into pervious gravel foundation soils, and
- Refusal on cobbles and/or boulders at 30.5 ft below ground surface (bgs).

Based on these difficulties, Geosyntec and Dynegy jointly agreed to abandon the collection of deep boring data at the site. Bedrock borings, if deemed necessary at a later date, should be advanced using another drilling technology, such as sonic drilling, to penetrate the cobbles/boulders.

Boring details are provided in **Table 4**, boring locations are shown in **Figure 1**, and boring logs are provided in **Appendix D**.

3.2 Laboratory Investigation

Laboratory testing was performed on samples of soil and CCR to evaluate the index properties, permeability, strength, and compressibility. The laboratory test program included:

- 8 Atterberg limits tests in accordance with ASTM D4318 (ASTM International, 2017)
- 8 Grain size analyses in accordance with ASTM D422 (ASTM International, 2007)
- 4 Grain size analyses with hydrometer testing in accordance with ASTM D422 (ASTM International, 2007)
- 24 Natural moisture content tests in accordance with ASTM D2216 (ASTM International, 2010)
- 1 Specific gravity test in accordance with ASTM D854 (ASTM International, 2014)
- 3 Unconsolidated-undrained triaxial compression tests in accordance with ASTM D2850 (ASTM International, 2015)
- 4 Incremental consolidation tests in accordance with ASTM D2435 (ASTM International, 2011)
- 6 Flexible wall hydraulic conductivity tests in accordance with ASTM D5084 (ASTM International, 2016)

Summarized laboratory testing results, and individual laboratory test results sheets, are provided in **Appendix E**.

3.3 Summary of Subsurface Conditions

3.3.1 Old West Ash Pond CCR

The CCR within the Old West Ash Pond can generally be classified as a cohesionless silt (ML) or silty sand (SM) based on the laboratory testing results. The CCR was found to be predominantly fly ash, with only limited amounts of bottom ash and slag present. The fines content of the material ranged from 87 to 95 percent, and the vertical permeability ranged from 6.7×10^{-6} to 1.4×10^{-5} centimeters per second (cm/sec), with a geometric mean value of 1.2×10^{-5} cm/sec.

Data from the test pits, when combined with existing boring and piezometer data from the OWAP (AECOM, 2015), (Civil and Environmental Consultants, 2017) indicated that CCR within the OWAP is generally unsaturated to at least 10 ft below grade over the eastern portions of the OWAP. Towards the western portions of the OWAP, the CCR became saturated at approximately three to seven feet below grade around the perimeter of the pond. These conclusions are based on a limited amount of piezometric data within the CCR and correspond to a relatively low pool elevation on the adjacent Illinois River[1]. Phreatic levels may change seasonally based on local precipitation and/or fluctuations in the pool level in the adjacent Illinois River. Additional piezometric data will be collected by Dynegy from piezometers screened within CCR and installed in 2017 by this study and others (Civil and Environmental Consultants, 2017) and will provide additional information on fluctuations in phreatic levels.

Phreatic levels likely decline from west to east because the eastern side of the OWAP is underlain by permeable sand and gravel that allows for vertical drainage of surface water into the foundation soils. The western side of the OWPP is underlain by low-permeability silt and clay; this impedes the flow of surface water into the foundation soils. Additionally, the surface grade of the OWAP decreases in elevation from east to west; this may result in temporary ponding of surface water on the surface of the OWAP after rainfall events.

3.3.2 Old West Polishing Pond Dike and Foundation Soils

Data from Geosyntec's piezometers (GS-P07 and GS-P08), when combined with existing boring and piezometer logs (AECOM, 2015), indicates that the OWPP perimeter dike was constructed in two stages. The first stage (original dike) was constructed on the alluvial foundation soils and a sand and gravel dike raise was constructed over the original dike at a later date.

The sand and gravel dike raise was present from the top of the dike to depths ranging from 6 to 10 ft, and consists of a loose to very dense coarse-grained soils including poorly-graded gravel (GP), clayey gravel (GC), poorly-graded sand (SP), silty sand (SM), and

[1] The pool level at the time of the field exploration was approximately El. 443 ft on the La Salle, IL gauging station (United States Army Corps of Engineers, 2018), located approximately 12 miles upriver from the Hennepin Power Station. The historic normal stage for November is approximately El. 442 ft. Annual historic normal stages vary from approximately El. 447 ft in May to El. 441 ft in October. During 2017, the maximum pool level recorded by the La Salle, IL gauging station was El. 457 ft on May 2nd, and flood stage is El. 450 ft. All elevations recorded by the La Salle, IL gauging station are in the NGVD29 datum, and are approximately 0.2 ft higher than the NAVD88 datum at the Hennepin Power Station.

clayey sand (SC) with a trace of coal fragments and slag. One sieve analysis was performed and measured a fines content of 24%.

The original dike was present between the bottom of the sand and gravel dike raise to depths ranging from 15 to 16 ft. It consisted of a mixture of medium dense to very stiff silt (ML) and silty sand (SM), with intermingled coal fragments and boiler slag. Fines contents of this material were measured to range from 20 to 61%, with a mean value of 48%.

Alluvial foundation materials were present between the bottom of the original dike and consist of soft lean clay (CL) and fat clay (CH) with fine contents ranging from 64 to 96%. Two flexible-wall hydraulic conductivity tests were performed on this material, and measured vertical hydraulic conductivities of 4.5×10^{-8} cm/sec and 7.5×10^{-8} cm/sec, with a geometric mean value of 6.0×10^{-8} cm/sec. The mass hydraulic conductivity of the alluvial foundation materials may be higher than the laboratory measurements from individual specimens. Sand and gravel alluvium was found to be present immediately below the cohesive alluvial foundation materials.

3.3.3 CCR and Alluvial Clay Compressibility

CCR within the OWAP had relatively low compressibility based on two consolidation tests performed on the material, with recompression indices (C_r) of 0.025 and 0.010. The CCR maximum past pressure (P'_p) of the CCR was estimated to be 1.9 and 1.0 tons per square foot (tsf); this indicates apparent over consolidation of the CCR.

Two consolidation tests were performed by Geosyntec on samples of alluvial clay collected from beneath the OWAP and one test was performed by AECOM in 2015 (AECOM, 2015). One of the Geosyntec tests (GS-B04 from 33.5 to 35.5 ft) was found to be highly compressible. The sample was noted by the testing laboratory as likely containing organic material, and is therefore considered an outlier. The remaining consolidation tests performed by Geosyntec and AECOM measured recompression indices of 0.03 for both samples and compression indices of 0.26 and 0.35. The maximum past pressure of the alluvial clay was measured to be 0.7 and 2.1 tsf, indicating over consolidation ratios ranging from approximately 1 to 2.

3.3.4 Sheet Pile Wall Alignment

Four borings were drilled along the sheet pile wall alignment. Two deep borings (GS-B03 and GS-B04) were drilled to collect information on the material interfaces and strengths along the maximum section of wall alignment, while two shallow borings (GS-

B05 and GS-B06) were drilled near the north and south limits of the wall to confirm the limits of CCR materials along the wall alignment.

Deep borings GS-B03 and GS-B04 borings encountered CCR to maximum depths of 19.0 and 18.5 feet, and alluvial clay from the bottom of the CCR to maximum depths of 48.5 and 38.5 feet. Sand and gravel alluvium was encountered immediately below the alluvial clay. The deep borings were terminated within the sand and gravel alluvium at depths of 55.5 and 45.5 ft, respectively.

Shallow boring GS-B05, drilled at the north end of the proposed wall, did not encounter CCR material. Shallow boring GS-B06, drilled at the south end of the proposed wall, only encountered CCR between five and nine feet in depth.

Undrained shear strengths from unconsolidated-undrained triaxial compression testing on three samples of alluvial clay were found to be approximately 460 psf at a depth of 25 feet and 870 psf at a depth of 34 feet. The measured shear strengths are consistent with a normally-consolidated alluvial clay.

3.3.5 Depth to Bedrock

The planned bedrock borings were not successful, as discussed in **Section 3.1.3**. A drilling log for a water well installed approximately one-half mile southwest of the OWPP, within the Illinois River floodplain, was obtained (Illinois State Geological Survey, 2017). This log indicates shale bedrock at a depth of 83 feet, overlain by gravel and sand. Boulders were noted between depths of 4 to 18 feet and 26 to 33 feet. This water well represents the best currently-available bedrock data for the site, and is provided in **Appendix F**.

3.4 Engineering Analysis – Old West Polishing Pond

The hydraulic conductivity and transmissivity of the OWPP original dikes were estimated using the instrumented pumping and recovery test data. The dikes were modeled as an unconfined, unconsolidated water-bearing unit, with a boundary layer of alluvial clay foundation materials at a depth of approximately 16 ft. The thickness of the water-bearing unit was measured from the static water level before pumping to the top of the alluvial clay foundation materials.

Data from the instrumented pumping and rebound tests were analyzed using AQTESOLV, Version 4.50 (HydroSOLVE Inc, 2002) software using three analytical methods including (Theis, 1935), (Jacob, 1946), and (Neuman, 1974). Unconfined water table corrections were used for each analytical method.

Based on the analysis, the hydraulic conductivity of the OWPP original dikes ranged from approximately 2.6×10^{-6} cm/sec at GS-P08 to 2.9×10^{-5} cm/sec at GS-P07, with a geometric mean value of 8.2×10^{-6} cm/sec for all piezometers. These values are consistent for silty materials with relatively high fines contents. A summary of the results is provided in **Table 5**.

Table 5 – Old West Polishing Pond Hydraulic Conductivity Results

Well ID	Water-Bearing Unit Thickness (ft)	Water-Bearing Unit Type	Method	Hydraulic Conductivity (cm/sec)
GS-P07	6.5	Unconfined	Theis (1935)	4.6E-05
			Cooper-Jacob (1946)	9.5E-06
			Neuman (1974)	5.8E-05
			Geometric Mean	2.9E-05
GS-P08	6.5	Unconfined	Theis (1935)	2.1E-06
			Cooper-Jacob (1946)	3.0E-06
			Neuman (1974)	2.8E-06
			Geometric Mean	2.6E-06
HEN-P001	4	Unconfined	Theis (1935)	6.0E-06
			Cooper-Jacob (1946)[1]	1.1E-02
			Neuman (1974)	7.6E-06
			Geometric Mean	6.7E-06

[1]Value is assumed to be an outlier and is not considered in the mean hydraulic conductivity.

4. CONCLUSIONS

Data collected from the geotechnical investigation will be used to complete final design of the OWAP and OWPP closure. Preliminary conclusions based on these data include:

- Phreatic levels in the CCR in the OWAP were at least five feet below the bottom of proposed excavation grades. In areas where fill will be placed, phreatic levels ranged from 3 to over 10 feet below grade. Small, isolated, saturated pockets of CCR were encountered above the phreatic surface in one test pit but were not found to be laterally or vertically continuous.
- Phreatic levels in the CCR may vary seasonally due to local precipitation and/or fluctuations in the adjacent Illinois River pool level. The lowest cut elevation in the OWAP is approximately El. 458 ft; this is approximately 8 ft above flood stage on the adjacent Illinois River (El. 450 ft) and approximately 1 ft above the maximum Illinois River pool level recorded during 2017 (El. 457 ft). Temporary work stoppages may be required if flooding occurs on the adjacent Illinois River, as the flooding could saturate CCR above levels observed during the field exploration.
- The presence low-permeability clay underneath the OWAP may result in perched phreatic conditions within the OWAP if high local rainfall occurs. While these conditions were not encountered within areas of proposed excavation during the field exploration, they could occur during construction as a result of local precipitation.
- Excavations within the OWAP can likely be completed using conventional earthwork equipment, without the need for construction dewatering. However, stormwater will need to be carefully managed during construction to prevent temporary ponding within excavations, which may saturate the surrounding CCR. Excavations should include provisions to temporarily direct stormwater into sumps or shallow basins for prompt removal by pumping. Stormwater, if allowed to pond within the excavations, may destabilize the excavations.
- Fill placement within the western portions of the OWAP may occur over CCR that is saturated at three feet or less below the ground surface. Temporary subgrade stabilization may be required to support equipment access in these areas. Methods for stabilization may include the construction of access roads or placement of bridging lifts to allow for equipment access.
- Closure-by-removal excavation of the OWPP can likely be completed using a system of shallow trenches and pumped sumps to control excavation inflows. Excavation inflow quantities will be estimated during final design. Temporary

subgrade improvements, including haul roads and/or work platforms, may be required to allow for equipment access into the OWPP during excavation.

- Closure-by-removal excavation of the OWPP may be affected by flood events on the adjacent Illinois River. The rim elevation of the excavation will be approximately El. 450 ft, which is equal to the Illinois River flood stage. The bottom elevation of the excavation is approximately equal to the mean annual historic normal river elevation of El. 443 ft. Temporary work stoppages may be required if a flood event occurs on the Illinois River during construction, and such a flood event may fill the excavation with water through either increased seepage inflows or overtopping. Careful staging of the excavation during should be performed to remove CCR from inside of the excavation prior to removing the perimeter dikes to reduce the potential of floodwater contact with CCR. The existing crest elevation of the OWPP perimeter dikes is approximately El. 459 ft; this is approximately nine feet above flood stage on the Illinois River.
- Bedrock at the site is anticipated to be present approximately 100 ft below grade, but the depth was unable to be verified at the OWAP. If bedrock data is deemed necessary at a later date, it should be collected using a drilling technique that can penetrate through boulders and cobbles, such as sonic drilling.

Note that the results of the investigation are applicable to the conditions at the time of the investigation and future results may be different as environmental and climate conditions change.

5. LIMITATIONS

The conclusions and recommendations presented in this report are based on a limited subsurface investigation program performed by Geosyntec and others. Subsurface conditions may vary between exploration locations. Additionally, observed phreatic conditions within CCR and foundation soils may change seasonally based on precipitation, levels in the Illinois River, and other factors.

Information provided by Dynegy and/or their contractors was used in the preparation of this report. Geosyntec has assumed that such information is correct and has not verified and is not responsible for the accuracy of such provide information.

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FIGURES

P:\JAX-CAD\D\DYNEGY\HENNEPIN WEST ASH POND SYSTEM\CLOSURE PROJECT - CHE8356\DRAWINGS (OPTION IV)\CHE8343 F007 (GEOTECHNICAL) (OPTION IV)

ILLINOIS RIVER

OLD WEST POLISHING POND

OLD WEST ASH POND

HEN-B007 HEN-C005A HEN-B006 HEN-B005 HEN-C004 HEN-B004 HEN-B019 HEN-B018 / HEN-P001 HEN-C019 HEN-B016 HEN-B017 HEN-C017 HEN-B001 HEN-C002 HEN-B003 HEN-B002 HEN-C012 HEN-C013B HEN-C014 HEN-B009 HEN-C007B HEN-B008 HEN-C006 HEN-C008B HEN-B010 HEN-C009 HEN-B011 HEN-B012 HEN-C010 HEN-B014 HEN-C015 HEN-B015

GS-B01 GS-B02 GS-B03 GS-B04 GS-B05 GS-B06

GS-P01 GS-P02 GS-P03 GS-P04 GS-P05 GS-P06 GS-P07 GS-P08

GS-T01 GS-T02 GS-T03 GS-T04 GS-T05 GS-T06 GS-T07 GS-T08 GS-T09

B1/LPZ-1 B2 B3/LPZ-3 B4 B5/LPZ-5 B6 B7 B8 B9 B10 B11 B12 B13/LPZ-13 B14 B15 B16 B17 B18 B19 B20

P-1 P-2 P-3 P-4 P-5 P-6 P-7 P-8 P-9

LEGEND

450	EXISTING CONTOUR ELEVATION
	OLD WEST ASH POND SURVEY LIMIT
B1/LPZ-1	EXISTING BORING LOCATION
GS-B02	2017 GEOSYNTEC BORING LOCATION
GS-P01	2017 GEOSYNTEC TEMPORARY PIEZOMETER LOCATION
GS-P07	2017 GEOSYNTEC COMBINED BORING AND TEMPORARY PIEZOMETER LOCATION
GS-T01	2017 GEOSYNTEC TEST PIT LOCATION

NOTES:

1. COORDINATES AND DIRECTIONS SHOWN ON THIS DRAWING ARE BASED ON ILLINOIS STATE PLANE COORDINATE SYSTEM (NAD83) (US FEET). ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) (US FEET).
2. ALL 2017 GEOSYNTEC BORINGS, PIEZOMETERS, AND TEST PIT LOCATIONS WERE TAKEN FROM SURVEY DATA COLLECTED BY INGENAE, LLC ON JANUARY 17, 2018.
3. LOCATIONS OF 2015 AECOM BORINGS AND CPTS (HEN- PREFIX) WERE TAKEN FROM SURVEY DATA COLLECTED BY WEAVER CONSULTANTS IN 2015, WHERE AVAILABLE. IF SURVEY DATA WAS NOT AVAILABLE FOR A 2015 AECOM BORING OR CPT, THE LOCATION WAS ESTIMATED BASED ON COORDINATES REPORTED IN THE 2016 AECOM "30% DESIGN DATA REPORT FOR DYNEGY HENNEPIN POWER STATION", DATED JANUARY 12, 2016.
4. LOCATIONS OF 2016 CEC OLD WEST POLISHING POND AND 2017 CEC OLD WEST ASH POND BORINGS WERE TAKEN FORM AN AUTOCAD FILE PROVIDED BY CED TITLED "BORING LOCATION MAP, OLD WEST ASH POND SYSTEM, HENNEPIN POWER STATION", DATED MARCH 29, 2017.

N

0 200

HORIZONTAL SCALE IN FEET

BORING, PIEZOMETER, AND TEST PIT LOCATION PLAN
HENNEPIN - OLD WEST ASH POND COMPLEX

Geosyntec consultants

PROJECT NO: CHE8356 | JANUARY 2018 | FIGURE 1

APPENDIX A

Field Investigation Photographs

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 1 Date: 11/15/2017 Comments: Test pit GS-T01 spoils pile. Note unsaturated nature of excavated CCR.	
Photograph 2 Date: 11/15/2017 Comments: Test pit GS-T01, immediately after excavation to 10.0 ft. Note vertical sides of excavation and lack of groundwater inflows or saturated CCR.	

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 3

Date: 11/16/2017

Comments:
Test pit GS-T01, 1 day after excavation.

Photograph 4

Date: 11/15/2017

Comments:
Test pit GS-T02 spoils pile. Note unsaturated nature of excavated CCR.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 5

Date: 11/15/2017

Comments:
Test pit GS-T02, immediately after excavation to 10.0 ft. Note vertical sides of excavation and lack of groundwater inflows or saturated CCR. Also note stratified nature of CCR, including bottom ash, soil, and fly ash.

Photograph 6

Date: 11/16/2017

Comments:
Test pit GS-T02, 1 day after excavation.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 7

Date: 11/15/2017

Comments:
Test pit GS-T03 spoils pile. Note unsaturated nature of excavated CCR.

Photograph 8

Date: 11/15/2017

Comments:
Test pit GS-T03, immediately after excavation to 10.0 ft. Note vertical sides of excavation and lack of groundwater inflows or saturated CCR.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 9 Date: 11/16/2017 Comments: Test pit GS-T03, 1 day after excavation.	
Photograph 10 Date: 11/15/2017 Comments: Test pit GS-T04 spoils pile. Note unsaturated nature of excavated CCR.	

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 11

Date: 11/15/2017

Comments:
Test pit GS-T04, immediately after excavation to 10.8 ft. Note vertical sides of excavation and lack of groundwater inflows or saturated CCR.

Photograph 12

Date: 11/16/2017

Comments:
Test pit GS-T04, 1 day after excavation. Note small amount of caving of sidewalls, which resulted in the stake falling into the pit.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 13

Date: 11/15/2017

Comments:
Test pit GS-T05 spoils pile. Most of the spoils are unsaturated, but a pocket of saturated spoils is present on the right.

Photograph 14

Date: 11/15/2017

Comments:
Test pit GS-T05, immediately after excavation to 10.4 ft. Note vertical sides of the excavation, but the presence of saturated CCR pockets. The operator noted that the excavation was soft, and then hard, which indicates pockets.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 15

Date: 11/16/2017

Comments:
Test pit GS-T05, 1 day after excavation.

Photograph 16

Date: 11/15/2017

Comments:
Test pit GS-T06 spoils pile. Note unsaturated nature of excavated CCR, and the presence of native soil and brown, oxidized CCR within the spoils.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 17

Date: 11/15/2017

Comments:
Test pit GS-T06, immediately after excavation to 10.4 ft. Note vertical sides of excavation and lack of groundwater inflows or saturated CCR. Also note transition to native soil near the bottom of the test pit.

Photograph 18

Date: 11/16/2017

Comments:
Test pit GS-T06, 1 day after excavation.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 19

Date: 11/15/2017

Comments:
Test pit GS-T07 spoils pile. Note saturated, flowing nature of excavated CCR.

Photograph 20

Date: 11/15/2017

Comments:
Test pit GS-T07, immediately after excavation to 5.0 ft. Note presence of saturated, mobile CCR below 3.0 feet in depth. Free water began to accumulate in the test pit several minutes later.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 21

Date: 11/16/2017

Comments:
Test pit GS-T07, 1 day after excavation. Note the presence of approximately 8 inches of free water in the test pit.

Photograph 22

Date: 11/15/2017

Comments:
Test pit GS-T08 spoils pile. Note saturated, flowing nature of excavated CCR.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 23

Date: 11/15/2017

Comments:
Test pit GS-T08, immediately after excavation to 7.0 ft. Note presence of saturated, mobile CCR at the bottom of the excavation.

Photograph 24

Date: 11/16/2017

Comments:
Test pit GS-T08, 1 day after excavation. Note that conditions are nearly identical to the conditions observed on 11/15/2017.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc. Project Number: CHE8356

Site Name: Hennepin Power Station Site Location: Hennepin, IL

Photograph 25

Date: 11/15/2017

Comments:
Test pit GS-T09 spoils pile. Note unsaturated nature of excavated CCR.

Photograph 26

Date: 11/15/2017

Test pit GS-T09, immediately after excavation to 10.4 ft. Note vertical sides of excavation and lack of groundwater inflows or saturated CCR.

DYNEGY HENNEPIN WEST ASH POND COMPLEX TEST PITS

Photographic Record

Client: Dynegy, Inc.	Project Number: CHE8356
Site Name: Hennepin Power Station	Site Location: Hennepin, IL

Photograph 27 Date: 11/16/2017 Comments: Test pit GS-T09, 1 day after excavation.	
Photograph 27 Date: 11/16/2017 Comments: Pumping/ recovery test equipment setup at piezometer HEN-P001.	

APPENDIX B

Piezometer Logs

Geosyntec consultants

BORING NUMBER GS-P01A

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/7/2017 **COMPLETED** 11/7/2017
GROUND ELEVATION 464.2 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES Log created from cuttings.
DRILLING EQUIPMENT CME-750 ATV
▽ **GWL AT TIME OF DRILLING** 5 ft.
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	WELL GRAPHIC	REMARKS
464	0											Riser stick-up = 3.0 ft. ags
			SANDY SILT (ML): black (10YR 2/1), nonplastic, some fine sand, some organic matter, few slag, soft, moist [FILL]	0.7								1689162 ft. N 2528812 ft. E Bentonite seal = 0-4 ft. bgs
			SILT (ML): dark gray (10YR 4/1), nonplastic, trace fine sand, trace coarse sand, trace slag, very soft, moist [FLY ASH]									
459	5		▽ - changes to wet at 5 ft.									Filter pack = 4-10.1 ft. bgs Screen = 4.8-9.8 ft. bgs
454	10			10.1								
			Note: (1) End of boring at 10.1 ft bgs. (2) Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Piezometer constructed from 2" diameter Schedule 40 PVC with 10-slot piezometer screen. Unimin FilterSil No. 1 sand used for filter pack. (4) Groundwater levels at time of drilling were estimated based on ash/soil moisture. Groundwater levels after drilling were measured.									Well total depth = 10.1 ft. bgs
449	15											
444	20											
439	25											

Report: GEOSYNTEC DYNEGY GEOTECH WELL; File: GEOSYNTECDYNEGYHENNEPINLOGSWITHWELLS.GPJ; 2/1/2018 LBL

Geosyntec consultants

BORING NUMBER GS-P02

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/7/2017 **COMPLETED** 11/7/2017
GROUND ELEVATION 464.4 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES Log created from cuttings.
DRILLING EQUIPMENT CME-750 ATV
GWL AT TIME OF DRILLING 4 ft.
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	WELL GRAPHIC	REMARKS
464	0											Riser stick-up = 3.0 ft. ags
			WELL-GRADED SAND (SW): black (10YR 2/1), fine to coarse, well graded, few silt, some slag and cinders, loose, moist [FILL]									1689147 ft. N 2528823 ft. E Bentonite seal = 0-3.8 ft. bgs
				2.5								
			SILT (ML): dark gray (10YR 4/1), nonplastic, trace fine sand, trace coarse sand, trace slag, very soft, moist [FLY ASH]									
			▽ - changes to wet at 4 ft.									
459	5											Filter pack = 3.8-10.4 ft. bgs
												Screen = 5.1-10.1 ft. bgs
454	10			10.4								
			Note: (1) End of boring at 10.4 ft bgs.									Well total depth = 10.4 ft. bgs
449	15		(2) Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum.									
			(3) Piezometer constructed from 2" diameter Schedule 40 PVC with 10-slot piezometer screen. Unimin FilterSil No. 1 sand used for filter pack.									
444	20		(4) Groundwater levels at time of drilling were estimated based on ash/soil moisture. Groundwater levels after drilling were measured.									
439	25											

Report: GEOSYNTEC DYNEGY GEOTECH WELL; File: GEOSYNTECDYNEGYHENNEPINLOGSWITHWELLS.GPJ; 2/1/2018 LBL

Geosyntec consultants

BORING NUMBER GS-P03

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/7/2017 **COMPLETED** 11/7/2017
GROUND ELEVATION 464.6 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES Log created from cuttings.
DRILLING EQUIPMENT CME-750 ATV
▽ **GWL AT TIME OF DRILLING** 6 ft.
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
▼ **GWL AFTER DRILLING** 9.64 ft. 11/8/17 2:35 pm

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	WELL GRAPHIC	REMARKS
465	0											Riser stick-up = 3.0 ft. ags
			POORLY GRADED SAND (SP): black (7.5YR 2.5/1), fine, poorly graded, few silt, some fine to coarse gravel, some organic matter, loose, moist [FILL]									1688339 ft. N 2528457 ft. E Bentonite seal = 0-4 ft. bgs
			- changes to no gravel at 2.5 ft.									
				3.5								
460	5		**SILT** (ML): dark gray (10YR 4/1), few fine sand, trace slag, nonplastic, very soft, moist [FLY ASH]									Filter Pack = 4-10.1 ft. bgs Screen = 4.8-9.8 ft. bgs
			▽ - changes to wet at 6 ft.									
455	10		▼	10.1								
			Note: (1) End of boring at 10.1 ft bgs. (2) Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Piezometer constructed from 2" diameter Schedule 40 PVC with 10-slot piezometer screen. Unimin FilterSil No. 1 sand used for filter pack. (4) Groundwater levels at time of drilling were estimated based on ash/soil moisture. Groundwater levels after drilling were measured.									Well total depth = 10.1 ft. bgs
450	15											
445	20											
440	25											

Report: GEOSYNTEC DYNEGY GEOTECH WELL; File: GEOSYNTECDYNEGYHENNEPINLOGSWITHWELLS.GPJ; 2/1/2018 LBL

BORING NUMBER GS-P04

Geosyntec consultants

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/7/2017 **COMPLETED** 11/7/2017
GROUND ELEVATION 464.7 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES Log created from cuttings.
DRILLING EQUIPMENT CME-750 ATV
▽ **GWL AT TIME OF DRILLING** 6 ft.
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	WELL GRAPHIC	REMARKS
465	0										Riser stick-up = 3.0 ft. ags
			SILTY SAND (SM): black (7.5YR 2.5/1), fine, poorly graded, little silt, little to some fine to coarse gravel, some organic matter, loose, moist [FILL]								1688335 ft. N 2528482 ft. E Bentonite seal = 0-4 ft. bgs
			- no gravel at 2.5 ft.								
				4							
460	5		**SILT** (ML): dark gray (10YR 4/1), trace fine sand, non plastic, very soft, moist, trace slag [FLY ASH]								Filter pack = 4.0-10.3 ft. bgs Screen = 5.0-10.0 ft. bgs
			▽ - changes to wet at 6 ft.								
455	10			10.25							
			Note: (1) End of boring at 10.25 ft bgs.								Well total depth = 10.3 ft. bgs
			(2) Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum.								
450	15		(3) Piezometer constructed from 2" diameter Schedule 40 PVC with 10-slot piezometer screen. Unimin FilterSil No. 1 sand used for filter pack.								
			(4) Groundwater levels at time of drilling were estimated based on ash/soil moisture. Groundwater levels after drilling were measured.								
445	20										
440	25										

Report: GEOSYNTEC DYNEGY GEOTECH WELL; File: GEOSYNTECDYNEGYHENNEPINLOGSWITHWELLS.GPJ; 2/1/2018 LBL

Geosyntec consultants

BORING NUMBER GS-P05

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/7/2017 **COMPLETED** 11/7/2017
GROUND ELEVATION 460.5 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES Log created from cuttings.
DRILLING EQUIPMENT CME-750 ATV
▽ **GWL AT TIME OF DRILLING** 8 ft.
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	WELL GRAPHIC	REMARKS
461	0		**POORLY GRADED SAND** (SP): black (7.5YR 2.5/1), fine, few silt, little fine to coarse gravel, some organic matter, loose, moist [TOPSOIL]								1688361 ft. N 2527512 ft. E Bentonite seal = 0-4 ft. bgs
			SILT (ML): dark gray (10YR 4/1), trace fine sand, few coarse sand, trace slag, nonplastic, very soft, moist [FLY ASH]	2							
456	5										Filter pack = 4-10.3 ft. bgs Screen = 5.0-10.0 ft. bgs
			▽ changes to wet at 8 ft.								
451	10			10.25							
			Note: (1) End of boring at 10.25 ft bgs. (2) Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Piezometer constructed from 2" diameter Schedule 40 PVC with 10-slot piezometer screen. Unimin FilterSil No. 1 sand used for filter pack. (4) Groundwater levels at time of drilling were estimated based on ash/soil moisture. Groundwater levels after drilling were measured.								Well total depth = 10.3 ft. bgs
446	15										
441	20										
436	25										

Report: GEOSYNTEC DYNEGY GEOTECH WELL; File: GEOSYNTECDYNEGYHENNEPINLOGSWITHWELLS.GPJ; 2/1/2018 LBL

Geosyntec consultants

BORING NUMBER GS-P06

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/7/2017 **COMPLETED** 11/7/2017
GROUND ELEVATION 460.5 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES Log created from cuttings.
DRILLING EQUIPMENT CME-750 ATV
▽ **GWL AT TIME OF DRILLING** 2.5 ft.
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	WELL GRAPHIC	REMARKS
461	0										Riser stick-up = 3.0 ft. ags
			POORLY GRADED SAND (SP): black (7.5YR 2.5/1), fine, few to little silt, trace gravel, some organic matter, loose, moist [TOPSOIL]	1							1688360 ft. N 2527539 ft. E Bentonite seal = 0-4 ft. bgs
			▽ **SILT** (ML): dark gray (10YR 4/1), trace fine sand, trace coarse sand, trace slag, nonplastic, moist, very soft [FLY ASH] - changes to wet at 2.5 ft.								
456	5										Filter pack = 4-10.3 ft. bgs Screen = 5.0-10.0 ft. bgs
451	10			10.25							
			Note: (1) End of boring at 10.25 ft bgs. (2) Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Piezometer constructed from 2" diameter Schedule 40 PVC with 10-slot piezometer screen. Unimin FilterSil No. 1 sand used for filter pack. (4) Groundwater levels at time of drilling were estimated based on ash/soil moisture. Groundwater levels after drilling were measured.								Well total depth = 10.3 ft. bgs
446	15										
441	20										
436	25										

Report: GEOSYNTEC DYNEGY GEOTECH WELL; File: GEOSYNTECDYNEGYHENNEPINLOGSWITHWELLS.GPJ; 2/1/2018 LBL

Geosyntec consultants

BORING NUMBER GS-P07

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/10/2017 **COMPLETED** 11/10/2017
GROUND ELEVATION 459.2 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES
DRILLING EQUIPMENT CME-750 ATV
GWL AT TIME OF DRILLING 11 ft.
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING 10.82 ft. 11/16/17 9:25 am

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	WELL GRAPHIC	REMARKS
459	0											Riser stick-up = 3.0 ft. ags
			CLAYEY SAND (SP): dark yellowish brown (10YR 4/4), medium, some fine to coarse gravel, trace silt, loose, moist [FILL]		SPT-1	5.5/ 24	1-1-5-5 (6)					1688524 ft. N 2526764 ft. E Bentonite seal = 0.0-9.0 ft. bgs
					SPT-2	13/ 24	2-3-6-10 (9)					
454	5		- changes to no silt, medium dense at 4 ft.		SPT-3	18.5/ 24	4-9-8-7 (17)					
			- changes to little gravel at 6 ft.		SPT-4	17/ 24	5-7-10-11 (17)					
			CLAYEY GRAVEL (GW): dark yellowish brown (10YR 4/4), fine to coarse gravel, well graded, some fine to very coarse sand, medium dense, moist [FILL]	8	SPT-5	19.5/ 24	4-10-11-12 (21)					Filter pack = 9.0-20.0 ft. bgs Screen = 9.7-19.7 ft. bgs
449	10			10								
			SILT (ML): black (2.5Y 2.5/1), nonplastic, few fine sand, trace fine coal and slag fragments, trace coarse gravel, stiff, moist [FILL] - changes to wet at 11 ft. - changes to very stiff at 12 ft.		SPT-6	14/ 24	2-5-10-11 (15)					
					SPT-7	24/ 24	1-7-10-15 (17)					
444	15		- changes to stiff at 14 ft. - changes to some fine gravel and slag from 14.8 to 15.2 ft.		SPT-8	22.5/ 24	3-5-7-5 (12)					
			LEAN CLAY (CL): very dark gray (10YR 3/1), soft, wet	16	SPT-9	16/ 24	1-1-2-1 (3)	1.25 1.5	4.5 5.0			
					T-10	24/ 24		1.25 1.0	3.5			
439	20			20								
			Note: (1) End of boring at 20 ft bgs. (2) Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Piezometer constructed from 2" diameter Schedule 40 PVC with 10-slot piezometer screen. Unimin FilterSil No. 1 sand used for filter pack.									Well total depth = 20.0 ft. bgs
434	25											

Report: GEOSYNTEC DYNEGY GEOTECH WELL; File: GEOSYNTECDYNEGYHENNEPINLOGSWITHWELLS.GPJ; 2/1/2018 LBL

(Continued Next Page)

Geosyntec consultants

BORING NUMBER GS-P07

CLIENT Dynegy Midwest Generation, LLC **PROJECT NAME** Dynegy - Hennepin Power Station

PROJECT NUMBER CHE8356 **PROJECT LOCATION** Hennepin, Illinois

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	WELL GRAPHIC	REMARKS
434	25		(4) Groundwater levels at time of drilling were estimated based on ash/soil moisture. Groundwater levels after drilling were measured.									
429	30											
424	35											
419	40											
414	45											
409	50											

Report: GEOSYNTEC DYNEGY GEOTECH WELL; File: GEOSYNTECDYNEGYHENNEPINLOGSWITHWELLS.GPJ; 2/1/2018 LBL

Geosyntec consultants

BORING NUMBER GS-P08

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/10/2017 **COMPLETED** 11/10/2017
GROUND ELEVATION 458.7 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES
DRILLING EQUIPMENT CME-750 ATV
GWL AT TIME OF DRILLING 10 ft.
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING 8.61 ft. 11/16/17 8:02 am

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	WELL GRAPHIC	REMARKS
459	0											Riser stick-up = 3.0 ft. ags
			GRAVEL (GP): gray (GLEY 4/N), coarse angular gravel, dense, moist [FILL]		SPT-1	2/ 24	40-20-25-14 (45)					1688312 ft. N 2527027 ft. E
				2								Bentonite seal = 0.0-7.0 ft. bgs
			POORLY GRADED SAND (SP): dark yellowish brown (10YR 4/4), medium, some fine to coarse gravel, few silt, trace clay, loose, moist [FILL]		SPT-2	10.5/ 24	7-6-4-5 (10)					
				4								
454	5		**SILTY SAND** (SM): brownish-yellow (10YR 6/8), fine to medium, well graded, little silt, little coal and slag, very dense, moist [FILL]	5	SPT-3	20/ 24	7-19-38-14 (57)					
			SILT (ML): black (2.5Y 2.5/1), nonplastic, trace to few sand, few coal, hard, dry [FILL]	6								
			SILTY SAND (SM): black (2.5Y 2.5/1), fine, trace coal and slag, medium dense, moist [FILL]		SPT-4	24/ 24	2-4-7-15 (11)					Filter pack = 7.0-18.3 ft. bgs
					SPT-5	20.5/ 24	4-9-6-15 (15)					Screen = 8.0-18.0 ft. bgs
449	10		- changes to wet at 10 ft.		SPT-6	20/ 24	5-10-14-20 (24)					
			- changes to some fine to coarse coal and slag from 12.7-12.9 ft.		SPT-7	24/ 24	5-4-6-8 (10)					
444	15				SPT-8	19.5/ 24	1-2-4-4 (6)	2.5	7.5			
			FAT CLAY (CH): very dark gray (10YR 3/1), medium stiff, wet	15.5								
					T-9	14/ 24		1.75 1.75	5.25			
				18.3								
439	20		Note: (1) End of boring at 18.3 ft bgs. (2) Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Piezometer constructed from 2" diameter Schedule 40 PVC with 10-slot piezometer screen. Unimin FilterSil No. 1 sand used for filter pack. (4) Groundwater levels at time of drilling were estimated based on ash/soil moisture. Groundwater levels after drilling were measured.									Well depth = 18.3 ft. bgs
434	25											

Report: GEOSYNTEC DYNEGY GEOTECH WELL; File: GEOSYNTECDYNEGYHENNEPINLOGSWITHWELLS.GPJ; 2/1/2018 LBL

APPENDIX C

Test Pit Logs

Geosyntec consultants

TEST PIT NUMBER GS-T01

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/15/2017 **COMPLETED** 11/16/2017
GROUND ELEVATION 464.3 ft. **HOLE SIZE** 4.5' x 10'
CONTRACTOR Gensini Excavation, Inc.
NOTES Test pit logged from excavation spoils.
EQUIPMENT CAT Excavator
GWL AT TIME OF EXCAVATION Not Encountered
EXCAVATION METHOD Vertical trenching
GWL AT END OF EXCAVATION Dry
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER EXCAVATION Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0											
460	5		**SILT** (ML): dark gray (10YR 4/1), nonplastic, soft, moist [FLY ASH]									
455	10											
			Note: (1) End of test pit at 10 ft. bgs (2) Test pit is located at 1689176 ft. N and 2528804 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of excavation were estimated based on ash/soil moisture. Groundwater levels after excavation were measured.									
450	15											
445	20											
440	25											

Report: GEOSYNTEC DYNEGY HENNEPIN TEST PIT; File: GEOSYNTECDYNEGYHENNEPINTESTPITS.GPJ; 1/31/2018 LBL

Geosyntec consultants

TEST PIT NUMBER GS-T02

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/15/2017 **COMPLETED** 11/16/2017
GROUND ELEVATION 464.9 ft. **HOLE SIZE** 4.5' x 10'
CONTRACTOR Gensini Excavation, Inc.
NOTES Test pit logged from excavation spoils.
EQUIPMENT CAT Excavator
GWL AT TIME OF EXCAVATION Not Encountered
EXCAVATION METHOD Vertical trenching
GWL AT END OF EXCAVATION Dry
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER EXCAVATION Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0		**SILTY SAND** (SM): black (10YR 2/1), fine, poorly graded, some silt, loose, moist [BOTTOM ASH]									
			CLAY (CL): brown (10YR 5/3), moist [FILL]									
460	5		**SILT** (ML): dark gray, nonplastic, little fine-grained sand, soft, moist [FLY ASH]									
455	10											
			Note: (1) End of test pit at 10 ft. bgs (2) Test pit is located at 1688346 ft. N and 2528447 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of excavation were estimated based on ash/soil moisture. Groundwater levels after excavation were measured.									
450	15											
445	20											
440	25											

Report: GEOSYNTEC DYNEGY HENNEPIN TEST PIT; File: GEOSYNTECDYNEGYHENNEPINTESTPITS.GPJ; 1/31/2018 LBL

Geosyntec consultants

TEST PIT NUMBER GS-T03

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/15/2017 **COMPLETED** 11/16/2017
GROUND ELEVATION 461.1 ft. **HOLE SIZE** 4.5' x 10'
CONTRACTOR Gensini Excavation, Inc.
NOTES Test pit logged from excavation spoils.
EQUIPMENT CAT Excavator
GWL AT TIME OF EXCAVATION Not Encountered
EXCAVATION METHOD Vertical trenching
GWL AT END OF EXCAVATION Dry
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER EXCAVATION Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0											
460			**SILT** (ML): dark gray (10YR 4/1), nonplastic, few to little fine sand, soft, moist [FLY ASH]									
	5											
455			**SILTY SAND** (SM): brownish yellow (10YR 6/6), fine, little silt, few slag, loose, moist [FILL]									
	10		changes to wet at 10 ft.									
450			Note: (1) End of test pit at 10 ft. bgs (2) Test pit is located at 1688361 ft. N and 2527502 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of excavation were estimated based on ash/soil moisture. Groundwater levels after excavation were measured.									
	15											
445												
	20											
440												
	25											

Report: GEOSYNTEC DYNEGY HENNEPIN TEST PIT; File: GEOSYNTECDYNEGYHENNEPINTESTPITS.GPJ; 1/31/2018 LBL

Geosyntec consultants

TEST PIT NUMBER GS-T04

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/15/2017 **COMPLETED** 11/16/2017
GROUND ELEVATION 464.7 ft. **HOLE SIZE** 4.5' x 10'
CONTRACTOR Gensini Excavation, Inc.
NOTES Test pit logged from excavation spoils.
EQUIPMENT CAT Excavator
GWL AT TIME OF EXCAVATION Not Encountered
EXCAVATION METHOD Vertical trenching
GWL AT END OF EXCAVATION Dry
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER EXCAVATION Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0		**SILT** (ML); dark gray (10YR 4/1), nonplastic, soft, moist [FLY ASH]									
460	5											
455	10											
			Note: (1) End of test pit at 10.8 ft. bgs (2) Test pit is located at 1688934 ft. N and 2528886 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of excavation were estimated based on ash/soil moisture. Groundwater levels after excavation were measured.									
450	15											
445	20											
440	25											

Geosyntec consultants

TEST PIT NUMBER GS-T05

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/15/2017 **COMPLETED** 11/16/2017
GROUND ELEVATION 464.1 ft. **HOLE SIZE** 4.5' x 10'
CONTRACTOR Gensini Excavation, Inc.
NOTES Test pit logged from excavation spoils.
EQUIPMENT CAT Excavator
GWL AT TIME OF EXCAVATION 8 ft
EXCAVATION METHOD Vertical trenching
GWL AT END OF EXCAVATION Dry
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER EXCAVATION Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0		**SILT** (ML): dark gray (10YR 4/1), nonplastic, soft, moist [FLY ASH]									
460	5											
			changes to saturated, brown (10YR 5/3), few to little fine sand at 8 ft.									
455	10											
			Note: (1) End of test pit at 10.4 ft. bgs (2) Test pit is located at 1688881 ft. N and 2528697 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of excavation were estimated based on ash/soil moisture. Groundwater levels after excavation were measured.									
450	15											
445	20											
440	25											

Report: GEOSYNTEC DYNEGY HENNEPIN TEST PIT; File: GEOSYNTECDYNEGYHENNEPINTESTPITS.GPJ; 1/31/2018 LBL

Geosyntec consultants

TEST PIT NUMBER GS-T06

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/15/2017 **COMPLETED** 11/16/2017
GROUND ELEVATION 463.0 ft. **HOLE SIZE** 4.5' x 10'
CONTRACTOR Gensini Excavation, Inc.
NOTES Test pit logged from excavation spoils.
EQUIPMENT CAT Excavator
GWL AT TIME OF EXCAVATION Not Encountered
EXCAVATION METHOD Vertical trenching
GWL AT END OF EXCAVATION Dry
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER EXCAVATION Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0		**SILT** (ML): gray (10YR 6/1), nonplastic, few medium sand, few to some coal and slag, soft, moist, trace to some organic matter [FLY ASH]									
460												
	5											
455												
	10		**POORLY GRADED SAND** (SP): reddish-brown (5YR 4/4), medium-grained, poorly graded, little to some coarse gravel, moist, medium dense to dense [FILL]									
			Note: (1) End of test pit at 10.4 ft. bgs (2) Test pit is located at 1688590 ft. N and 2528822 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of excavation were estimated based on ash/soil moisture. Groundwater levels after excavation were measured.									
450												
	15											
445												
	20											
440												
	25											

Report: GEOSYNTEC DYNEGY HENNEPIN TEST PIT; File: GEOSYNTECDYNEGYHENNEPINTESTPITS.GPJ; 1/31/2018 LBL

TEST PIT NUMBER GS-T07

Geosyntec consultants

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/15/2017 **COMPLETED** 11/16/2017
GROUND ELEVATION 455.4 ft. **HOLE SIZE** 4.5' x 10'
CONTRACTOR Gensini Excavation, Inc.
NOTES Test pit logged from excavation spoils.
EQUIPMENT CAT Excavator
GWL AT TIME OF EXCAVATION 3 ft
EXCAVATION METHOD Vertical trenching
GWL AT END OF EXCAVATION Dry
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER EXCAVATION 4.2 ft at 10:35 AM on 11/16/17

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
455	0		**SILT** (ML): dark gray (10YR 4/1), nonplastic, soft, moist with lenses of saturated material [FLY ASH]									
	5		changes to very soft, saturated at 3 ft.									
450			Note: (1) End of test pit at 5 ft. bgs (2) Test pit is located at 1688711 ft. N and 2527343 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of excavation were estimated based on ash/soil moisture. Groundwater levels after excavation were measured.									
	10											
445												
	15											
440												
	20											
435												
	25											

Report: GEOSYNTEC DYNEGY HENNEPIN TEST PIT; File: GEOSYNTECDYNEGYHENNEPINTESTPITS.GPJ; 1/31/2018 LBL

Geosyntec consultants

TEST PIT NUMBER GS-T08

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/15/2017 **COMPLETED** 11/16/2017
GROUND ELEVATION 456.4 ft. **HOLE SIZE** 4.5' x 10'
CONTRACTOR Gensini Excavation, Inc.
NOTES Test pit logged from excavation spoils.
EQUIPMENT CAT Excavator
GWL AT TIME OF EXCAVATION 5.8 ft
EXCAVATION METHOD Vertical trenching
GWL AT END OF EXCAVATION Dry
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER EXCAVATION Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0											
455			**SILT** (ML): dark gray (10YR 4/1), nonplastic, few to little fine sand, soft, moist [FLY ASH]									
	5											
450			changes to very soft, saturated at 5.8 ft.									
	10		Note: (1) End of test pit at 7 ft. bgs (2) Test pit is located at 1688422 ft. N and 2527538 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of excavation were estimated based on ash/soil moisture. Groundwater levels after excavation were measured.									
445												
	15											
440												
	20											
435												
	25											

Report: GEOSYNTEC DYNEGY HENNEPIN TEST PIT; File: GEOSYNTECDYNEGYHENNEPINTESTPITS.GPJ; 1/31/2018 LBL

Geosyntec consultants

TEST PIT NUMBER GS-T09

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/15/2017 **COMPLETED** 11/16/2017
GROUND ELEVATION 461.3 ft. **HOLE SIZE** 4.5' x 10'
CONTRACTOR Gensini Excavation, Inc.
NOTES Test pit logged from excavation spoils.
EQUIPMENT CAT Excavator
GWL AT TIME OF EXCAVATION Not Encountered
EXCAVATION METHOD Vertical trenching
GWL AT END OF EXCAVATION Dry
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER EXCAVATION Dry

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0		**SILT** (ML): gray (10YR 6/1), nonplastic, trace to few fine sand, soft, moist [FLY ASH]									
460												
	5											
455			changes to dark gray (10YR 4/1), moist to wet at 6 ft.									
	10											
450			Note: (1) End of test pit at 10.4 ft. bgs (2) Test pit is located at 1688411 ft. N and 2528388 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of excavation were estimated based on ash/soil moisture. Groundwater levels after excavation were measured.									
	15											
445												
	20											
440												
	25											

Report: GEOSYNTEC DYNEGY HENNEPIN TEST PIT; File: GEOSYNTECDYNEGYHENNEPINTESTPITS.GPJ; 1/31/2018 LBL

APPENDIX D

Boring Logs

Geosyntec consultants

BORING NUMBER GS-B01

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/7/2017 **COMPLETED** 11/8/2017
GROUND ELEVATION 464.6 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES
DRILLING EQUIPMENT CME-750 ATV
▽ **GWL AT TIME OF DRILLING** 7.5 ft.
DRILLING METHOD HSA (0-23', 28.5-30.5') / Mud Rotary (23-28.5')
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Not Measured

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0		**SAND** (SW): black (10YR 2/1) with yellowish brown (10YR 5/3), fine to coarse, well graded, some cinders and slag, little fine gravel, few silt, loose, moist [FILL]	SPT-1	21.5/ 24	2-4-6-7 (10)						
			SILT (ML): light gray (10YR 7/1) to gray (10YR 5/1), nonplastic, trace fine sand, medium stiff, moist [FLY ASH]	SPT-2	20.5/ 24	2-4-3-3 (7)	1.25 1.5	1.5 1.75				
460	5			T-3	21/ 24		1.75 1.75	0.5 1.5		61.0		
			▽ - changes to wet at 7.5 ft.	T-4	15.5/ 24		1.5 1.75	1.5 2.0		46.0		
455	10		- changes to dark gray (10YR 4/1), very soft, trace organics at 10 ft.	SPT-5	15/ 24	WOH	1.25 0.5	1.75				
450	15		**CLAYEY SAND** (SC): very dark grayish brown (2.5YR 3/2), few to little clay, trace fine gravel, medium dense, wet	SPT-6	20/ 24	1-7-8-4 (15)	1.75 1.75	4.0 4.5				
445	20		**GRAVELLY SAND** (SW): pale yellow (2.5Y 7/4), medium to very coarse, well-graded, medium dense, wet	SPT-7	13/ 24	9-9-10-12 (19)						
440	25		- changes to yellowish brown (10YR 6/4) at 23.5 ft.	SPT-8	13.5/ 24	14-21-14-14						

(Continued Next Page)

Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-B01

CLIENT Dynegy Midwest Generation, LLC **PROJECT NAME** Dynegy - Hennepin Power Station

PROJECT NUMBER CHE8356 **PROJECT LOCATION** Hennepin, Illinois

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	25		**GRAVELLY SAND** (SW): pale yellowish brown (10YR 6/4), medium to very coarse, well-graded, medium dense, wet			(35)						
435	30		**WELL-GRADED GRAVEL** (GW): light yellowish brown (2.5Y 6/4), fine to coarse, well-graded, few sand, very dense, wet	SPT-9	4/ 24	38-28-24-17 (52)						
430	35		Note: (1) Auger refusal at 30.5 ft. bgs. SPT advanced to 31 ft. bgs. End of boring at 31 ft. bgs. (2) Boring is located at 1689138 ft. N and 2528829 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of drilling were estimated based on ash/soil moisture.									
425	40											
420	45											
415	50											

Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-B02

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/11/2017 **COMPLETED** 11/11/2017
GROUND ELEVATION 460.9 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES
DRILLING EQUIPMENT CME-750 ATV
GWL AT TIME OF DRILLING Not Encountered
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Encountered
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Not Encountered

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0											
460			**POORLY GRADED SAND** (SP): black (7.5YR 2.5/1), fine, poorly graded, few silt, little fine to coarse gravel, some organic matter, loose, moist [TOPSOIL]									
			SILT (ML): dark gray (10YR 4/1), nonplastic, trace fine sand, few coarse sand, trace coal and slag, very soft to soft, moist [FLY ASH]									
	5											
455				T-1	24/ 24		1.25 1.25	0.5		50.0		
				T-2	24/ 24		0.75 0.75	0.25		58.0		
	10		Note: (1) End of boring at 9 ft. bgs. (2) Boring is located at 1688362 ft. N and 2527555 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of drilling were estimated based on ash/soil moisture.									
450												
	15											
445												
	20											
440												
	25											

Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-B03

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/9/2017 **COMPLETED** 11/9/2017
GROUND ELEVATION 460.1 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES
DRILLING EQUIPMENT CME-750 ATV
▽ **GWL AT TIME OF DRILLING** 14 ft.
DRILLING METHOD Hollow Stem Auger (0-46') / Mud Rotary (46-55.5')
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Not Measured

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
460	0		**POORLY GRADED SAND** (SP): dark yellowish brown (10YR 4/6), medium, trace coarse gravel, trace clay, loose, moist [FILL]									
				SPT-1	13/ 24	2-2-3-3 (5)						
			SANDY LEAN CLAY (CL): dark yellowish brown (10YR 4/6), low plasticity, some sand, soft, moist [FILL]									
	5			SPT-2	14/ 24	1-1-2-3 (3)	1.5 1.25	2.75 1.75		17.0		
455			**SANDY SILT** (ML): dark gray (10YR 4/1), nonplastic, little to some sand, trace coal fragments, very soft, moist to wet [FLY ASH]									
				SPT-3	8.5/ 24	WOH-WOH-1-1	0.5 0.25	0.75				
			- changes to medium stiff at 9 ft.									
	10			SPT-4	21/ 24	1-1-4-5 (5)				64.0	NP	NP
450												
			▽ - changes to very soft and wet at 14 ft.									
	15			SPT-5	24/ 24	WOH-1	0.0	0.0		40.0		
445												
			LEAN CLAY (CL): very dark gray (7.5YR 3/1), trace to few silt, soft, wet									
	20			SPT-6	17.5/ 24	1-1-2-3 (3)	1.25 1.5	2.0 1.75				
440			- changes to dark gray (7.5YR 4/1) at 21 ft.									
				T-7	21.5/ 24		1.25 1.25	2.5				
	25				23/		0.75	2.75				

(Continued Next Page)

Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-B03

CLIENT Dynegy Midwest Generation, LLC **PROJECT NAME** Dynegy - Hennepin Power Station

PROJECT NUMBER CHE8356 **PROJECT LOCATION** Hennepin, Illinois

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
435	25		**LEAN CLAY** (CL): dark gray (7.5YR 4/1), trace to few silt, soft, wet	T-8	24			1.0		32.0	44	25
			- changes to grayish brown (10YR 5/2) at 26 ft.									
430	30			T-9	23/ 24		1.25 1.25	3.5				
			- changes to dark greenish gray (GLEY 4/N) at 31 ft.									
425	35		- changes to dark gray (GLEY 4/N), very soft at 34 ft.	SPT-10	24/ 24	WOH-1-1-2 (2)	1.0 1.25	1.25 3.5				
				T-11	23/ 24		1.0 1.25	3.0				
			- changes to dark gray (10YR 4/1) at 38 ft.									
420	40		**FAT CLAY** (CH): very dark gray (7.5 YR 3/1), trace to few silt, few organic matter, soft, wet	SPT-12	24/ 24	WOH-2-2-2 (4)	0.75 1.25	5.0 5.5		50.0	79	51
			- changes to trace coarse sand at 44 ft.									
415	45			SPT-13	24/ 24	1-1-2-3 (3)	1.5 1.5	4.0 3.5				
410	50		**SILTY SAND** (SM): gray (GLEY 5/N), trace gravel, medium, loose, wet	SPT-14	17/ 24	2-3-6-7 (9)				18.0		

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Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-B03

CLIENT Dynegy Midwest Generation, LLC **PROJECT NAME** Dynegy - Hennepin Power Station

PROJECT NUMBER CHE8356 **PROJECT LOCATION** Hennepin, Illinois

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
405	55		**WELL-GRADED GRAVEL** (GW): grayish brown (2.5Y 5/2) with some pale yellow (2.5Y 8/3), fine to coarse, little very coarse sand, loose, saturated	SPT-15	9.5/ 24	5-5-5-3 (10)						
400	60		Note: (1)End of boring at 55.5 ft. bgs. (2) Boring is located at 1688617 ft. N and 2527230 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of drilling were estimated based on ash/soil moisture.									
395	65											
390	70											
385	75											
380	80											

Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-B04

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/10/2017 **COMPLETED** 11/10/2017
GROUND ELEVATION 459.1 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES
DRILLING EQUIPMENT CME-750 ATV
▽ **GWL AT TIME OF DRILLING** 6 ft.
DRILLING METHOD Hollow Stem Auger (0-20.5') / Mud Rotary (20.5-45.5')
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Not Measured

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0		**POORLY GRADED SAND** (SP): dark yellowish brown (10YR 4/6), medium, trace gravel, trace clay, medium dense, moist [FILL]	SPT-1	14/ 24	3-8-3-2 (11)						
455	5		- changes to few gravel, few to little clay, very loose at 3.5 ft.	SPT-2	13/ 24	2-2-2-3 (4)						
		▽	**SANDY SILT** (ML): dark gray (10YR 4/1), no plasticity, little to some fine sand, trace fine coal fragments, very soft, wet [FLY ASH]	SPT-3	16/ 24	WOH	0.25 0.25	0.50		37.0		
450	10		- changes to gray (10YR 5/1 to 6/1) with no sand at 8.5 ft.	SPT-4	8/ 24	WOH						
445	15			SPT-5	24/ 24	WR				49.0		
440	20		**LEAN CLAY** (CL): dark greenish gray (GLEY 4/N), soft, wet	SPT-6	17.5/ 24	1-2-2-3 (4)	1.0 1.25	3.0 2.5				
435	25			T-7	24/ 24		1.0 1.0	3.0		31.0	45	25

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Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-B04

CLIENT Dynegy Midwest Generation, LLC **PROJECT NAME** Dynegy - Hennepin Power Station

PROJECT NUMBER CHE8356 **PROJECT LOCATION** Hennepin, Illinois

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTICITY INDEX
	25		**LEAN CLAY** (CL): dark greenish gray (GLEY 4/N), soft, wet *(continued)*									
			- changes to dark grayish brown (10YR 4/2) at 25.5 ft.									
430	30			T-8	19/ 24		1.0 1.25	4.5				
			- changes to dark greenish gray (GLEY 3/N) at 30.5 ft.									
425	35			T-9	24/ 24		1.0 1.25	5.0 3.5		61.0	61	30
			FAT CLAY (CH): very dark gray (10YR 3/1), soft, wet									
420	40		**SILTY SAND** (SM): gray (10YR 5/1), medium, trace gravel, medium dense, wet	SPT-10	17.5/ 24	5-6-7-7 (13)				23.0		
			- changes to light yellowish brown (10YR 6/4), some gravel, dense at 43.5 ft.									
415	45			SPT-11	5/ 24	15-15-16-14 (31)						
			Note: (1) End of boring at 45.5 ft. bgs. (2) Boring is located at 1688435 ft. N and 2527245 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of drilling were estimated based on ash/soil moisture.									
410	50											

Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-B05

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/9/2017 **COMPLETED** 11/9/2017
GROUND ELEVATION 459.2 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES
DRILLING EQUIPMENT CME-750 ATV
▽ **GWL AT TIME OF DRILLING** 8.5 ft.
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Not Measured

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0		**GRAVELLY SAND** (SP): dark yellowish brown (10YR 4/4) and very dark gray (10YR 3/1), fine, poorly graded, little to some fine to coarse gravel, few to little clay, medium dense, moist [FILL]	SPT-1	15.5/ 24	5-12-9-10 (21)						
455	5		**SANDY LEAN CLAY** (CL): dark brown (10YR 3/3), trace coarse gravel, few to little fine sand, trace silt, medium stiff, moist	SPT-2	15.5/ 24	2-4-3-3 (7)	1.0 1.75	3.5 4.5				
			- changes to little to some fine sand, soft at 6 ft.	SPT-3	13/ 24	1-2-2-2 (4)	1.0 1.0	2.75 3.0		32.0		
			▽ - changes to wet at 8.5 ft.									
450	10			SPT-4	13/ 24	2-2-2-2 (4)	0.75	2.5				
445	15		**LEAN CLAY** (CL): black (5Y 2.5/1), some silt, soft, saturated, some organic matter	SPT-5	24/ 24	1-2-1-1 (3)	0.75 1.0	1.5 2.0				
440	20		**FAT CLAY** (CH): dark gray (2.5Y 4/1), few silt, trace sand, soft, wet	SPT-6	20.5/ 24	WOH-2-2-2 (4)	1.25 1.25	2.0 2.5				
435	25		Note: (1) End of boring at 20.5 ft. bgs. (2) Boring is located at 1688777 ft. N and 2527235 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of drilling were estimated based on ash/soil moisture.									

Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-B06

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/8/2017 **COMPLETED** 11/8/2017
GROUND ELEVATION 458.4 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES
DRILLING EQUIPMENT CME-750 ATV
▽ **GWL AT TIME OF DRILLING** 5 ft.
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Measured
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Not Measured

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0		**GRAVELLY SAND** (SW): dark yellowish brown (10YR 4/6), fine to very coarse-grained, well graded, some fine to coarse gravel, trace to few silt, loose, moist [FILL]									
455				SPT-1	12/ 24	2-3-3-3 (6)						
	5		**POORLY GRADED SAND** (SP): dark gray (2.5Y 4/1), fine, trace fine gravel, trace coal, few clay, very loose, moist [FILL]	SPT-2	18/ 24	1-1-1-1 (2)	0.25	0.5				
			▽ **SILT** (ML): dark gray (10YR 4/1), nonplastic, very soft, wet [FLY ASH]									
				SPT-3	23/ 24	WOH	0.25 0.0	0.0 0.0		50.0		
450												
	10		**WELL-GRADED GRAVEL** (GW): very dark gray (10YR 3/1), fine to coarse gravel, well-graded, little coarse to very coarse sand, little silt, very loose, wet	SPT-4	23/ 24	1-1-1-1 (2)						
445												
	15		**LEAN CLAY** (CL): very dark gray (7.5YR 3/1), medium stiff, moist to wet	SPT-5	12/ 24	2-2-4-4 (6)	1.5 2.0	6.0 7.0				
440												
	20		- changes to dark gray (7.5YR 4/1), soft, wet at 19 ft.	SPT-6	22/ 24	1-1-2-3 (3)	1.5 1.5	2.5		38.0		
435	25		Note: (1) End of boring at 21 ft. bgs. (2) Boring is located at 1688347 ft. N and 2527250 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. (3) Groundwater levels at time of drilling were estimated based on									

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Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-B06

CLIENT Dynegy Midwest Generation, LLC **PROJECT NAME** Dynegy - Hennepin Power Station

PROJECT NUMBER CHE8356 **PROJECT LOCATION** Hennepin, Illinois

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	25		ash/soil moisture.									
430	30											
425	35											
420	40											
415	45											
410	50											
405												

Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

Geosyntec consultants

BORING NUMBER GS-P01

CLIENT Dynegy Midwest Generation, LLC
PROJECT NAME Dynegy - Hennepin Power Station
PROJECT NUMBER CHE8356
PROJECT LOCATION Hennepin, Illinois
DATE STARTED 11/7/2017 **COMPLETED** 11/7/2017
GROUND ELEVATION 464.5 ft. **HOLE SIZE** 8"
CONTRACTOR Roberts Environmental Drilling, Inc.
NOTES
DRILLING EQUIPMENT CME-750 ATV
GWL AT TIME OF DRILLING Not Encountered
DRILLING METHOD Hollow Stem Auger
GWL AT END OF DRILLING Not Encountered
LOGGED BY D. Mateas **CHECKED BY** L. Carr
GWL AFTER DRILLING Not Encountered

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
	0		No recovery of cuttings from 0 to 5.0 ft.									
460	5		**SILT** (ML): dark gray (10YR 4/1), nonplastic, trace fine sand, very soft, moist to wet [FLY ASH]									
455	10		**GRAVELLY CLAY** (CL): very dark grayish brown (10YR 3/2), low plasticity, few to little silt, little to some fine to coarse gravel, soft, moist to dry									
			Note: (1) End of boring at 10 ft. bgs. (2) Boring is located at 1689301 ft. N and 2528851 ft. E. Coordinates are in NAD83 (IL West) datum and elevations are in NAVD88 datum. Location was not surveyed, and coordinates are approximate. (3) Groundwater levels at time of drilling were estimated based on ash/soil moisture.									
450	15											
445	20											
440	25											

Report: GEOSYNTEC DYNEGY HENNEPIN BORING LOG; File: GEOSYNTECDYNEGYHENNEPINGENERALLOGS.GPJ; 1/31/2018 LBL

APPENDIX E

Laboratory Testing

Table E-1 - Laboratory Testing Results

Sample Information					Natural Moisture Content	Atterberg Limits[3]			Grain Size				Specific Gravity	Unconsolidated-Undrained Triaxial Compression[4]		Flexible Wall Hydraulic Conductivity	Incremental Consolidation[5, 6]			
					ASTM D 2216	ASTM D 4318			ASTM D 422				ASTM D 854	ASTM D 2560		ASTM D 5084	ASTM D 2435			
Boring	Depth (ft)	Number	Type[1]	USCS Classification[2]	w (%)	LL (%)	PL (%)	PI (%)	Gravel (%)	Sand (%)	Fines (%)	< 5 mm (%)	G_s	S_u (psf)	Strain (%)	k (cm/sec)	P'_p (tsf)	C_c	C_r	e_o
GS-B01	5.0 - 7.0	3	T	ML	60.6				0.0	12.8	87.2	21.5				2.10E-05	1.9	0.289	0.025	1.29
	7.5 - 9.5	4	T	ML	45.8				0.0	5.2	94.8	26				1.20E-05				
GS-B02	5.0 - 7.0	1	T	ML	49.9				0.0	5.8	94.2	28				6.70E-06	1.0	0.258	0.010	1.26
	7.0 - 9.0	2	T	ML	57.7				0.0	10.6	89.4	19.5				1.40E-05				
GS-B03	4.0 - 6.0	2	SPT		17.4															
	9.0 - 11.0	4	SPT	SM	63.5	NP	NP	NP												
	14.0 - 16.0	5	SPT		40.0								2.29							
	24.0 - 26.0	8	T	CL	32.3	44	19	25						453	11.6		0.7	0.260	0.030	0.90
	39.0 - 41.0	12	SPT	CH	50.0	79	28	51												
	48.5 - 50.5	14	SPT	SM	18.3				0.0	71.2	28.8	ND								
GS-B04	6.0 - 8.0	3	SPT		36.6															
	13.5 - 15.5	5	SPT		48.9								2.38							
	23.5 - 25.5	7	T	CL	31.2	45	20	25						464	9.8					
	33.5 - 35.5	9	T	CH	61.3	84	30	54						871	7.3		0.7	0.666	0.156	1.74
	38.5 - 40.5	10	SPT	SM	22.5				4.9	81.1	14.0	ND								
GS-B05	18.5 - 20.5	6	SPT		32.3															
GS-B06	6.5 - 8.5	3	SPT		50.1															
	19.0 - 21.0	6	SPT		38.0															
GS-P07	2.0 - 4.0	2	SPT	SC	8.9				36.1	40.0	23.9	ND								
	8.0 - 10.0	5	SPT	GC	6.8				44.2	36.0	19.8	ND								
	12.0 - 14.0	7	SPT	ML	46.7	NP	NP	NP	6.1	32.7	61.2	ND	2.38							
	18.0 - 20.0	10	T	CL	32.8	43	20	23	0.0	35.8	64.2	ND				4.50E-08				
GS-P08	10.0 - 12.0	8	SPT	ML	39.3				7.5	30.7	61.8	ND								
	16.0 - 18.0	9	T	CH	40.4	61	24	37	0.0	4.1	95.9	ND				7.50E-08				

Notes:

[1]Shelby tube samples are denoted by "T". Standard Penetration Test samples are denoted by "SPT"

[2]USCS classifications are based on field classifications for soil samples where only a Atterberg limit or only a sieve analysis were performed.

[3]Samples determined to be noNplastic are denoted by "NP"

[4]Failure is defined as peak deviator stress ($s_1 - s_3$), limited to 15% axial strain

[5]Consolidation parameters were estimated by Geosyntec using the Casagrande method

[6]Sample 9 from boring BS-B04 was noted by the laboratory as likely having a significant organics content, which likely resulted in the high compressibility of this sample.

[7]Samples where a hydrometer was not perfumed are denoted by "ND"

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	---	Sample Type:	---	Tested By:	twh
Sample ID:	---	Test Date:	12/15/17	Checked By:	MCM
Depth :	---	Test Id:	291526		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
GS-B01	3	5-7	Moist, very dark gray silt (ASH)	60.6
GS-B01	4	7.5-9.5	Moist, dark gray silt (ASH)	45.8
GS-B02	1	5-7	Moist, dark gray silt (ASH)	49.9
GS-B02	2	7-9	Moist, dark gray silt (ASH)	57.7
GS-B03	4	9-11	Moist, very dark gray silty sand (ASH)	63.5
GS-B03	5	14-16	Moist, dark gray silty sand (ASH)	40.0
GS-B04	3	6-8	Moist, very dark gray silty sand (ASH)	36.6
GS-B04	5	13.5-15.5	Moist, dark gray silty sand (ASH)	48.9
GS-B06	3	6.5-8.5	Moist, dark gray silty sand (ASH)	50.1
GS-P07	5	8-10	Moist, brown silty gravel with sand	6.8

Notes: Temperature of Drying : 60 degrees Celsius

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	---	Sample Type:	---	Tested By:	twh
Sample ID:	---	Test Date:	12/15/17	Checked By:	MCM
Depth :	---	Test Id:	291536		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
GS-P07	7	12-14	Moist, very dark gray sandy silt (ASH)	46.7
GS-P08	8	10-12	Moist, very dark gray sandy silt (ASH)	39.3

Notes: Temperature of Drying : 60° Celsius

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	---	Sample Type:	---	Tested By:	twh
Sample ID:	---	Test Date:	12/15/17	Checked By:	MCM
Depth :	---	Test Id:	291526		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
GS-B03	2	4-6	Moist, dark brown clay with sand	17.4
GS-B03	8	24-26	Moist, dark grayish brown clay	32.3
GS-B03	14	48.5-50.5	Moist, grayish brown clayey sand	18.3
GS-B04	7	23.5-25.5	Moist, dark olive brown clay	31.2
GS-B04	9	33.5-35.5	Moist, very dark gray clay	61.3
GS-B04	10	38.5-40.5	Moist, brownish gray silty sand	22.5
GS-B05	6	18.5-20.5	Moist, dark grayish brown clay with sand	32.3
GS-B06	6	19-21	Moist, dark grayish brown clay	38.0
GS-P07	2	2-4	Moist, brown silty sand with gravel	8.9
GS-P07	5	8-10	Moist, brown silty gravel with sand	6.8

Notes: Temperature of Drying : 110° Celsius

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	---	Sample Type:	---	Tested By:	twh
Sample ID:	---	Test Date:	12/19/17	Checked By:	MCM
Depth :	---	Test Id:	291538		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
GS-P07	10	18-20	Moist, dark gray sandy clay	32.8
GS-P08	9	16-18	Moist, very dark gray clay	40.4

Notes: Temperature of Drying : 110° Celsius

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	---	Sample Type:	---	Tested By:	jm
Sample ID:	---	Test Date:	12/20/17	Checked By:	MCM
Depth :	---	Test Id:	291665		

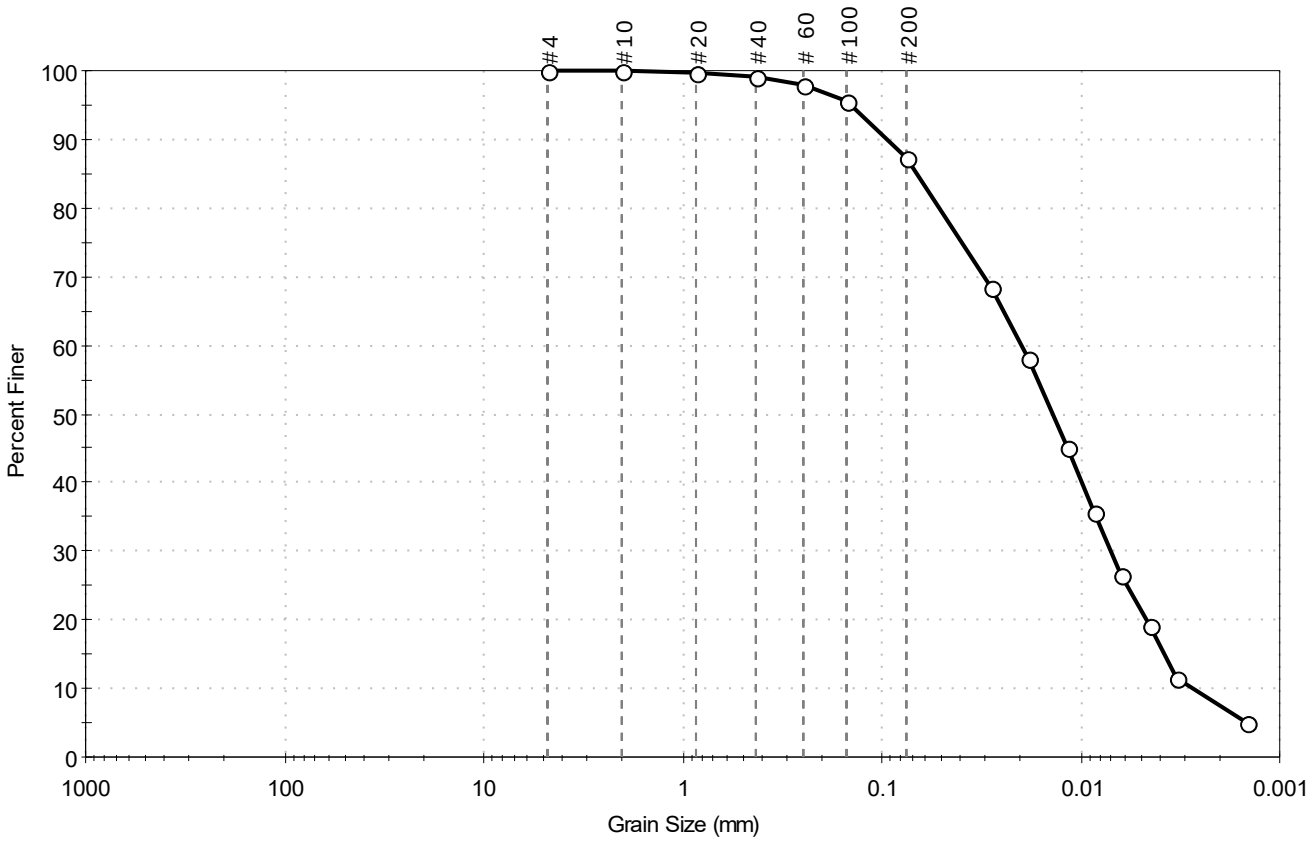
Specific Gravity of Soils by ASTM D854

Boring ID	Sample ID	Depth	Visual Description	Specific Gravity	Comment
GS-B03	5	14-16	Moist, dark gray silty sand (ASH)	2.29	
GS-B04	5	13.5-15.5	Moist, dark gray silty sand (ASH)	2.38	
GS-P07	7	12-14	Moist, very dark gray sandy silt (ASH)	2.38	

Notes: Specific Gravity performed by using method B (oven dried specimens) of ASTM D854
Moisture Content determined by ASTM D2216.

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B01	Sample Type:	tube	Tested By:	twh
Sample ID:	3	Test Date:	12/20/17	Checked By:	MCM
Depth :	5-7	Test Id:	291470		
Test Comment:	---				
Visual Description:	Moist, very dark gray silt (ASH)				
Sample Comment:	Moisture Content determined at 60°C for ash.				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	12.8	87.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
# 60	0.25	98		
#100	0.15	96		
#200	0.075	87		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0280	68		
---	0.0182	58		
---	0.0117	45		
---	0.0086	36		
---	0.0063	27		
---	0.0045	19		
---	0.0033	12		
---	0.0014	5		

Coefficients

D_{85} = 0.0668 mm	D_{30} = 0.0070 mm
D_{60} = 0.0196 mm	D_{15} = 0.0038 mm
D_{50} = 0.0138 mm	D_{10} = 0.0027 mm
C_u = 7.259	C_c = 0.926

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

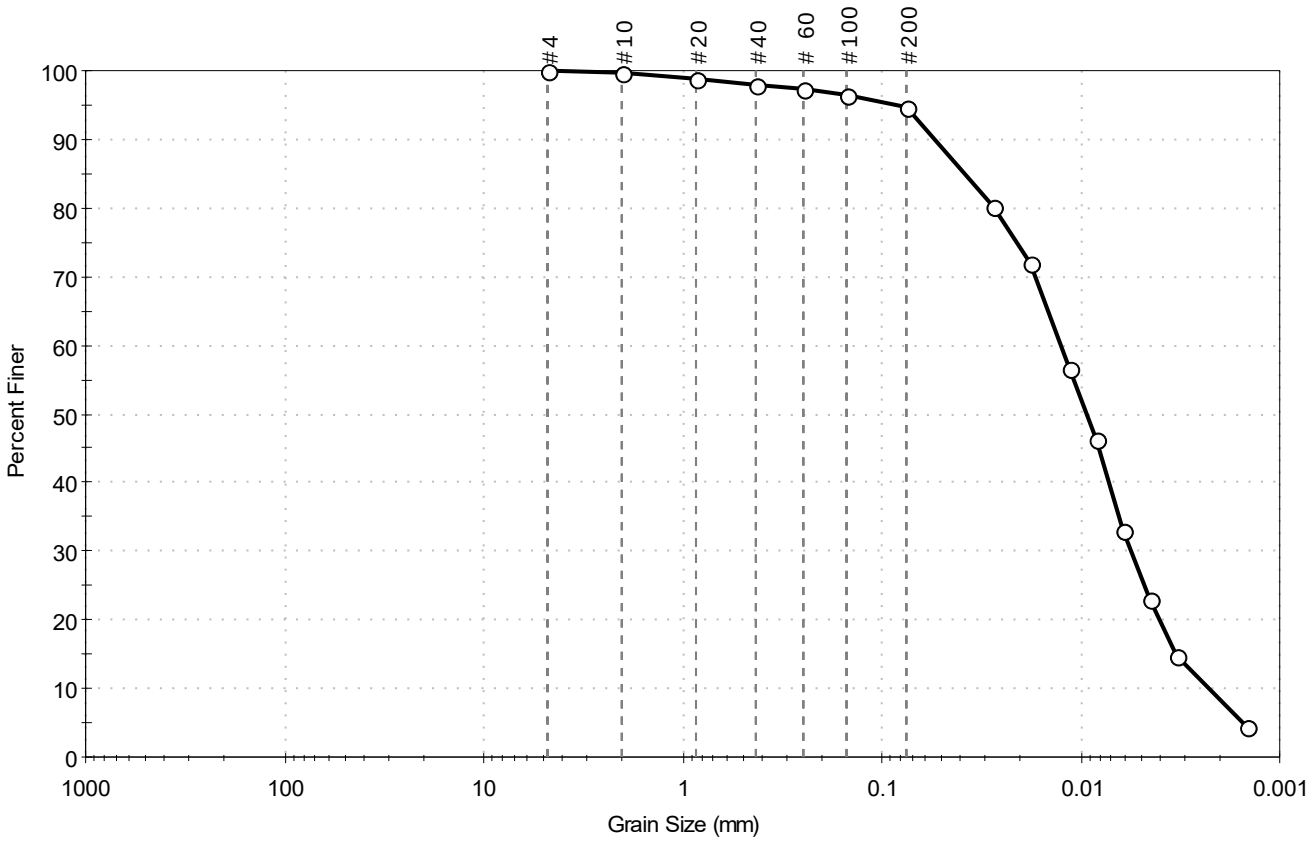
Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B01	Sample Type:	tube	Tested By:	twh
Sample ID:	4	Test Date:	12/20/17	Checked By:	MCM
Depth :	7.5-9.5	Test Id:	291488		
Test Comment:	---				
Visual Description:	Moist, dark gray silt (ASH)				
Sample Comment:	Moisture Content determined at 60°C for ash.				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	5.2	94.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	98		
# 60	0.25	97		
#100	0.15	97		
#200	0.075	95		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0274	80		
---	0.0178	72		
---	0.0113	57		
---	0.0084	46		
---	0.0062	33		
---	0.0045	23		
---	0.0033	15		
---	0.0015	5		

Coefficients

D_{85} = 0.0383 mm	D_{30} = 0.0056 mm
D_{60} = 0.0125 mm	D_{15} = 0.0033 mm
D_{50} = 0.0093 mm	D_{10} = 0.0022 mm
C_u = 5.682	C_c = 1.140

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

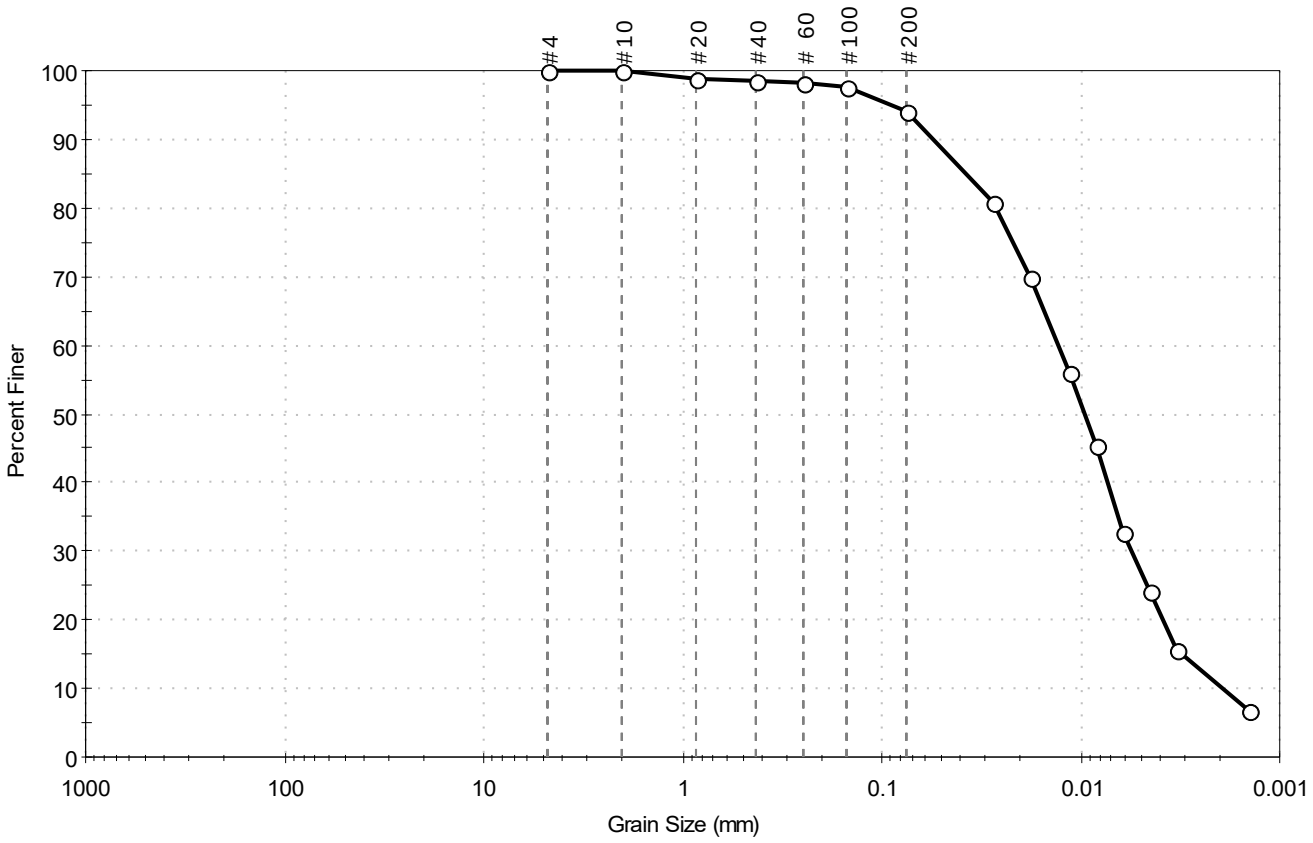
Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B02	Sample Type:	tube	Tested By:	twh
Sample ID:	1	Test Date:	12/20/17	Checked By:	MCM
Depth :	5-7	Test Id:	291492		

Test Comment: ---
Visual Description: Moist, dark gray silt (ASH)
Sample Comment: Moisture Content determined at 60°C for ash.

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	5.8	94.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	99		
# 60	0.25	98		
#100	0.15	98		
#200	0.075	94		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0277	81		
---	0.0181	70		
---	0.0114	56		
---	0.0085	45		
---	0.0062	33		
---	0.0045	24		
---	0.0033	15		
---	0.0014	7		

Coefficients

D_{85} = 0.0380 mm D_{30} = 0.0056 mm
D_{60} = 0.0129 mm D_{15} = 0.0031 mm
D_{50} = 0.0096 mm D_{10} = 0.0019 mm
C_u = 6.789 C_c = 1.279

Classification

ASTM N/A

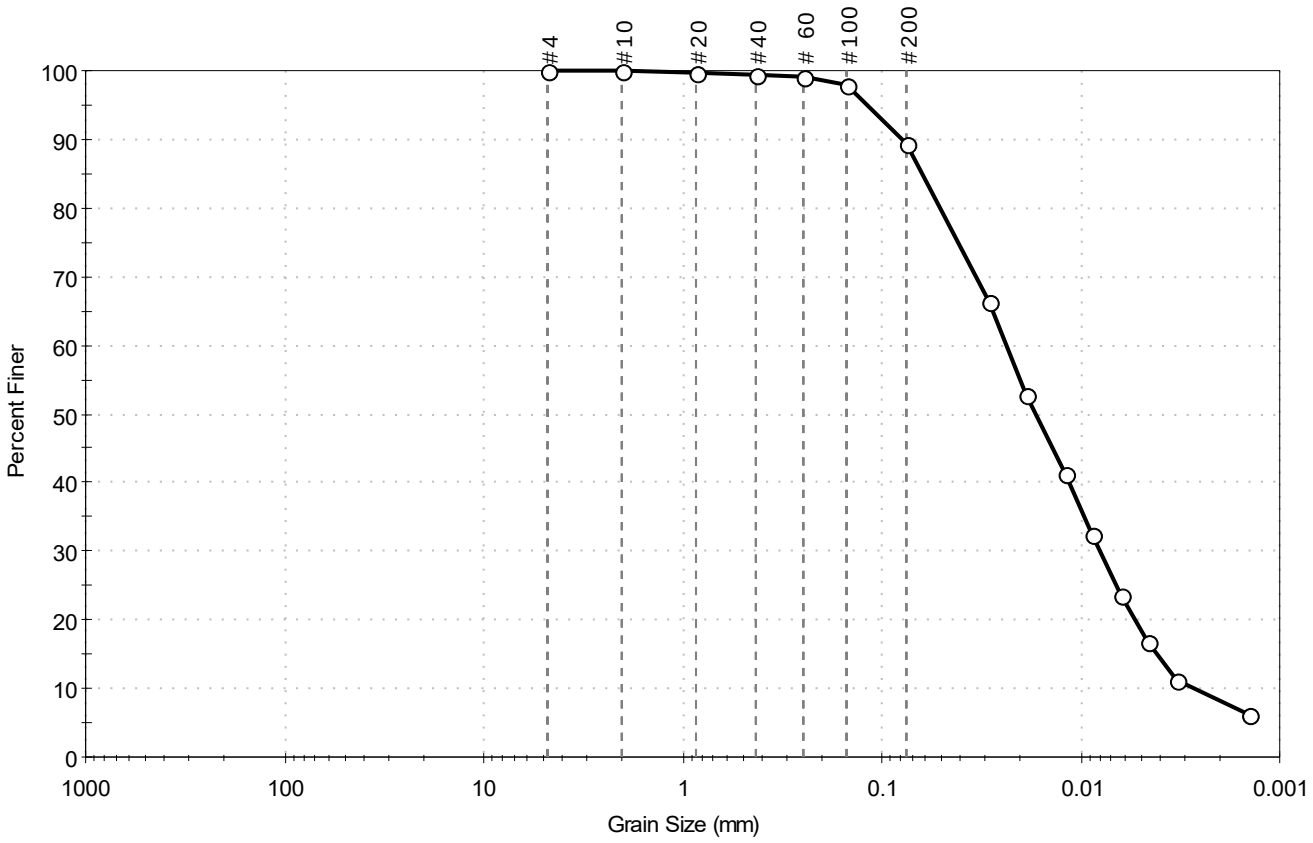
AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Specific Gravity : 2.65
Separation of Sample: #200 Sieve

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B02	Sample Type:	tube	Tested By:	twh
Sample ID:	2	Test Date:	12/20/17	Checked By:	MCM
Depth :	7-9	Test Id:	291493		
Test Comment:	---				
Visual Description:	Moist, dark gray silt (ASH)				
Sample Comment:	Moisture Content determined at 60°C for ash.				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	10.6	89.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
# 60	0.25	99		
#100	0.15	98		
#200	0.075	89		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0287	66		
---	0.0190	53		
---	0.0119	41		
---	0.0087	32		
---	0.0064	24		
---	0.0046	17		
---	0.0033	11		
---	0.0014	6		

Coefficients

D_{85} = 0.0625 mm	D_{30} = 0.0079 mm
D_{60} = 0.0236 mm	D_{15} = 0.0041 mm
D_{50} = 0.0169 mm	D_{10} = 0.0027 mm
C_u = 8.741	C_c = 0.979

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

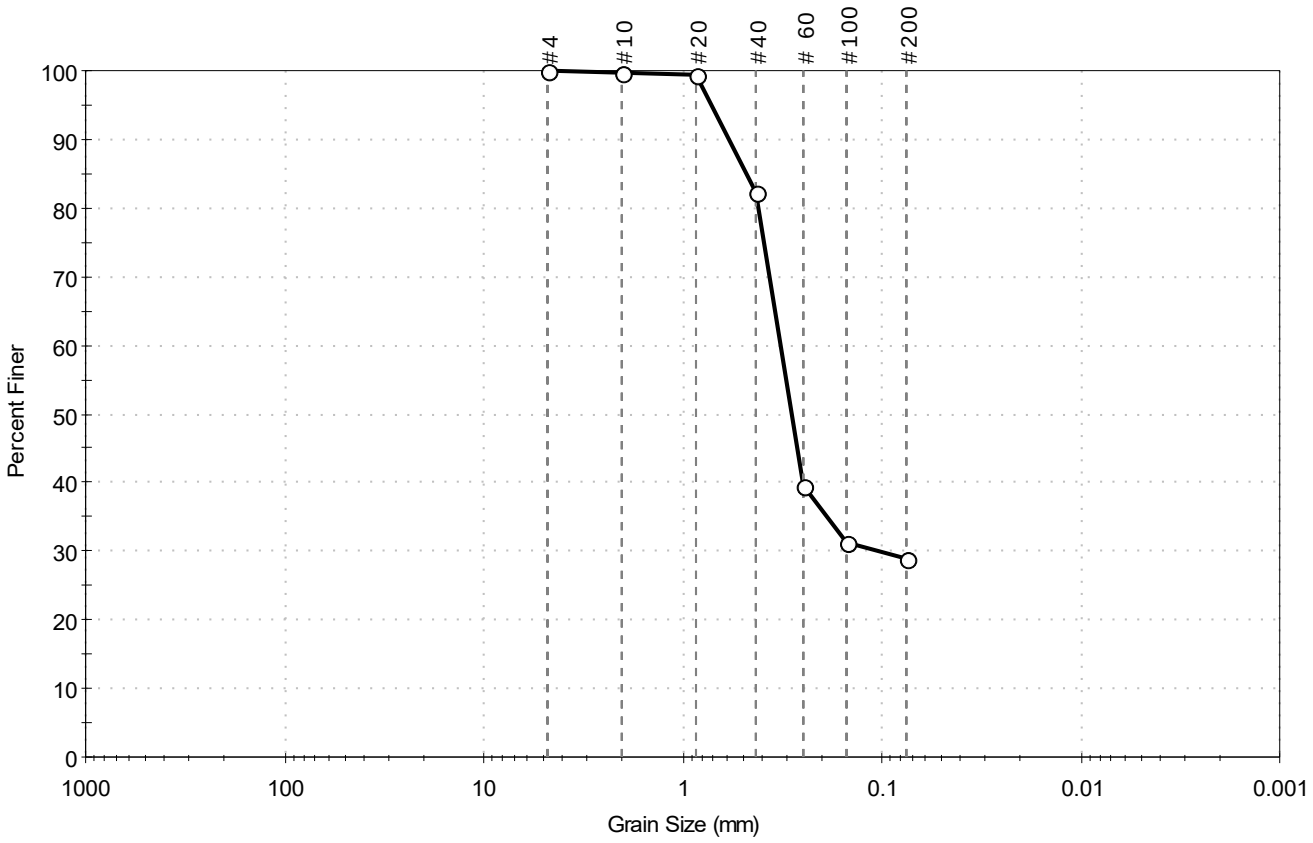
Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B03	Sample Type:	bag	Tested By:	twh
Sample ID:	14	Test Date:	12/15/17	Checked By:	MCM
Depth :	48.5-50.5	Test Id:	291507		
Test Comment:	---				
Visual Description:	Moist, grayish brown clayey sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	71.2	28.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	82		
# 60	0.25	39		
#100	0.15	31		
#200	0.075	29		

Coefficients

D_{85} = 0.4745 mm	D_{30} = 0.1058 mm
D_{60} = 0.3226 mm	D_{15} = N/A
D_{50} = 0.2850 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

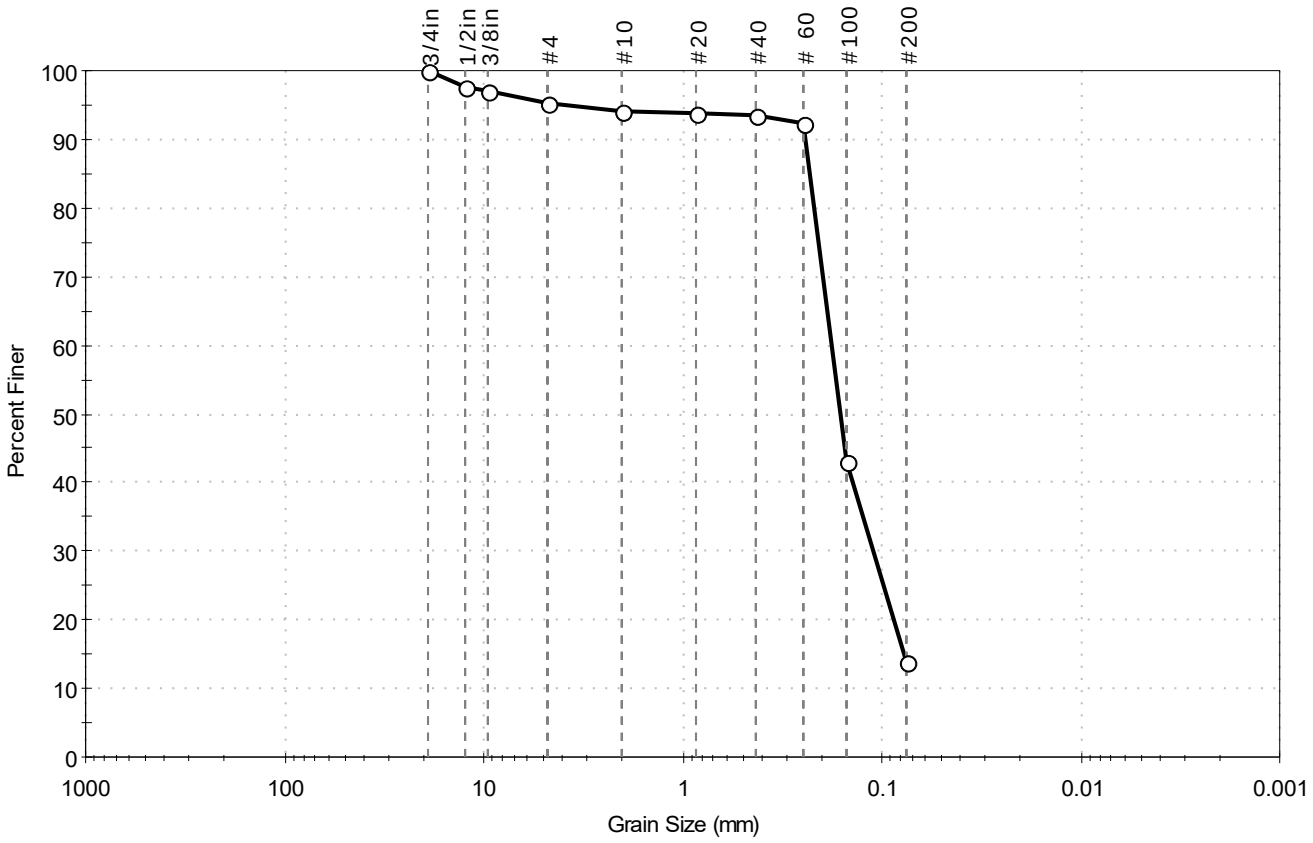
Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B04	Sample Type:	tube	Tested By:	twh
Sample ID:	10	Test Date:	12/15/17	Checked By:	MCM
Depth :	38.5-40.5	Test Id:	291520		
Test Comment:	---				
Visual Description:	Moist, brownish gray silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	4.9	81.1	14.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4in	19.00	100		
1/2in	12.50	98		
3/8in	9.50	97		
#4	4.75	95		
#10	2.00	94		
#20	0.85	94		
#40	0.42	93		
# 60	0.25	92		
#100	0.15	43		
#200	0.075	14		

Coefficients

D_{85} = 0.2318 mm
D_{30} = 0.1098 mm
D_{60} = 0.1788 mm
D_{15} = 0.0768 mm
D_{50} = 0.1611 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

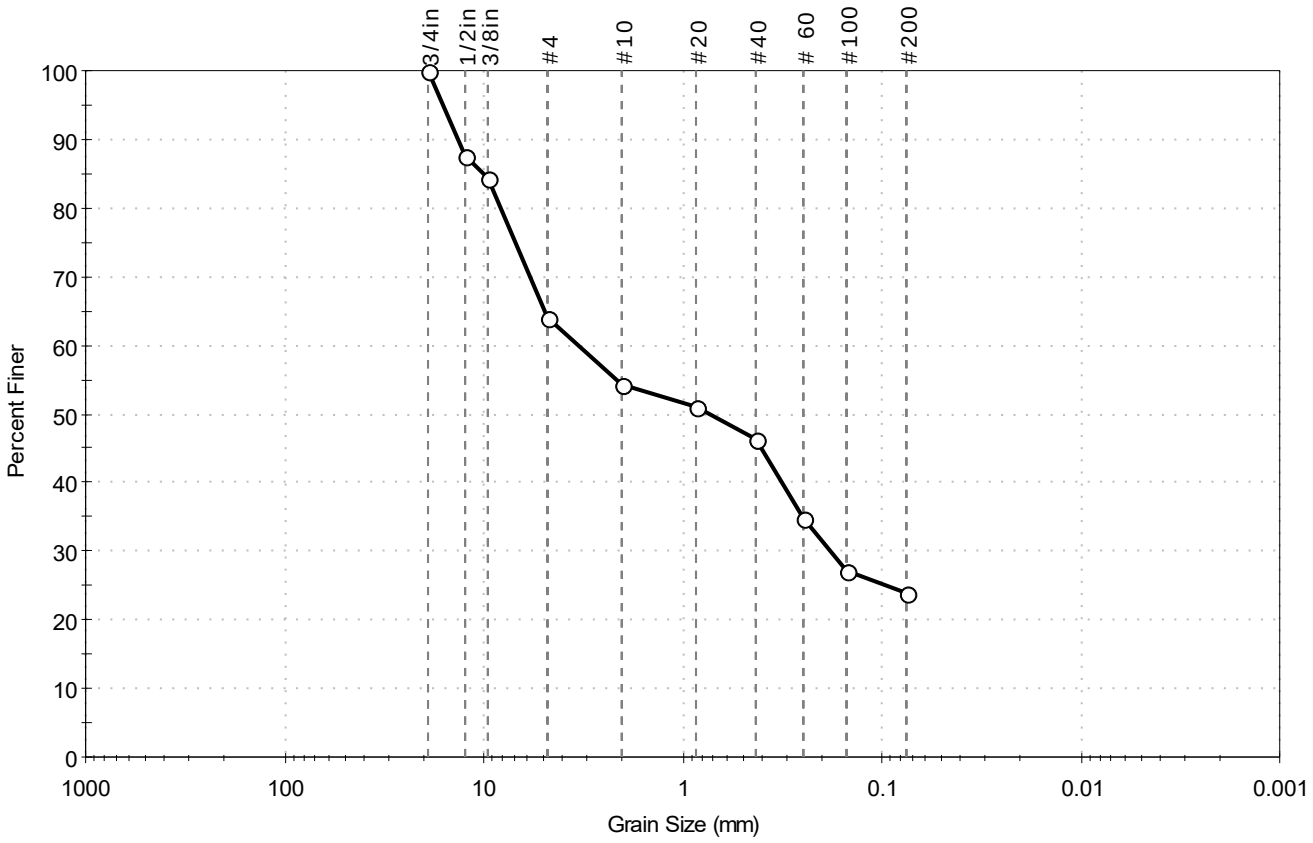
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-P07	Sample Type:	bag	Tested By:	twh
Sample ID:	2	Test Date:	12/15/17	Checked By:	MCM
Depth :	2-4	Test Id:	291528		
Test Comment:	---				
Visual Description:	Moist, brown silty sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	36.1	40.0	23.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4in	19.00	100		
1/2in	12.50	88		
3/8in	9.50	84		
#4	4.75	64		
#10	2.00	54		
#20	0.85	51		
#40	0.42	46		
# 60	0.25	35		
#100	0.15	27		
#200	0.075	24		

Coefficients

D_{85} = 10.0976 mm	D_{30} = 0.1821 mm
D_{60} = 3.3473 mm	D_{15} = N/A
D_{50} = 0.7446 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

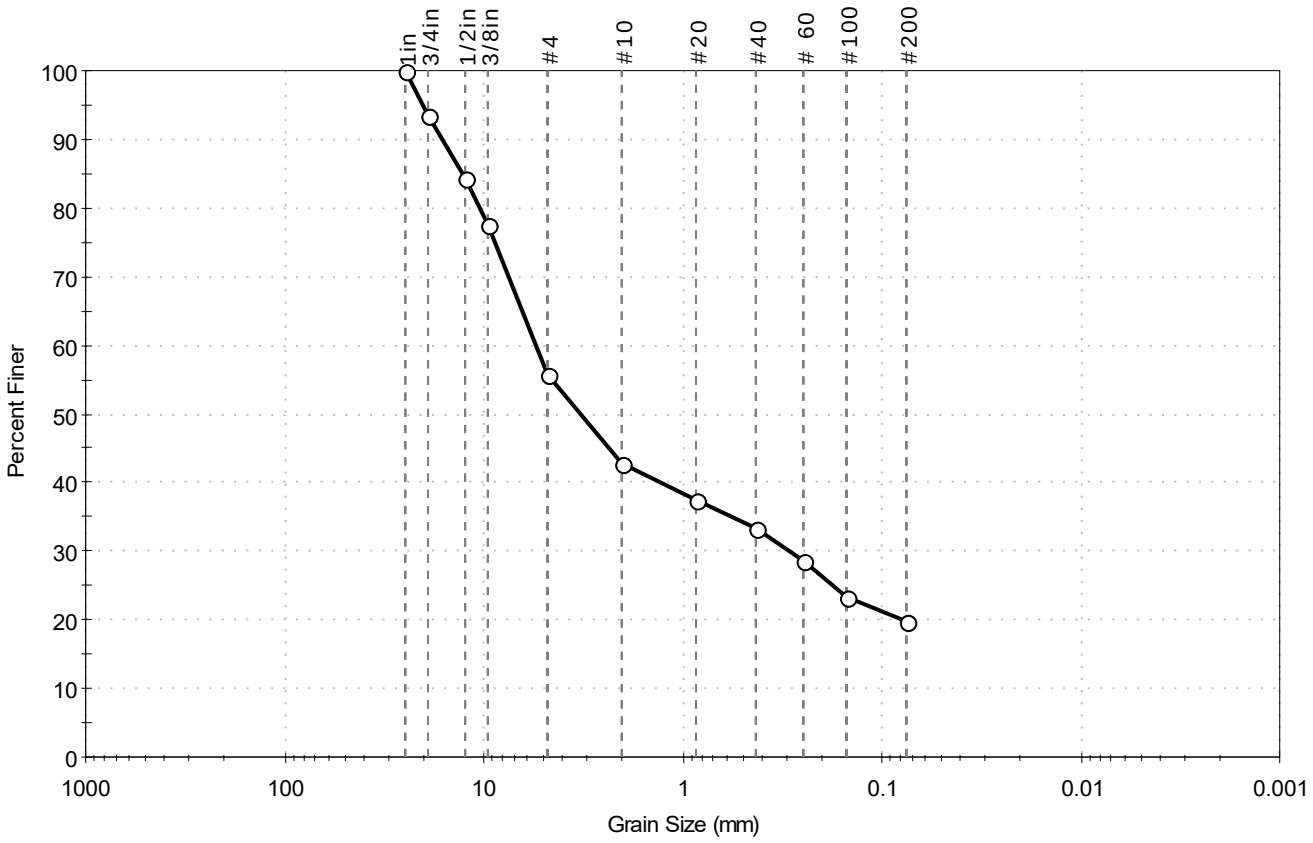
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-P07	Sample Type:	bag	Tested By:	twh
Sample ID:	5	Test Date:	12/15/17	Checked By:	MCM
Depth :	8-10	Test Id:	291529		
Test Comment:	---				
Visual Description:	Moist, brown silty gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	44.2	36.0	19.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1in	25.00	100		
3/4in	19.00	94		
1/2in	12.50	84		
3/8in	9.50	78		
#4	4.75	56		
#10	2.00	43		
#20	0.85	37		
#40	0.42	33		
# 60	0.25	29		
#100	0.15	23		
#200	0.075	20		

Coefficients

D_{85} = 12.8376 mm	D_{30} = 0.2928 mm
D_{60} = 5.4299 mm	D_{15} = N/A
D_{50} = 3.2422 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

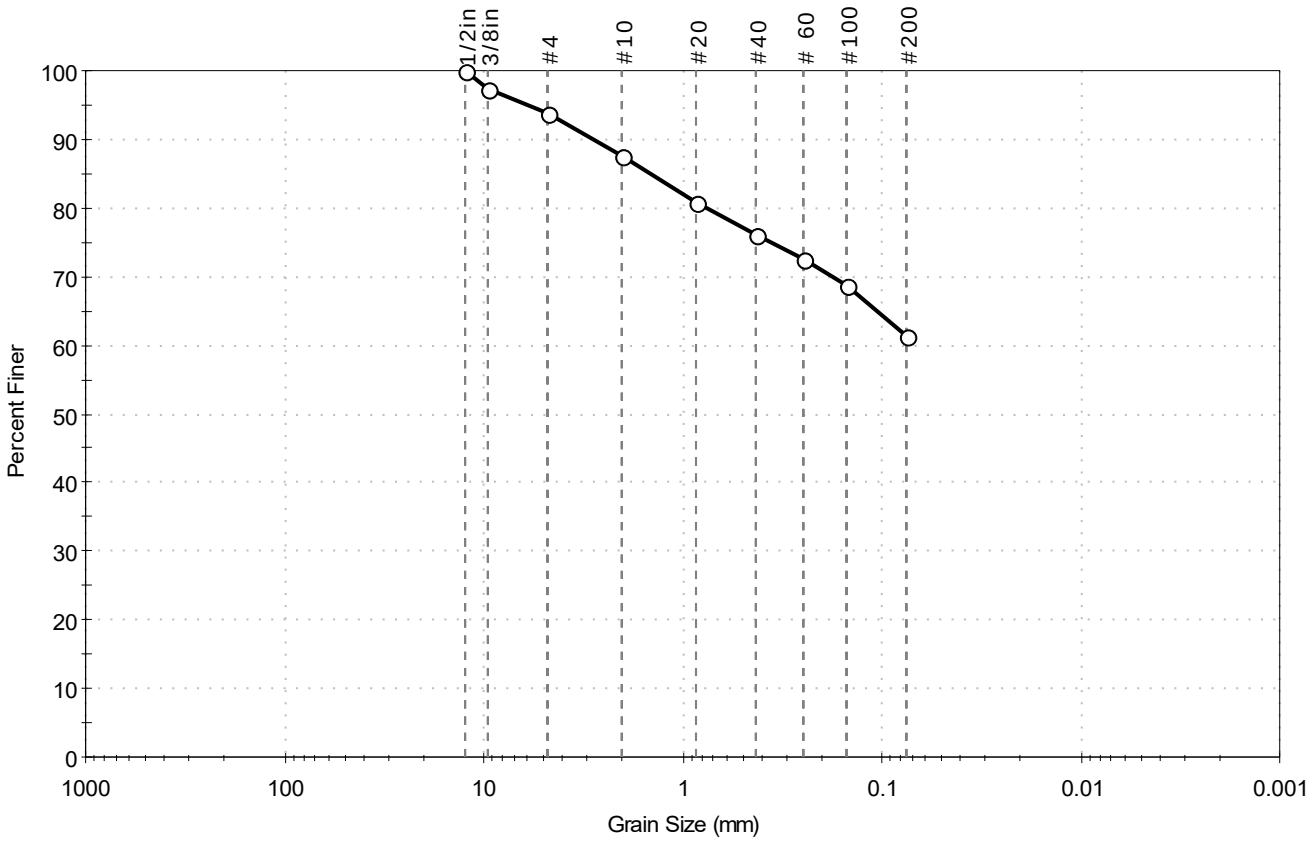
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-P07	Sample Type:	bag	Tested By:	twh
Sample ID:	7	Test Date:	12/15/17	Checked By:	MCM
Depth :	12-14	Test Id:	291530		
Test Comment:	---				
Visual Description:	Moist, very dark gray sandy silt (ASH)				
Sample Comment:	Moisture Content determined at 60°C for ash.				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.1	32.7	61.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2in	12.50	100		
3/8in	9.50	97		
#4	4.75	94		
#10	2.00	88		
#20	0.85	81		
#40	0.42	76		
# 60	0.25	73		
#100	0.15	69		
#200	0.075	61		

Coefficients

D_{85} = 1.4357 mm	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Sandy Silt (ML)

AASHTO Silty Soils (A-4 (0))

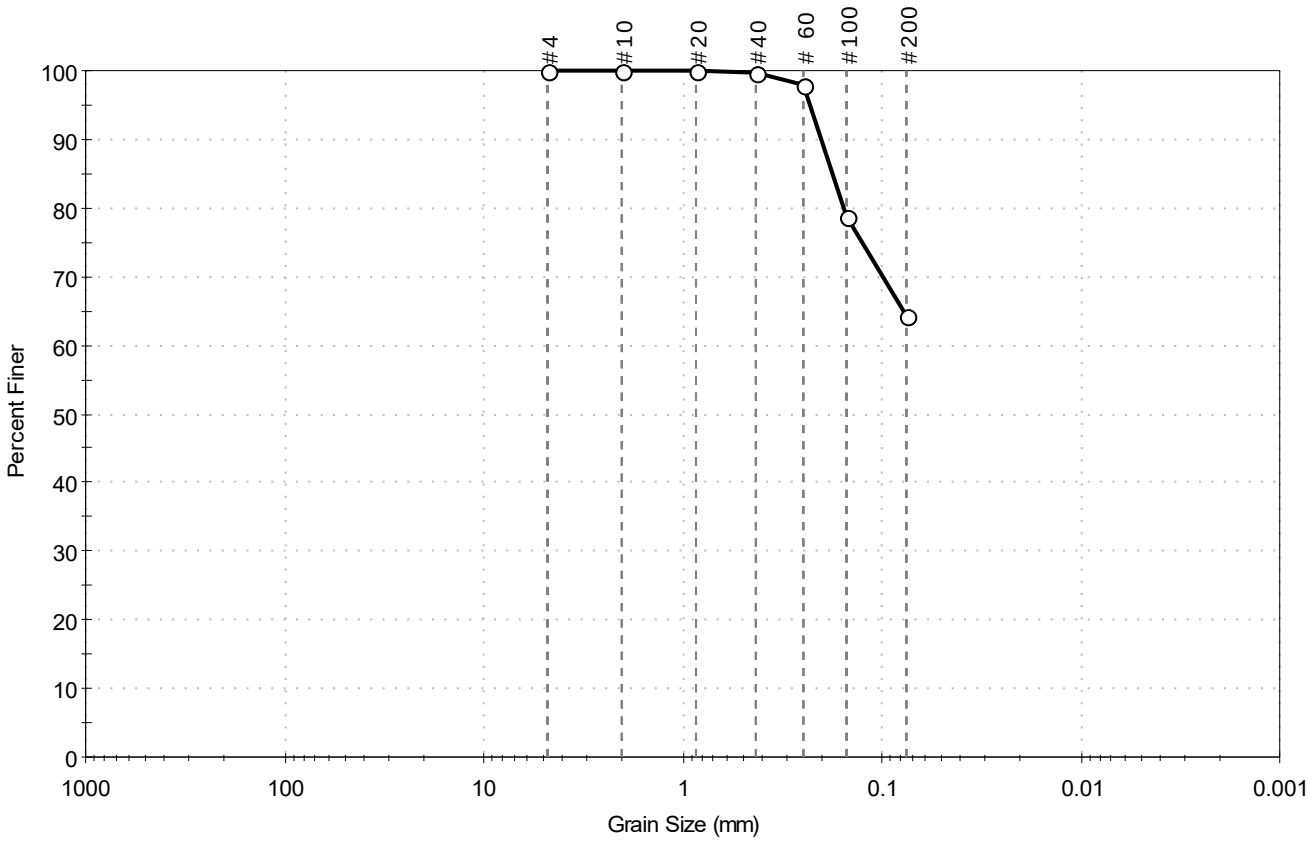
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-P07	Sample Type:	tube	Tested By:	twh
Sample ID:	10	Test Date:	12/19/17	Checked By:	MCM
Depth :	18-20	Test Id:	291533		
Test Comment:	---				
Visual Description:	Moist, dark gray sandy clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	35.8	64.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
# 60	0.25	98		
#100	0.15	79		
#200	0.075	64		

Coefficients

D_{85} = 0.1775 mm	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Sandy Lean clay (CL)

AASHTO Clayey Soils (A-7-6 (13))

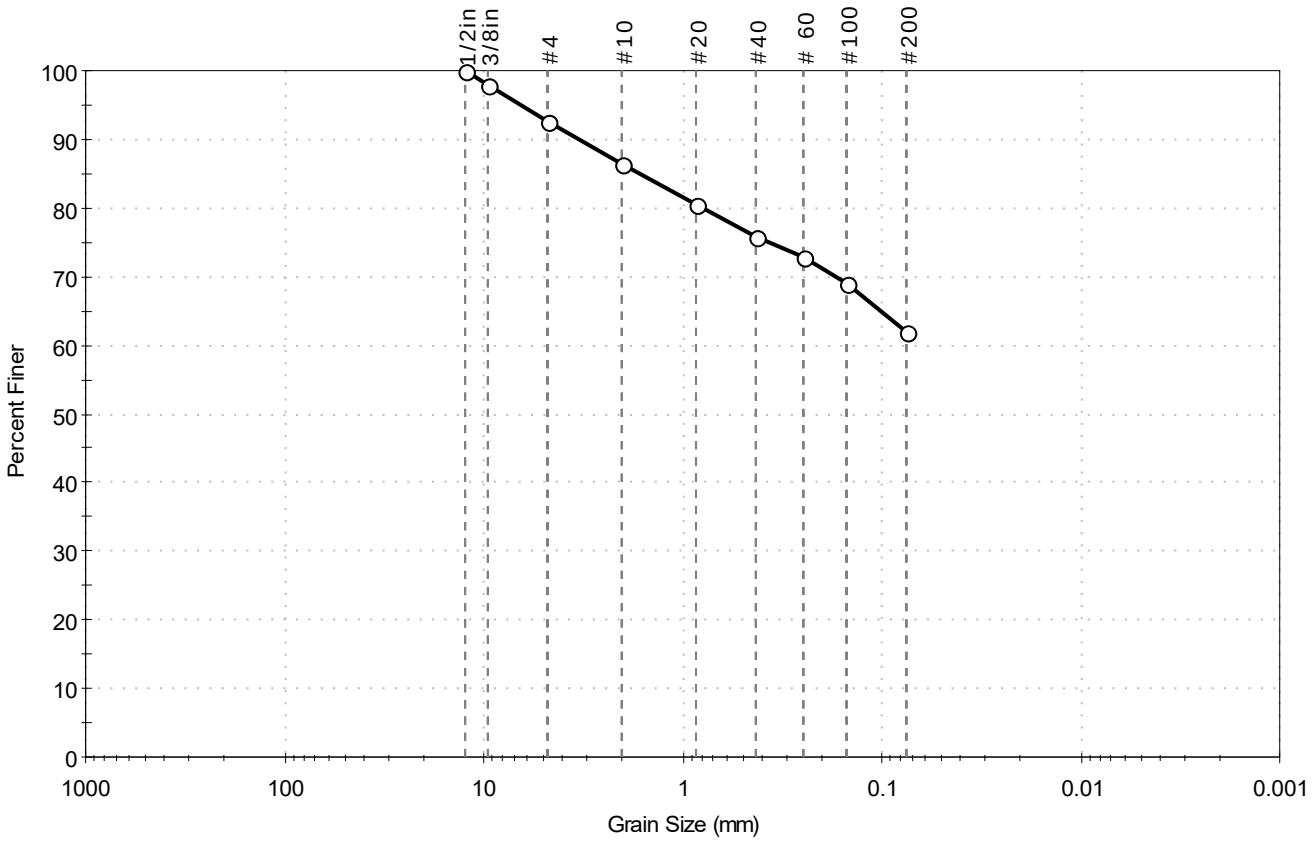
Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-P08	Sample Type:	bag	Tested By:	twh
Sample ID:	8	Test Date:	12/15/17	Checked By:	MCM
Depth :	10-12	Test Id:	291537		
Test Comment:	---				
Visual Description:	Moist, very dark gray sandy silt (ASH)				
Sample Comment:	Moisture Content determined at 60°C for ash.				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	7.5	30.7	61.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2in	12.50	100		
3/8in	9.50	98		
#4	4.75	93		
#10	2.00	87		
#20	0.85	80		
#40	0.42	76		
# 60	0.25	73		
#100	0.15	69		
#200	0.075	62		

Coefficients

D_{85} = 1.6110 mm D_{30} = N/A

D_{60} = N/A D_{15} = N/A

D_{50} = N/A D_{10} = N/A

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

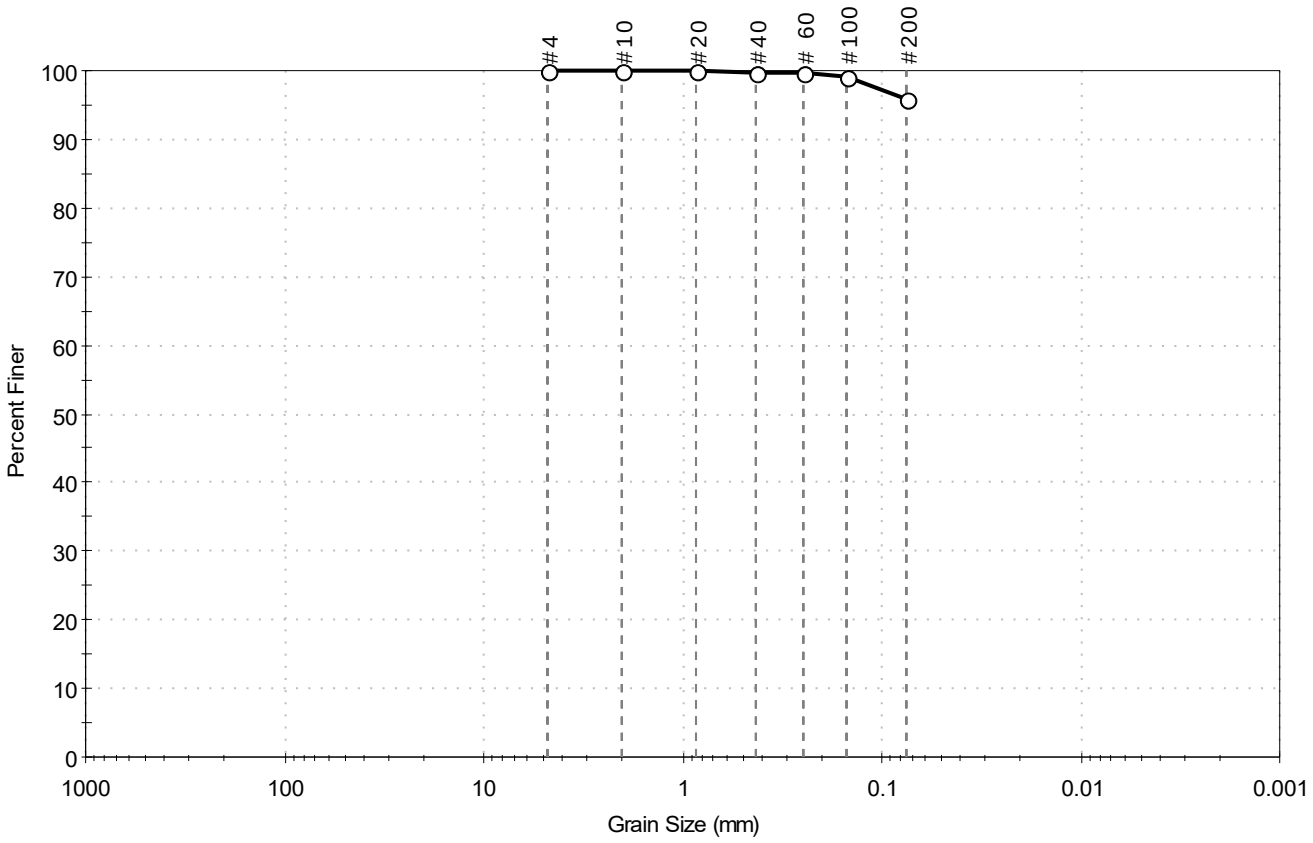
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-P08	Sample Type:	tube	Tested By:	twh
Sample ID:	9	Test Date:	12/19/17	Checked By:	MCM
Depth :	16-18	Test Id:	291539		
Test Comment:	---				
Visual Description:	Moist, very dark gray clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	4.1	95.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
# 60	0.25	100		
#100	0.15	99		
#200	0.075	96		

Coefficients

D_{85} = N/A	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Fat clay (CH)

AASHTO Clayey Soils (A-7-6 (40))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B03	Sample Type:	bag	Tested By:	twh
Sample ID:	4	Test Date:	12/19/17	Checked By:	MCM
Depth :	9-11	Test Id:	291500		
Test Comment:	---				
Visual Description:	Moist, very dark gray silty sand (ASH)				
Sample Comment:	Moisture Content determined at 60°C for ash.				

Atterberg Limits - ASTM D4318

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	4	GS-B03	9-11	63	n/a	n/a	n/a	n/a	

Dry Strength: NONE

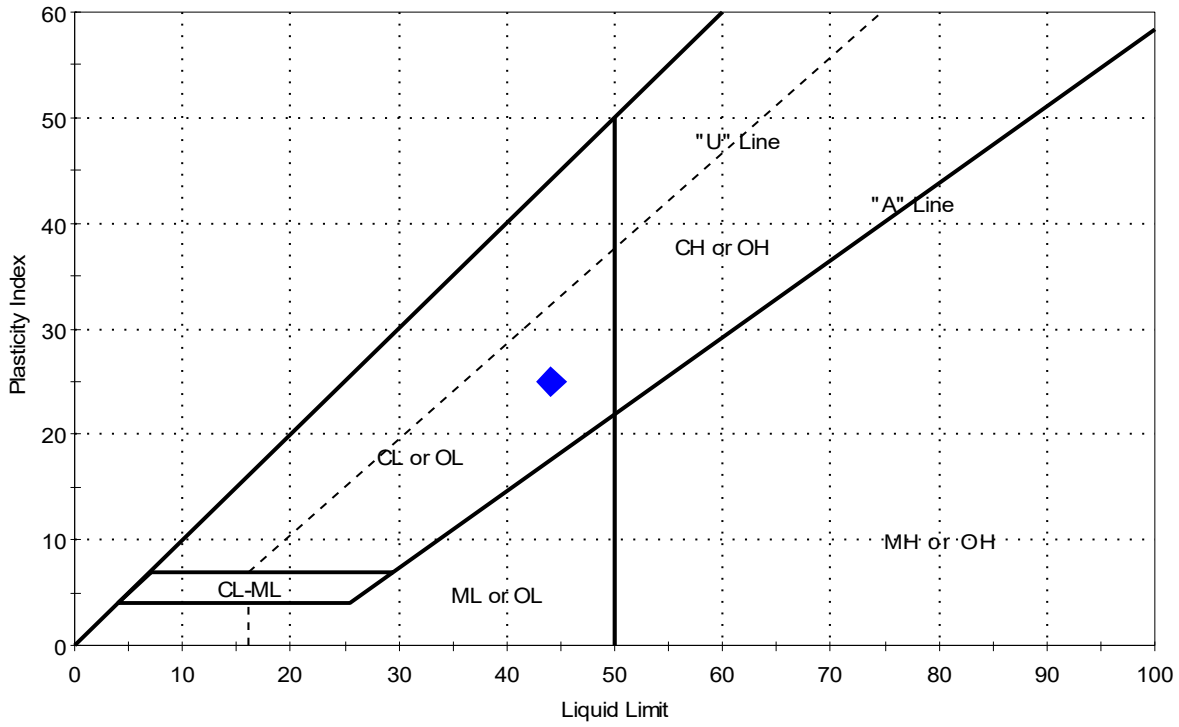
Dilatancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B03	Sample Type:	tube	Tested By:	twh
Sample ID:	8	Test Date:	12/19/17	Checked By:	MCM
Depth :	24-26	Test Id:	291503		
Test Comment:	---				
Visual Description:	Moist, dark grayish brown clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	8	GS-B03	24-26	32	44	19	25	0.5	

Sample Prepared using the WET method

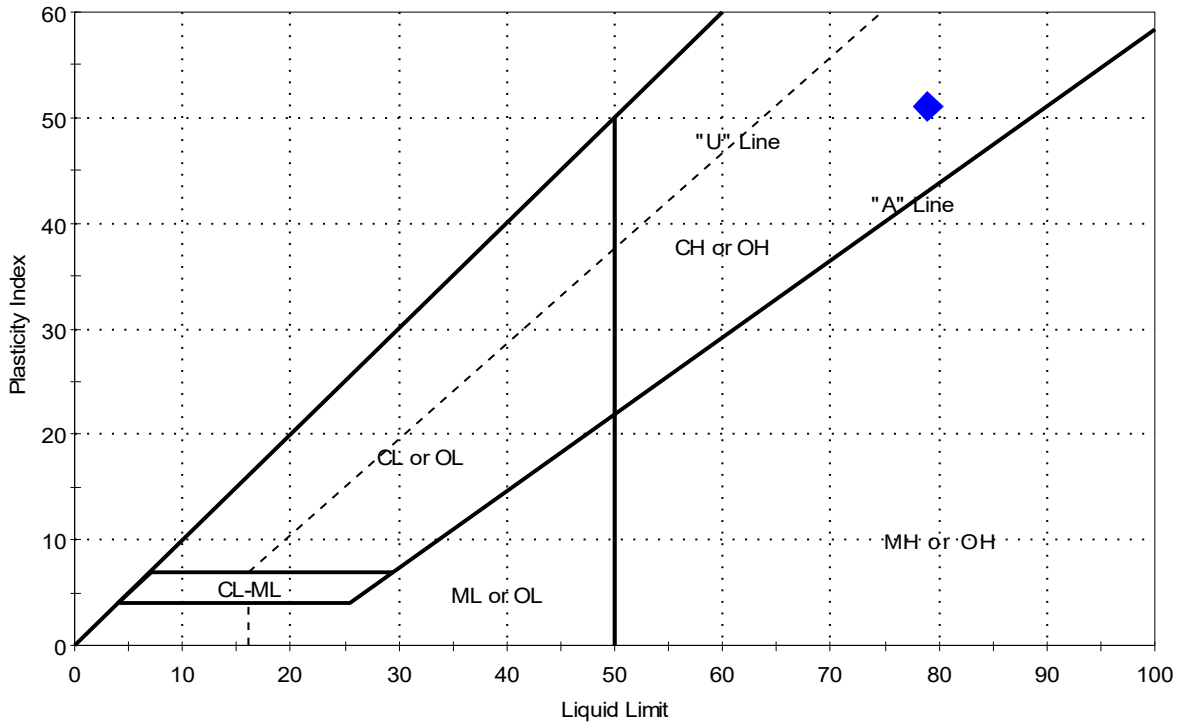
Dry Strength: HIGH

Dilatancy: NONE

Toughness: MEDIUM

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B03	Sample Type:	bag	Tested By:	twh
Sample ID:	12	Test Date:	12/19/17	Checked By:	MCM
Depth :	39-41	Test Id:	291506		
Test Comment:	---				
Visual Description:	Moist, very dark gray clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	12	GS-B03	39-41	50	79	28	51	0.4	

Sample Prepared using the WET method

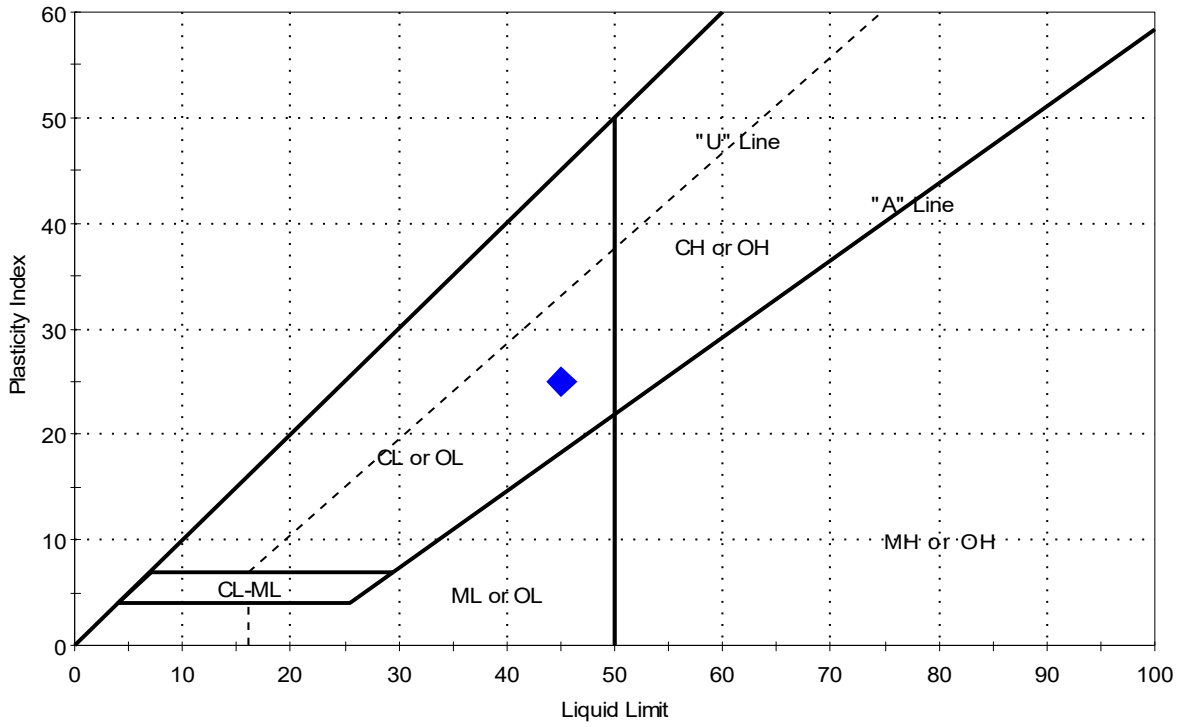
Dry Strength: HIGH

Dilatancy: NONE

Toughness: MEDIUM

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B04	Sample Type:	tube	Tested By:	twh
Sample ID:	7	Test Date:	12/19/17	Checked By:	MCM
Depth :	23.5-25.5	Test Id:	291514		
Test Comment:	---				
Visual Description:	Moist, dark olive brown clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	7	GS-B04	23.5-25.5	31	45	20	25	0.4	

Sample Prepared using the WET method

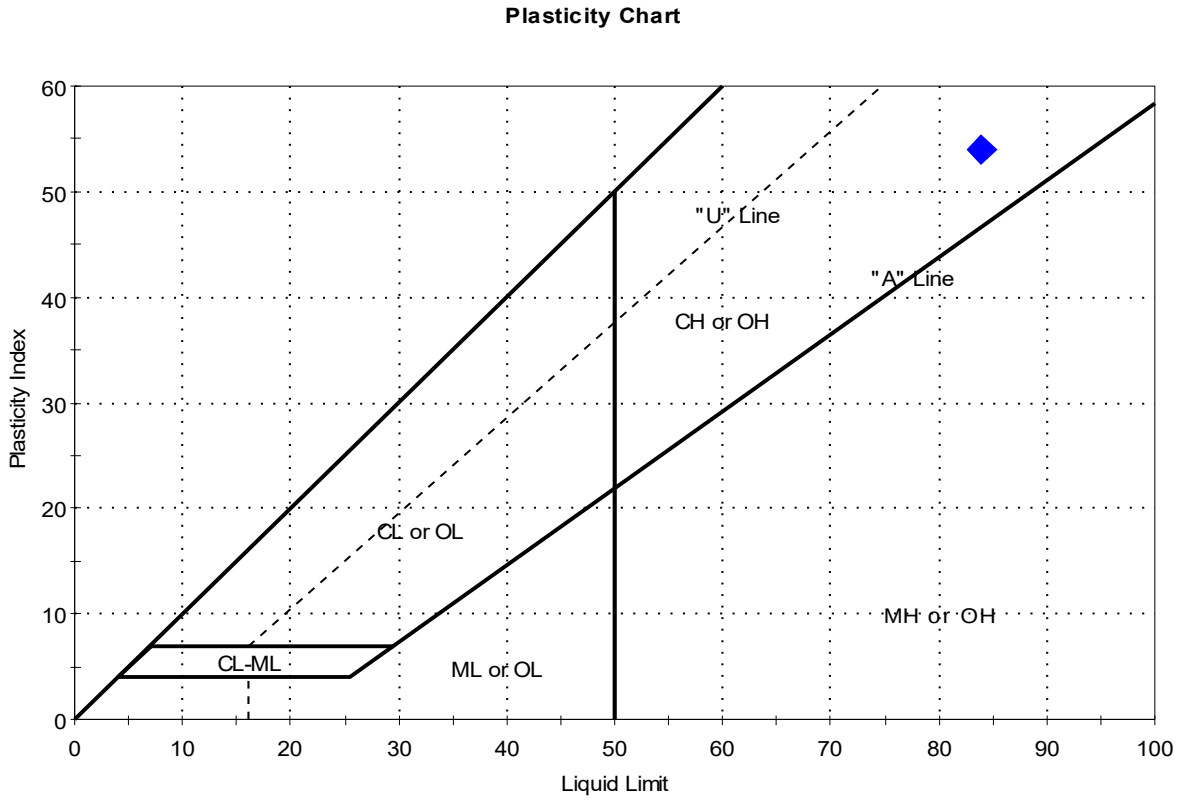
Dry Strength: HIGH

Dilatancy: NONE

Toughness: MEDIUM

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-B04	Sample Type:	tube	Tested By:	twh
Sample ID:	9	Test Date:	12/19/17	Checked By:	MCM
Depth :	33.5-35.5	Test Id:	291515		
Test Comment:	---				
Visual Description:	Moist, very dark gray clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	9	GS-B04	33.5-35.5	61	84	30	54	0.6	

Sample Prepared using the WET method

Dry Strength: HIGH

Dilatancy: NONE

Toughness: MEDIUM

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-P07	Sample Type:	bag	Tested By:	twh
Sample ID:	7	Test Date:	12/15/17	Checked By:	MCM
Depth :	12-14	Test Id:	291531		
Test Comment:	---				
Visual Description:	Moist, very dark gray sandy silt (ASH)				
Sample Comment:	Moisture Content determined at 60°C for ash.				

Atterberg Limits - ASTM D4318

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	7	GS-P07	12-14	47	n/a	n/a	n/a	n/a	Sandy Silt (ML)

24% Retained on #40 Sieve

Dry Strength: NONE

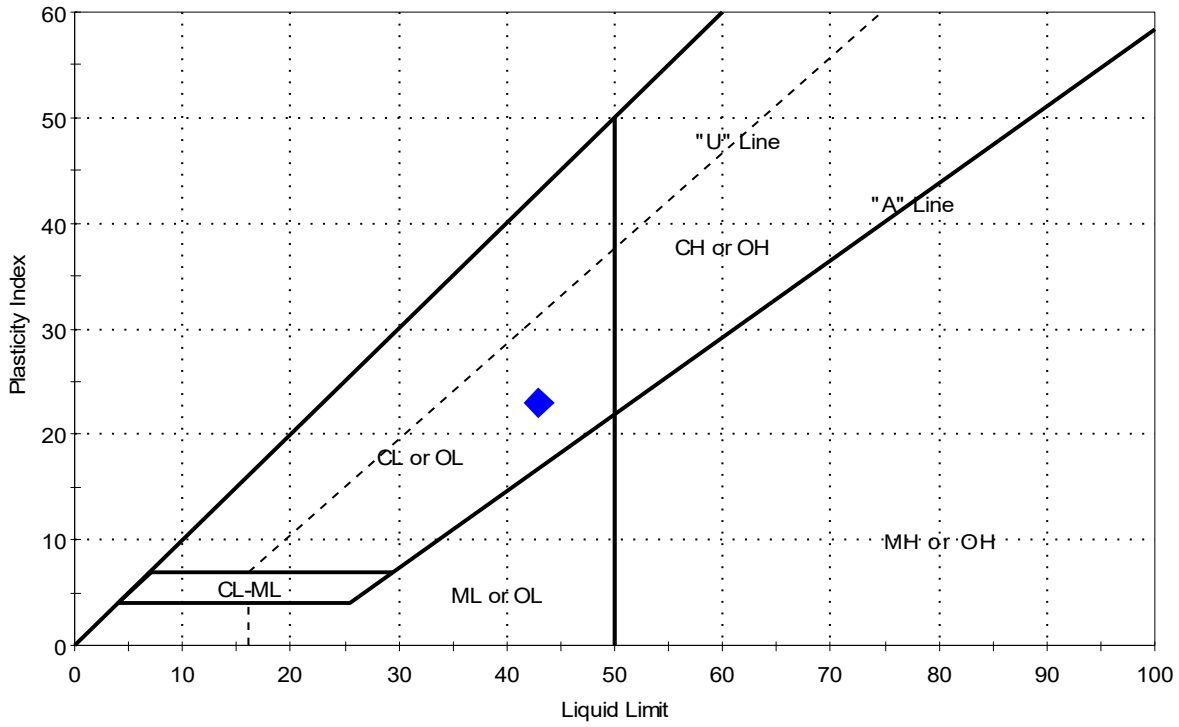
Dilatancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-P07	Sample Type:	tube	Tested By:	twh
Sample ID:	10	Test Date:	12/18/17	Checked By:	MCM
Depth :	18-20	Test Id:	291534		
Test Comment:	---				
Visual Description:	Moist, dark gray sandy clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	10	GS-P07	18-20	33	43	20	23	0.6	Sandy Lean clay (CL)

Sample Prepared using the WET method

0% Retained on #40 Sieve

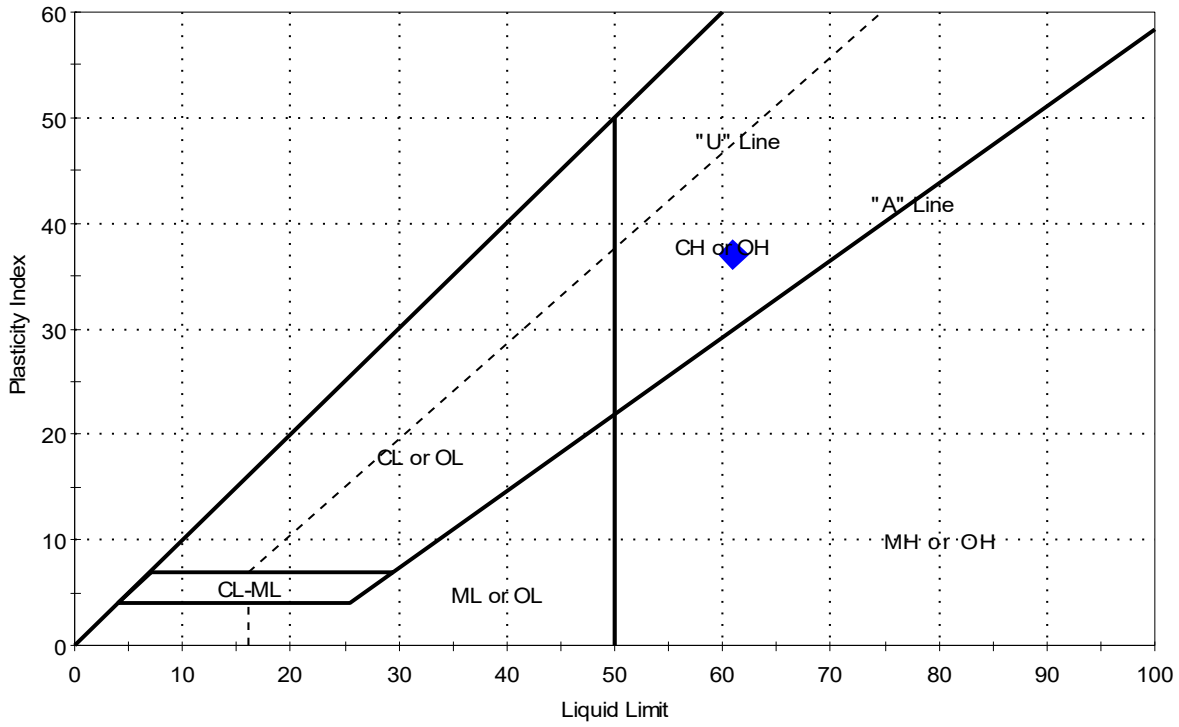
Dry Strength: HIGH

Dilatancy: NONE

Toughness: MEDIUM

Client:	Geosyntec Consultants				
Project:	Dynergy-Hennepin West Ash Ponds				
Location:	Hennepin, Illinois			Project No:	GTX-307367
Boring ID:	GS-P08	Sample Type:	tube	Tested By:	twh
Sample ID:	9	Test Date:	12/19/17	Checked By:	MCM
Depth :	16-18	Test Id:	291540		
Test Comment:	---				
Visual Description:	Moist, very dark gray clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	9	GS-P08	16-18	40	61	24	37	0.4	Fat clay (CH)

Sample Prepared using the WET method

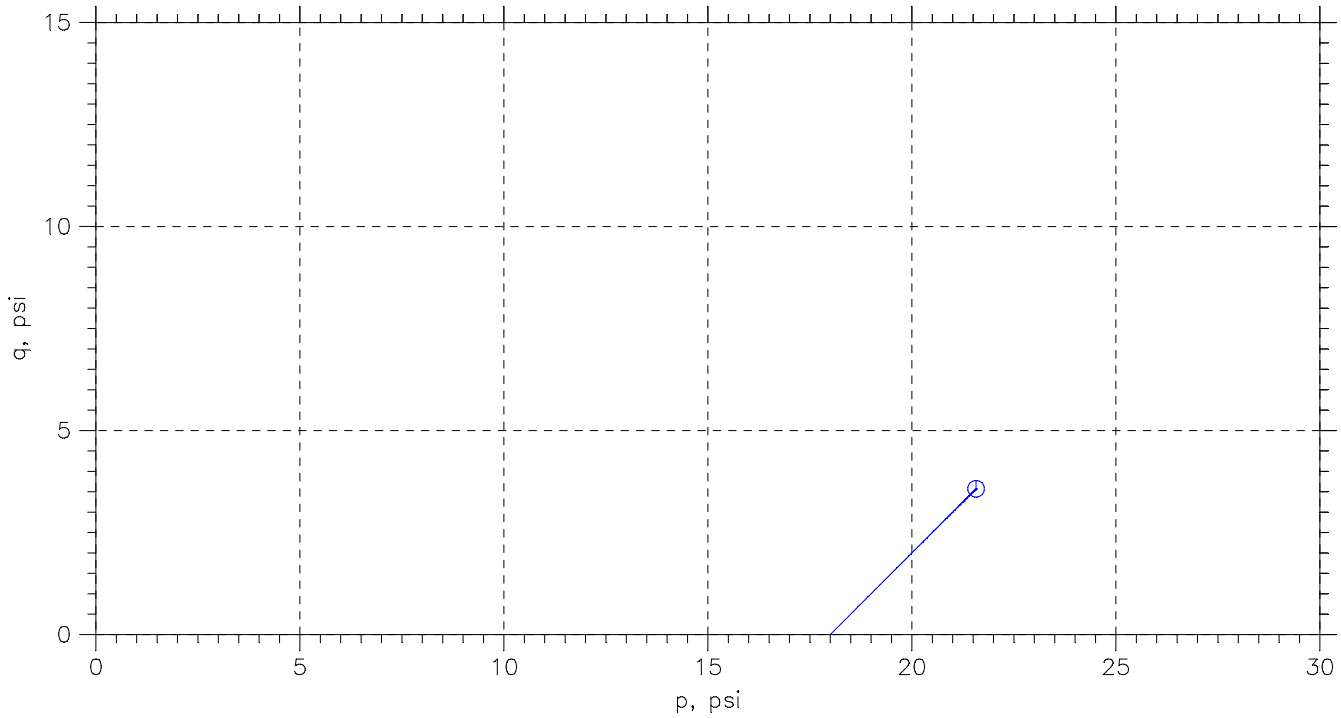
0% Retained on #40 Sieve

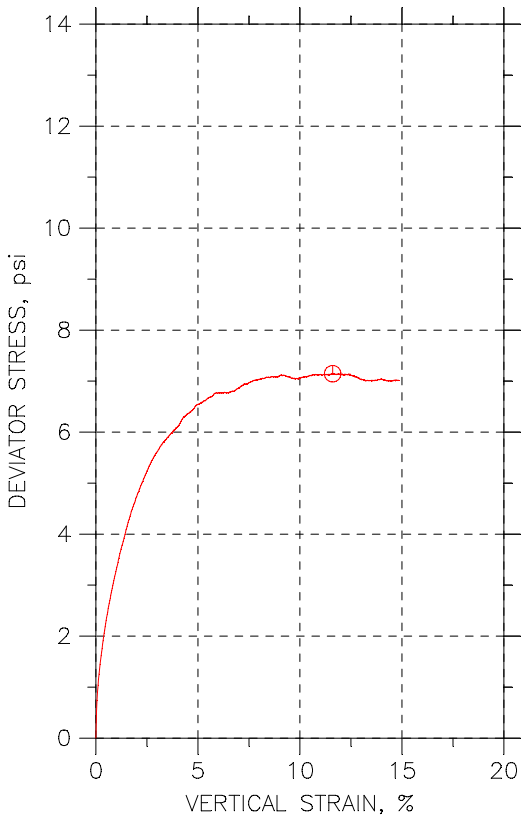
Dry Strength: HIGH

Dilatancy: NONE

Toughness: MEDIUM

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏲			
Sample No.	8			
Test No.	UU-1			
Depth	24-26 ft			
Tested by	jm			
Test Date	12/19/17			
Checked by	mcm			
Check Date	12/21/17			
Diameter, in	2.87			
Height, in	5.999			
Water Content, %	32.3			
Dry Density, pcf	89.54			
Saturation, %	99.0			
Void Ratio	0.882			
Confining Stress, psi	18			
Undrained Strength, psi	3.573			
Max. Dev. Stress, psi	7.145			
Strain at Failure, %	11.6			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	44			
Plastic Limit	19			
Plasticity Index	25			

GeoTesting EXPRESS

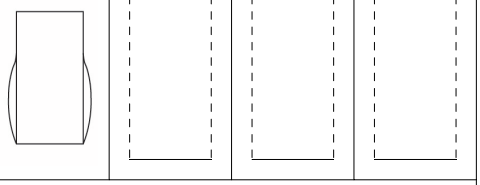
Project: Dynegy - Hennepin West As

Location: Hennepin, IL

Project No.: GTX-307367

Boring No.: GS-B03

Sample Type: intact

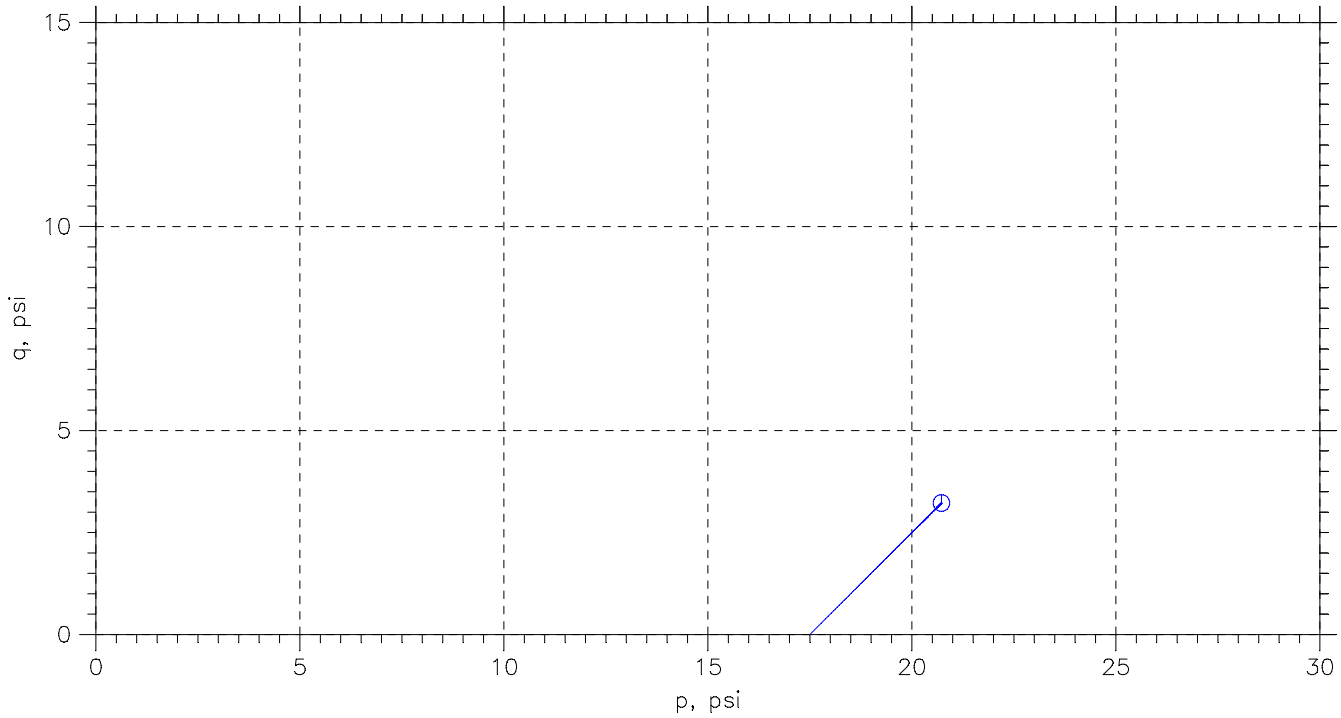


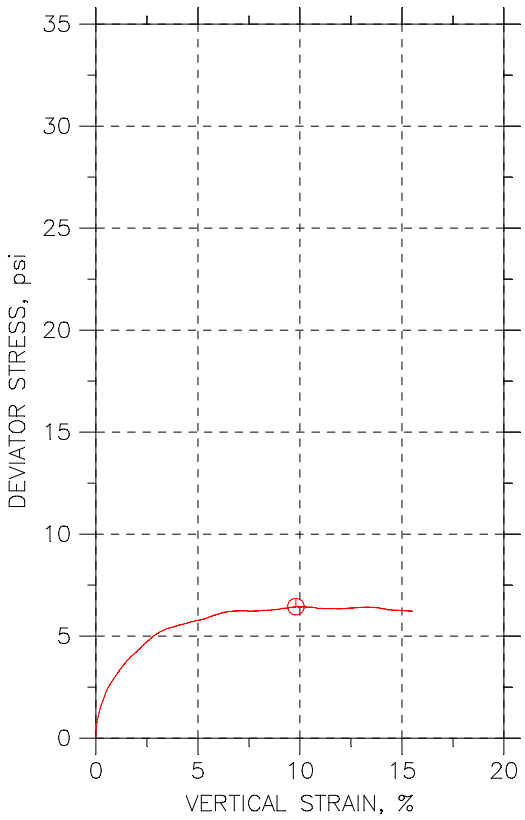
Description: Moist, dark grayish brown clay

Remarks: System 2054

Phase calculations based on start and end of test.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏲			
Sample No.	7			
Test No.	UU-2			
Depth	23.5-25. ft			
Tested by	jm			
Test Date	12/19/17			
Checked by	mcm			
Check Date	**12/21/17**			
Diameter, in	2.86			
Height, in	5.777			
Water Content, %	31.2			
Dry Density, pcf	91.			
Saturation, %	98.9			
Void Ratio	0.852			
Confining Stress, psi	17.5			
Undrained Strength, psi	3.223			
Max. Dev. Stress, psi	6.446			
Strain at Failure, %	9.8			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	45			
Plastic Limit	20			
Plasticity Index	25			

GeoTesting EXPRESS

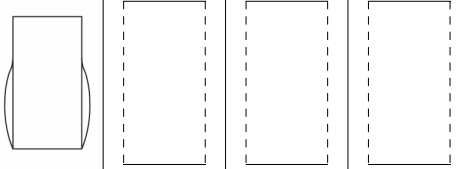
Project: Dynegy - Hennepin West As

Location: Hennepin, IL

Project No.: GTX-307367

Boring No.: GS-B04

Sample Type: intact

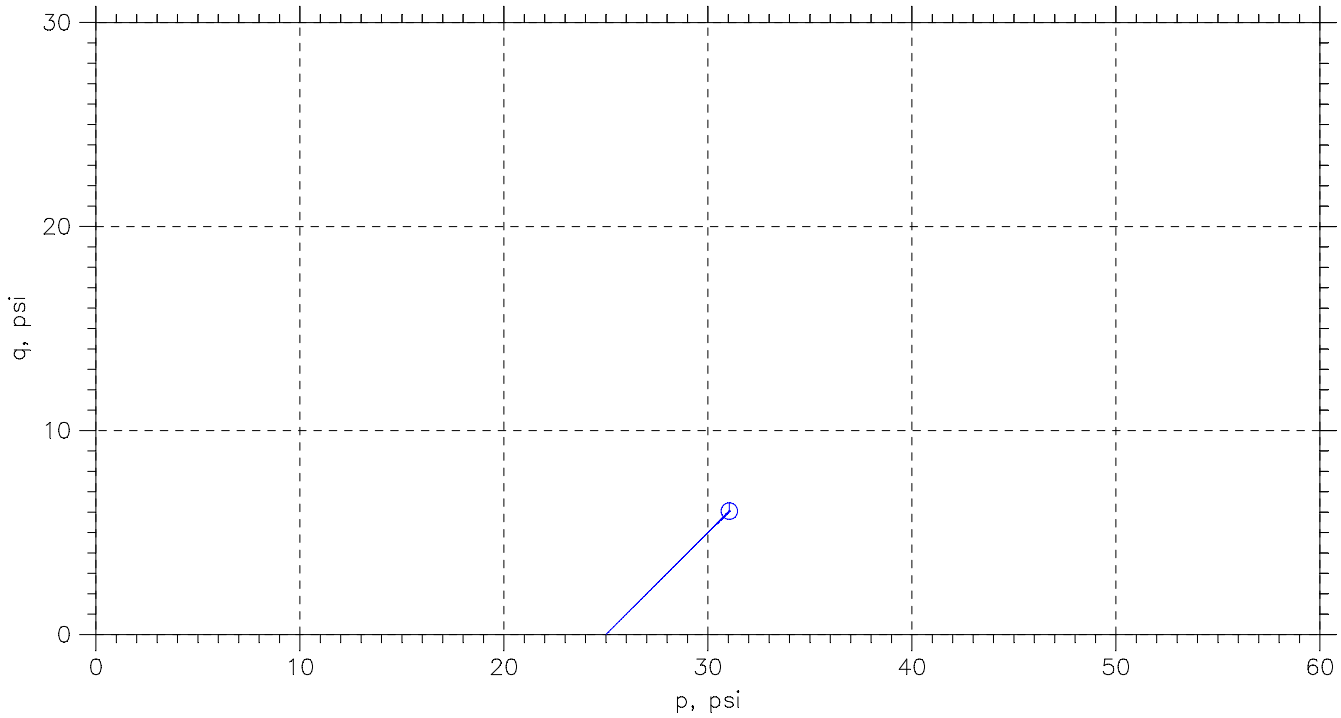


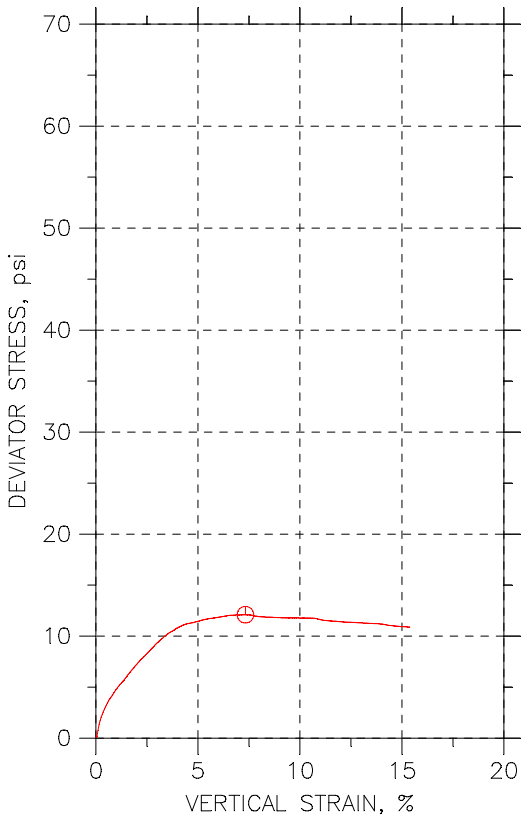
Description: Moist, dark olive brown clay

Remarks: System 2054

Phase calculations based on start and end of test.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏲			
Sample No.	9			
Test No.	UU-3			
Depth	33.5-35.5ft			
Tested by	jm			
Test Date	12/19/17			
Checked by	mcm			
Check Date	**12/21/17**			
Diameter, in	2.85			
Height, in	5.932			
Water Content, %	61.3			
Dry Density, pcf	63.25			
Saturation, %	99.4			
Void Ratio	1.66			
Confining Stress, psi	25			
Undrained Strength, psi	6.048			
Max. Dev. Stress, psi	12.1			
Strain at Failure, %	7.33			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	84			
Plastic Limit	30			
Plasticity Index	54			

GeoTesting EXPRESS

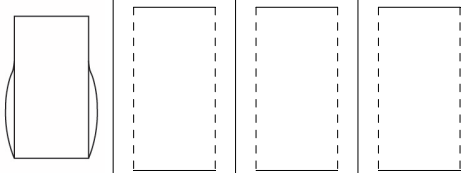
Project: Dynegy - Hennepin West As

Location: Hennepin, IL

Project No.: GTX-307367

Boring No.: GS-B04

Sample Type: intact



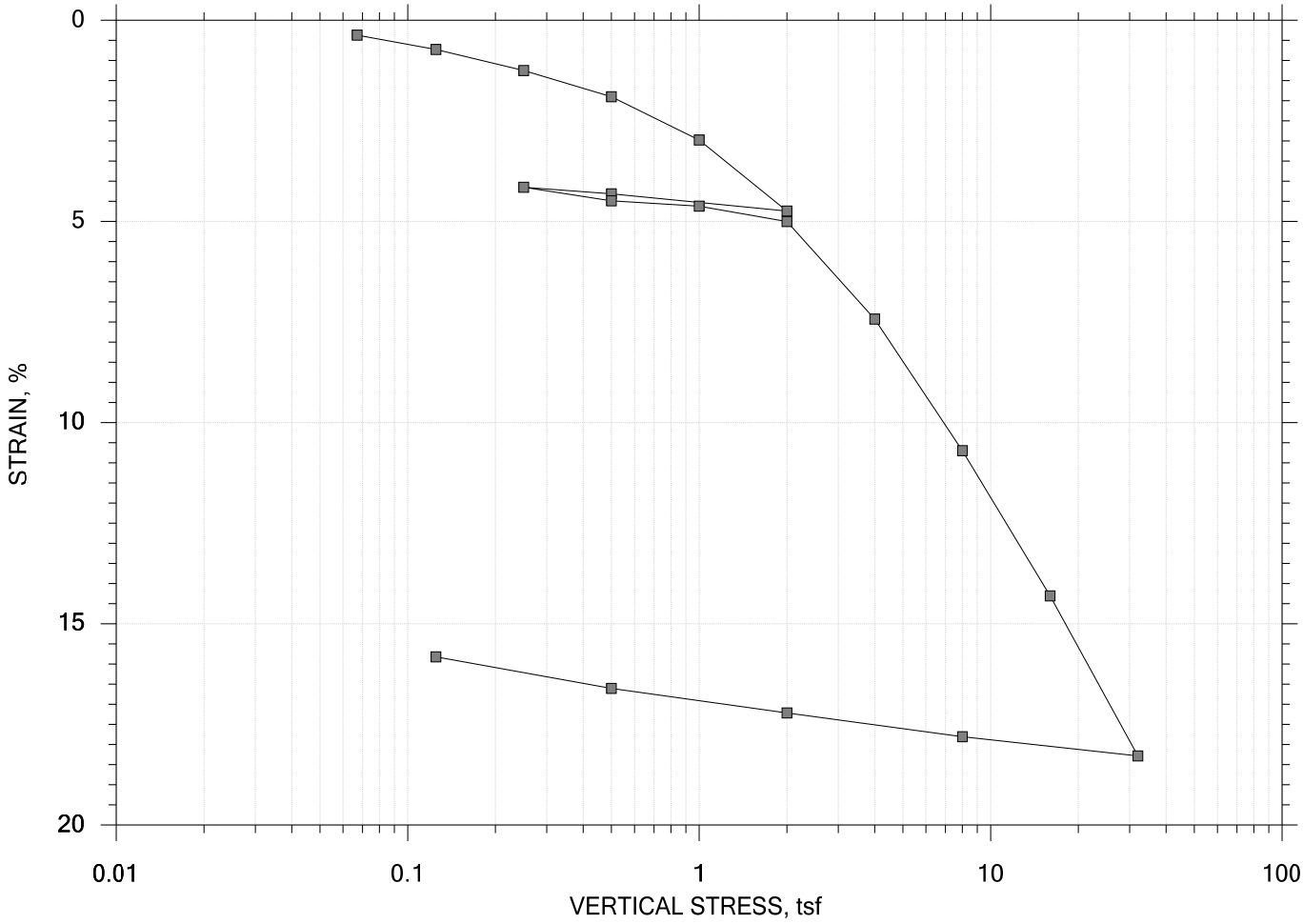
Description: Moist, very dark gray clay

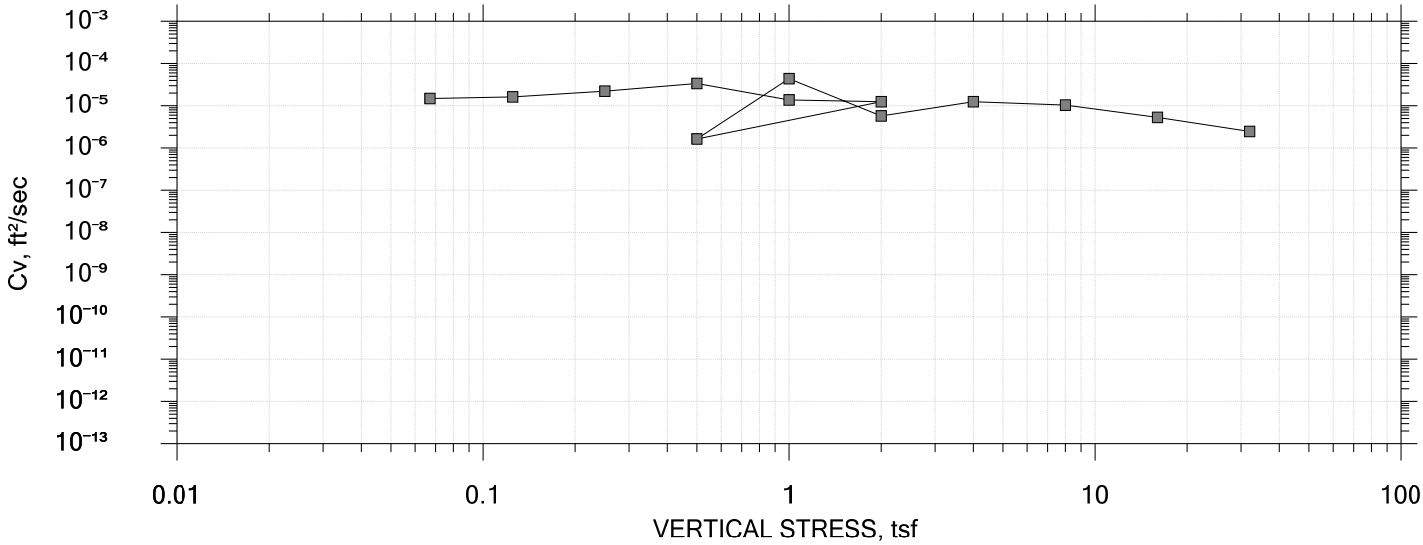
Remarks: System 2054

Phase calculations based on start and end of test.

One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT

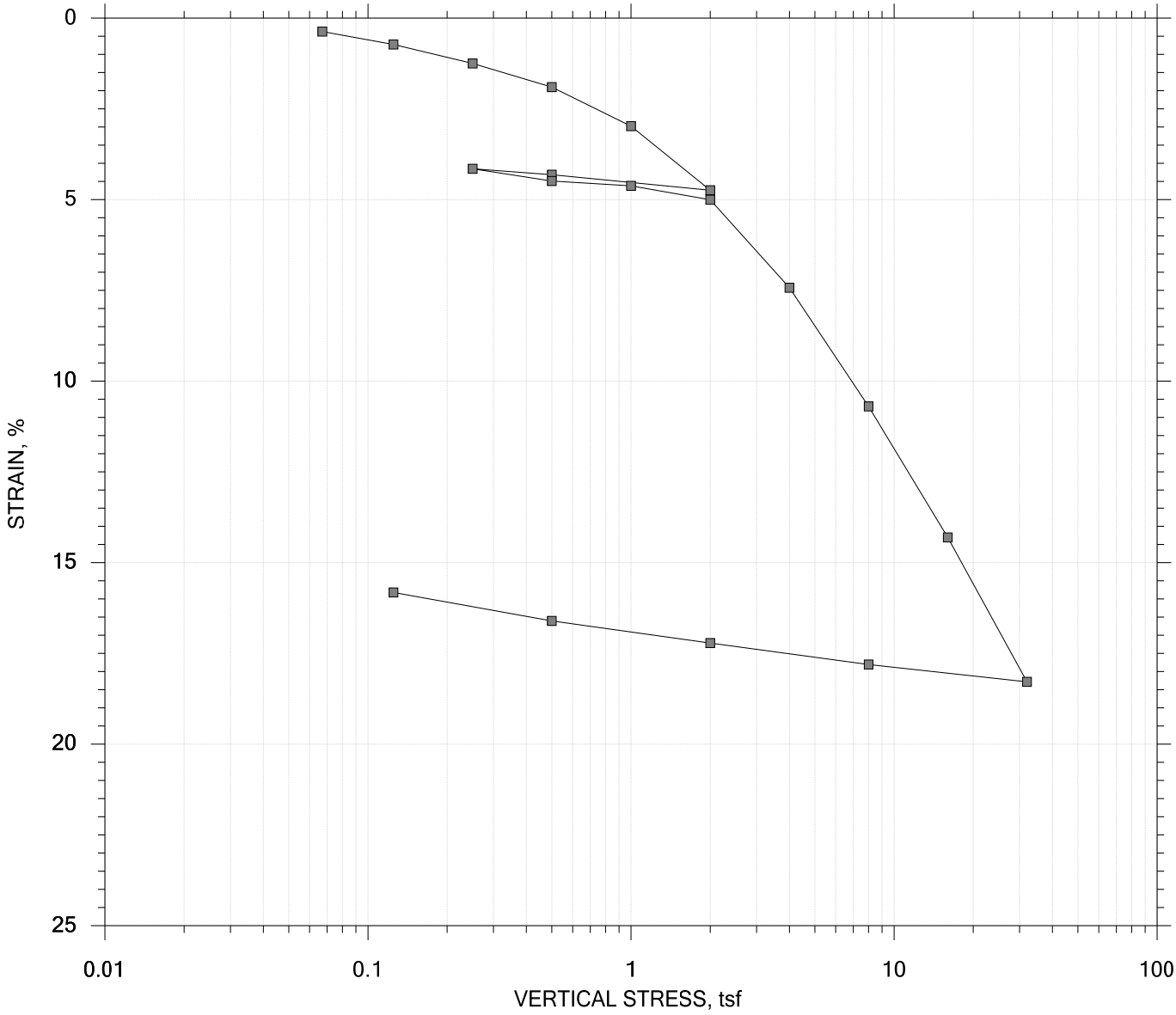




GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT



				Before Test	After Test
Current Vertical Effective Stress: ---			Water Content, %	51.48	40.10
Preconsolidation Stress: ---			Dry Unit Weight, pcf	63.15	75.017
Compression Ratio: ---			Saturation, %	92.36	100.00
Diameter: 2.5 in		Height: 1 in	Void Ratio	1.29	0.93
LL: ---	PL: ---	PI: ---	GS: 2.32		

GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: Dynergy Hennepin West Ash Pond | Location: Hennepin, IL | Project No.: GTX-307367
Boring No.: GS-B01 | Tested By: jm | Checked By: mcm
Sample No.: 3 | Test Date: 12/1/17 | Depth: 5-7 ft
Test No.: IP-1 | Sample Type: Intact | Elevation: ---

Soil Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.
Remarks: System 2054, Swell Pressure = 0.0671 tsf

Estimated Specific Gravity: 2.32 | Liquid Limit: --- | Specimen Diameter: 2.50 in
Initial Void Ratio: 1.29 | Plastic Limit: --- | Initial Height: 1.00 in
Final Void Ratio: 0.930 | Plasticity Index: --- | Final Height: 0.84 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	pr2	RING	ASH9	ASH9
Wt. Container + Wet Soil, gm	78.020	131.43	122.17	122.17
Wt. Container + Dry Soil, gm	54.270	89.540	89.540	89.540
Wt. Container, gm	8.1700	8.1700	8.1700	8.1700
Wt. Dry Soil, gm	46.100	81.370	81.370	81.370
Water Content, %	51.52	51.48	40.10	40.10
Void Ratio	---	1.29	0.930	---
Degree of Saturation, %	---	92.36	100.00	---
Dry Unit Weight, pcf	---	63.150	75.017	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: Dynergy Hennepin West Ash Pond | Location: Hennepin, IL | Project No.: GTX-307367
Boring No.: GS-B01 | Tested By: jm | Checked By: mcm
Sample No.: 3 | Test Date: 12/1/17 | Depth: 5-7 ft
Test No.: IP-1 | Sample Type: Intact | Elevation: ---

Soil Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.
Remarks: System 2054, Swell Pressure = 0.0671 tsf

Displacement at End of Increment

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt T90 min	Cv ft²/sec	Mv 1/tsf	k cm/sec
1	0.0671	0.003682	1.28	0.368	3.808	6.42e-006	5.49e-002	3.35e-007
2	0.125	0.007262	1.28	0.726	1.954	1.24e-005	6.18e-002	7.31e-007
3	0.250	0.01248	1.26	1.25	1.154	2.08e-005	4.17e-002	8.27e-007
4	0.500	0.01899	1.25	1.90	0.747	3.18e-005	2.60e-002	7.89e-007
5	1.00	0.02974	1.22	2.97	2.931	7.97e-006	2.15e-002	1.63e-007
6	2.00	0.04739	1.18	4.74	3.411	6.65e-006	1.77e-002	1.12e-007
7	0.500	0.04311	1.19	4.31	11.903	1.88e-006	2.86e-003	5.11e-009
8	0.250	0.04150	1.20	4.15	0.863	2.61e-005	6.43e-003	1.60e-007
9	0.500	0.04487	1.19	4.49	70.003	3.21e-007	1.35e-002	4.11e-009
10	1.00	0.04619	1.19	4.62	0.528	4.23e-005	2.64e-003	1.06e-007
11	2.00	0.05002	1.18	5.00	4.003	5.55e-006	3.84e-003	2.03e-008
12	4.00	0.07426	1.12	7.43	3.195	6.75e-006	1.21e-002	7.79e-008
13	8.00	0.1070	1.05	10.7	3.437	5.90e-006	8.17e-003	4.59e-008
14	16.0	0.1431	0.965	14.3	5.421	3.47e-006	4.51e-003	1.49e-008
15	32.0	0.1828	0.874	18.3	7.217	2.38e-006	2.49e-003	5.63e-009
16	8.00	0.1780	0.884	17.8	4.901	3.36e-006	1.99e-004	6.35e-010
17	2.00	0.1722	0.898	17.2	19.898	8.39e-007	9.83e-004	7.84e-010
18	0.500	0.1660	0.912	16.6	7.351	2.30e-006	4.08e-003	8.94e-009
19	0.125	0.1582	0.930	15.8	1.784	9.66e-006	2.09e-002	1.92e-007

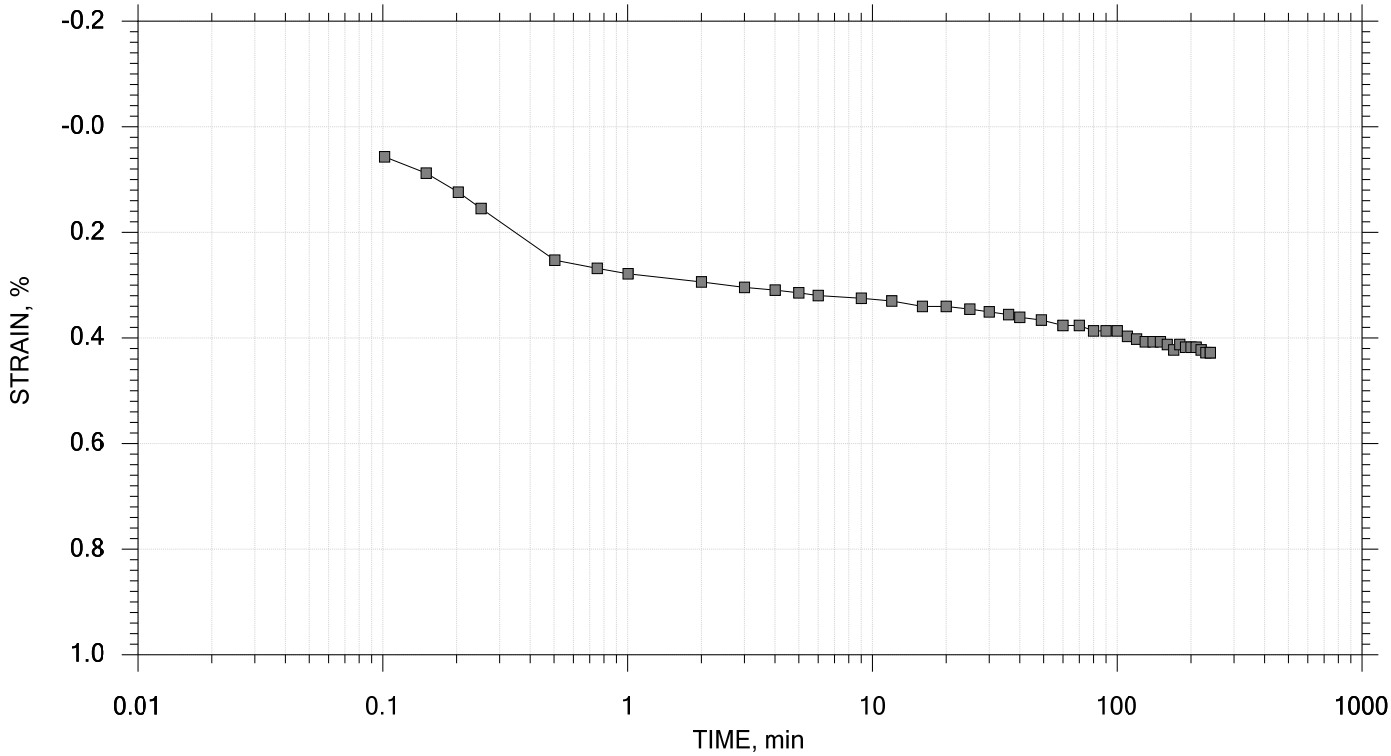
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/sec	Mv 1/tsf	k cm/sec	Ca %
1	0.0671	0.003682	1.28	0.368	0.305	1.86e-005	5.49e-002	9.72e-007	0.00e+000
2	0.125	0.007262	1.28	0.726	0.322	1.75e-005	6.18e-002	1.03e-006	0.00e+000
3	0.250	0.01248	1.26	1.25	0.264	2.11e-005	4.17e-002	8.39e-007	0.00e+000
4	0.500	0.01899	1.25	1.90	0.146	3.78e-005	2.60e-002	9.35e-007	0.00e+000
5	1.00	0.02974	1.22	2.97	0.186	2.91e-005	2.15e-002	5.96e-007	0.00e+000
6	2.00	0.04739	1.18	4.74	0.121	4.36e-005	1.77e-002	7.33e-007	0.00e+000
7	0.500	0.04311	1.19	4.31	0.000	0.00e+000	2.86e-003	0.00e+000	0.00e+000
8	0.250	0.04150	1.20	4.15	0.000	0.00e+000	6.43e-003	0.00e+000	0.00e+000
9	0.500	0.04487	1.19	4.49	0.000	0.00e+000	1.35e-002	0.00e+000	0.00e+000
10	1.00	0.04619	1.19	4.62	0.000	0.00e+000	2.64e-003	0.00e+000	0.00e+000
11	2.00	0.05002	1.18	5.00	0.000	0.00e+000	3.84e-003	0.00e+000	0.00e+000
12	4.00	0.07426	1.12	7.43	0.115	4.35e-005	1.21e-002	5.02e-007	0.00e+000
13	8.00	0.1070	1.05	10.7	0.163	2.89e-005	8.17e-003	2.24e-007	0.00e+000
14	16.0	0.1431	0.965	14.3	0.445	9.81e-006	4.51e-003	4.21e-008	0.00e+000
15	32.0	0.1828	0.874	18.3	0.000	0.00e+000	2.49e-003	0.00e+000	0.00e+000
16	8.00	0.1780	0.884	17.8	0.000	0.00e+000	1.99e-004	0.00e+000	0.00e+000
17	2.00	0.1722	0.898	17.2	0.000	0.00e+000	9.83e-004	0.00e+000	0.00e+000
18	0.500	0.1660	0.912	16.6	0.000	0.00e+000	4.08e-003	0.00e+000	0.00e+000
19	0.125	0.1582	0.930	15.8	0.200	2.00e-005	2.09e-002	3.98e-007	0.00e+000

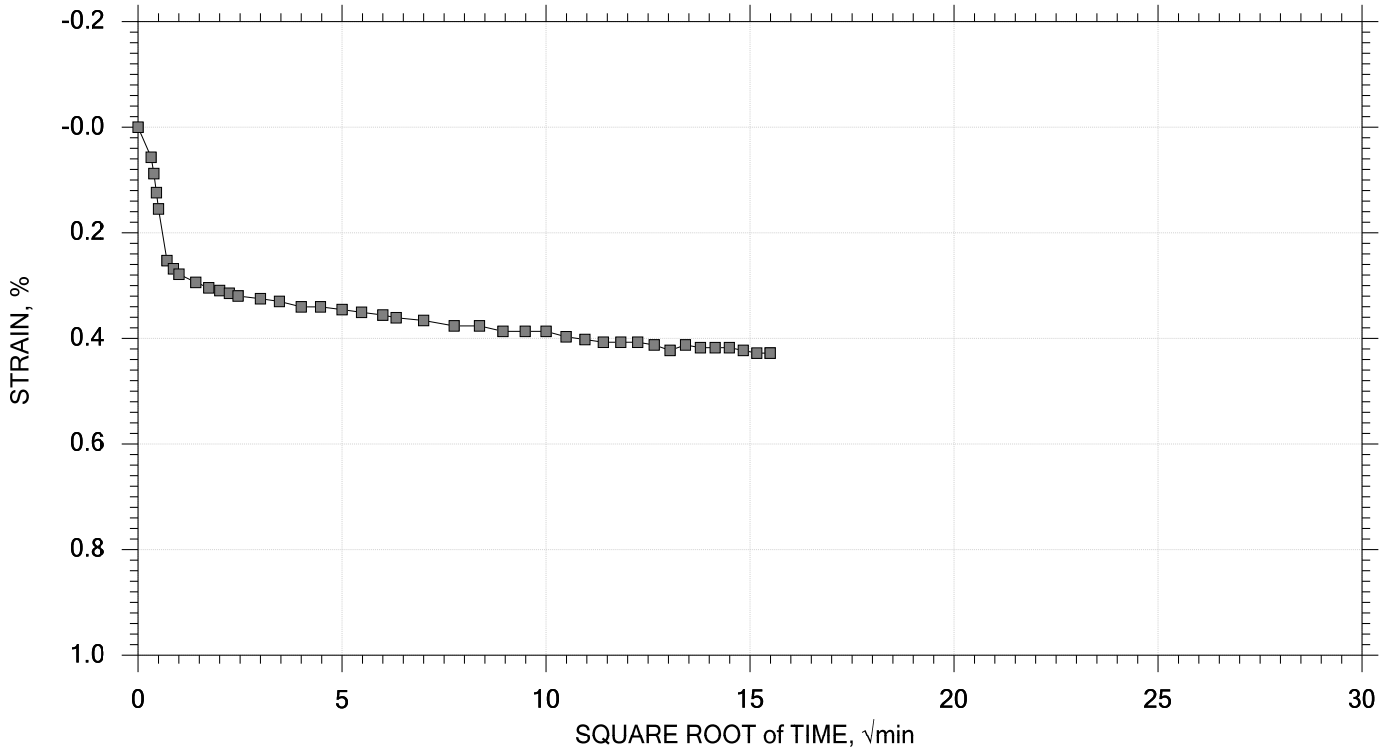
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Volume Step 1 of 19

Stress: 0.067092 tsf





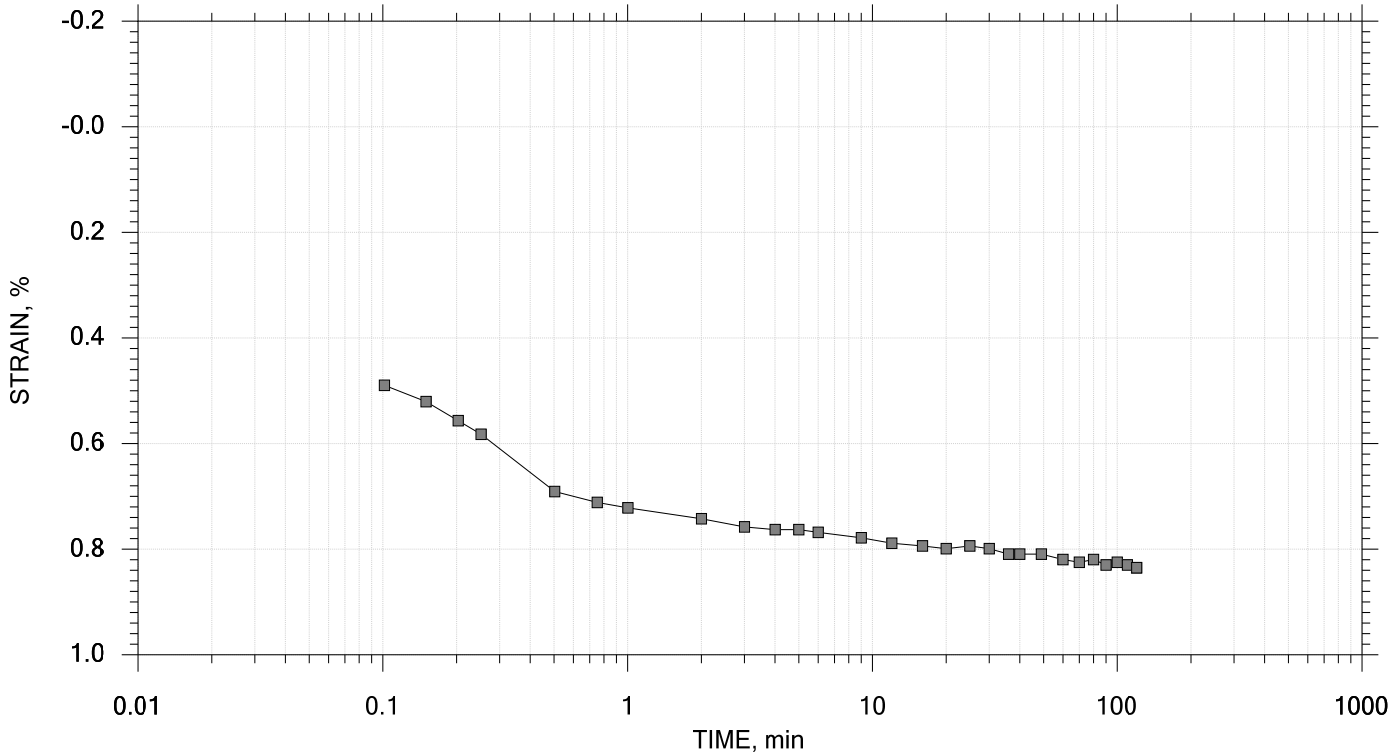
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

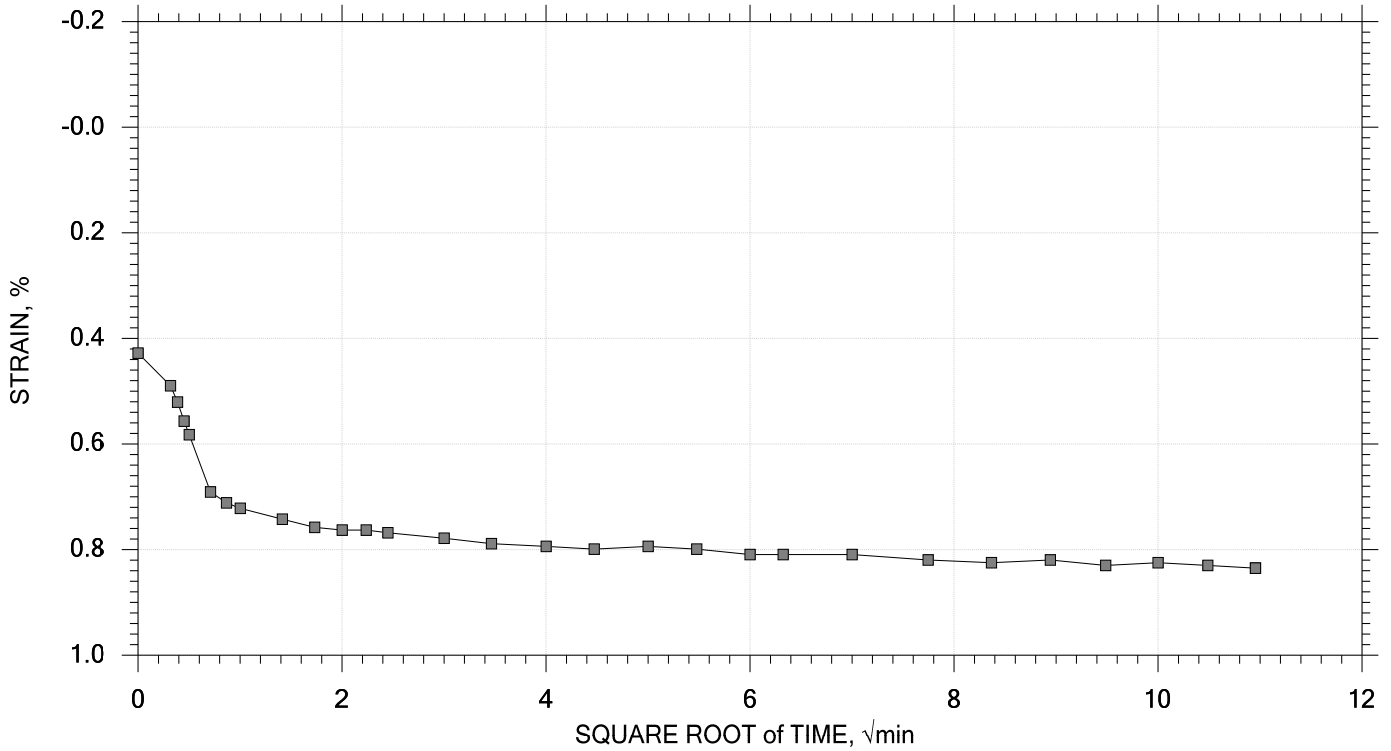
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 2 of 19

Stress: 0.125 tsf





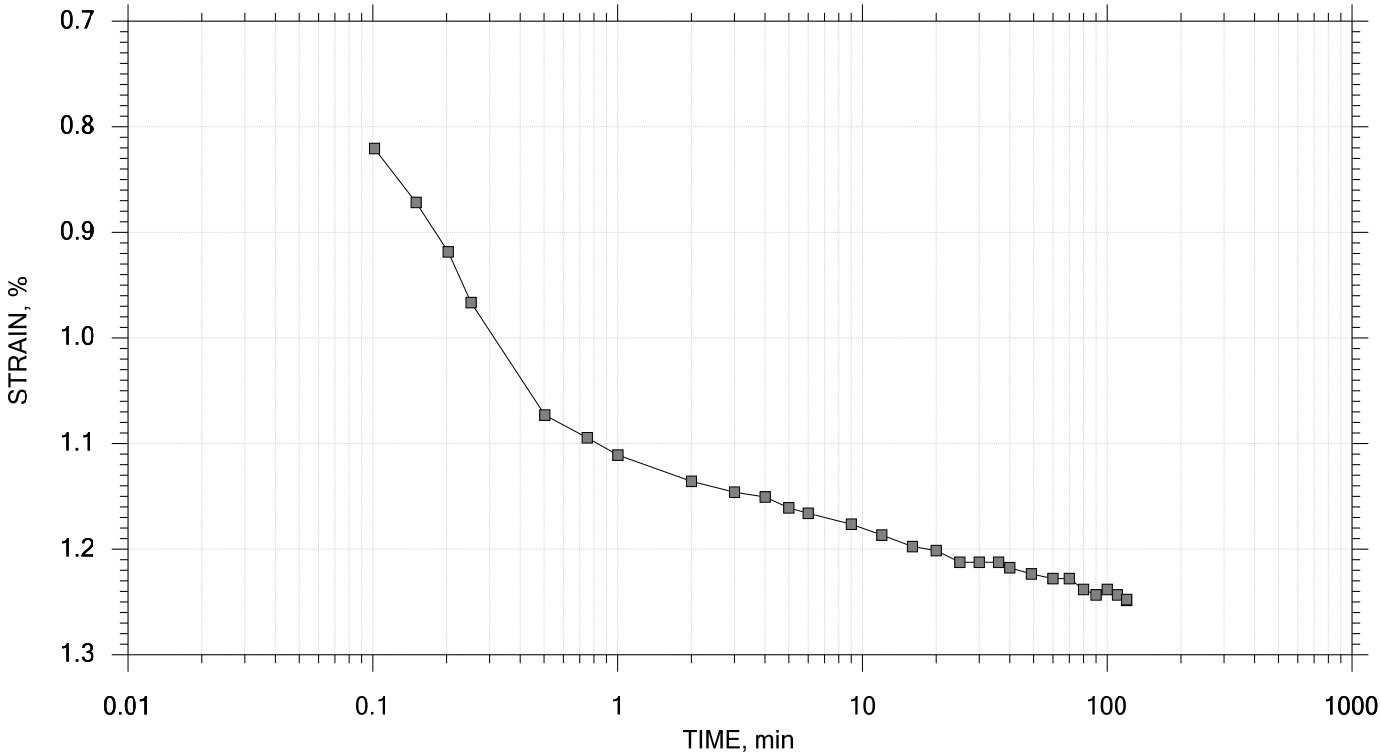
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

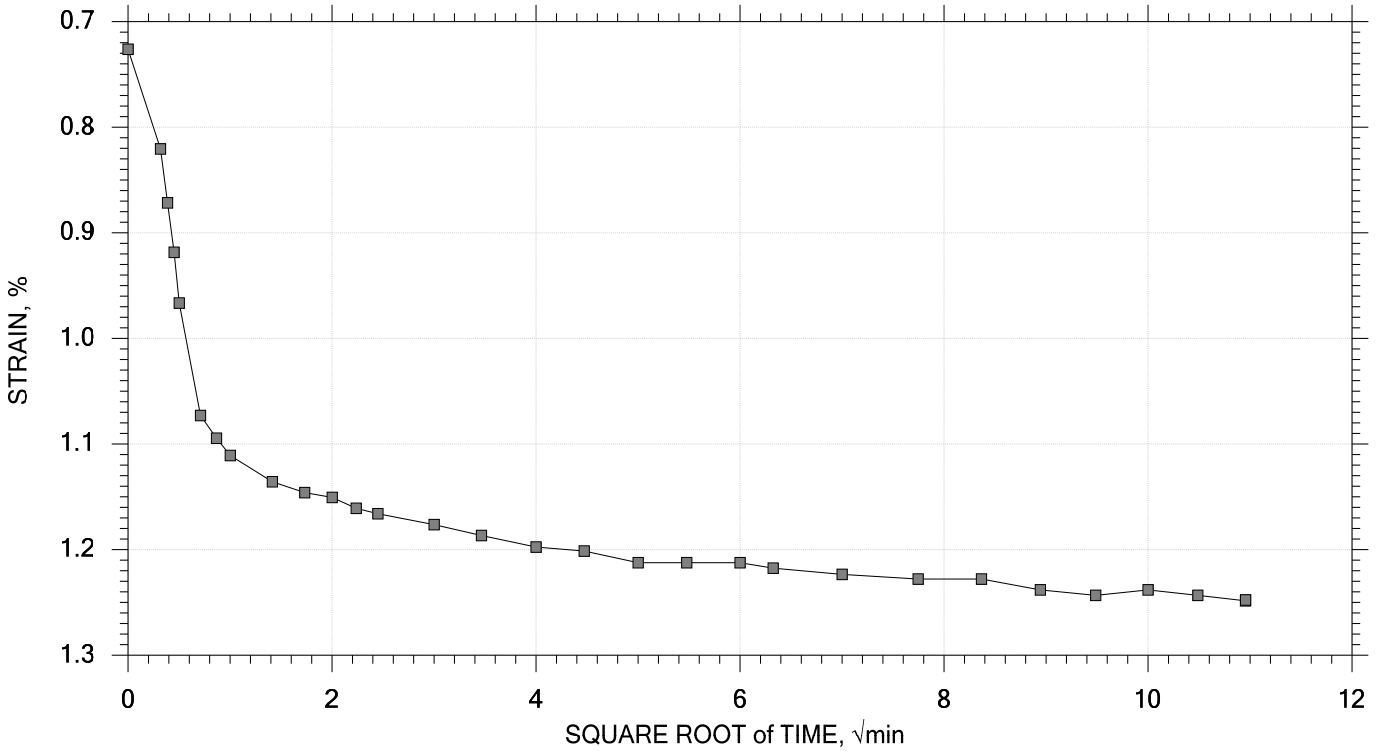
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 3 of 19

Stress: 0.25 tsf





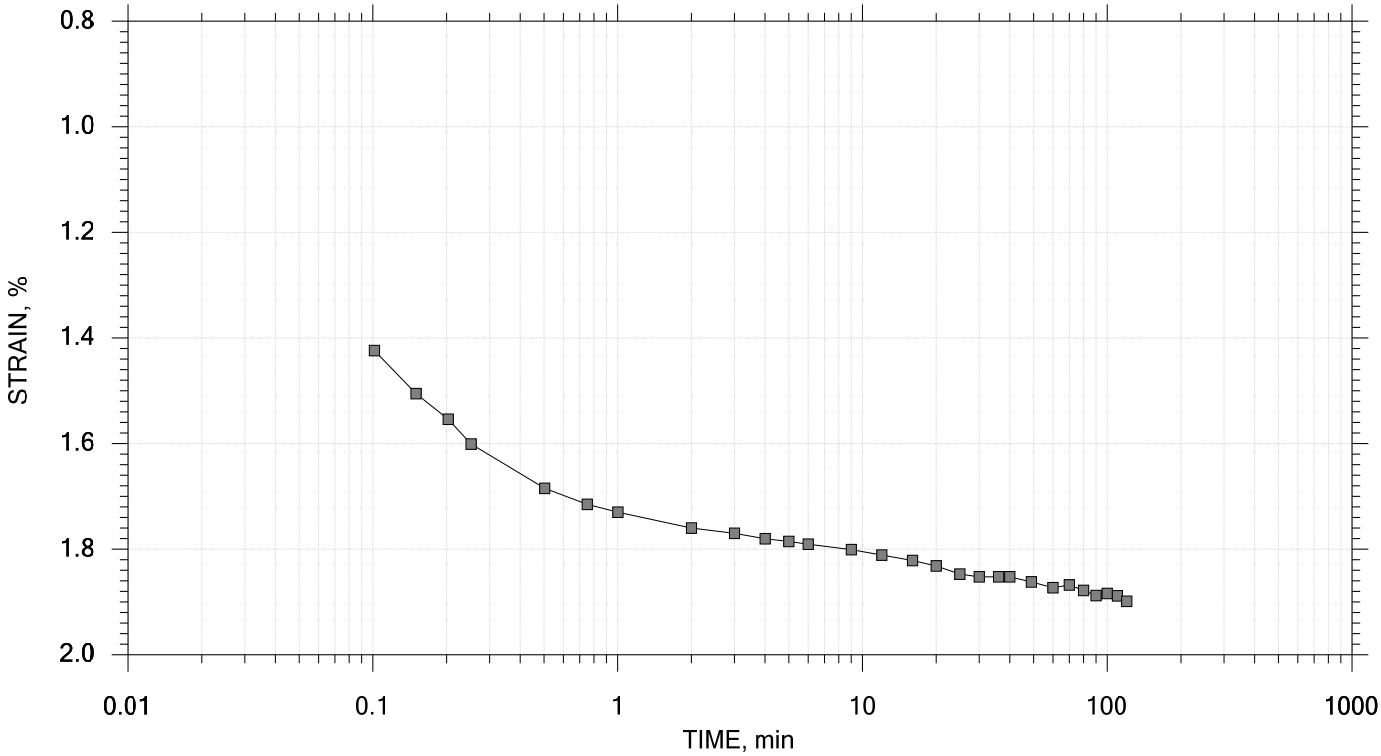
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

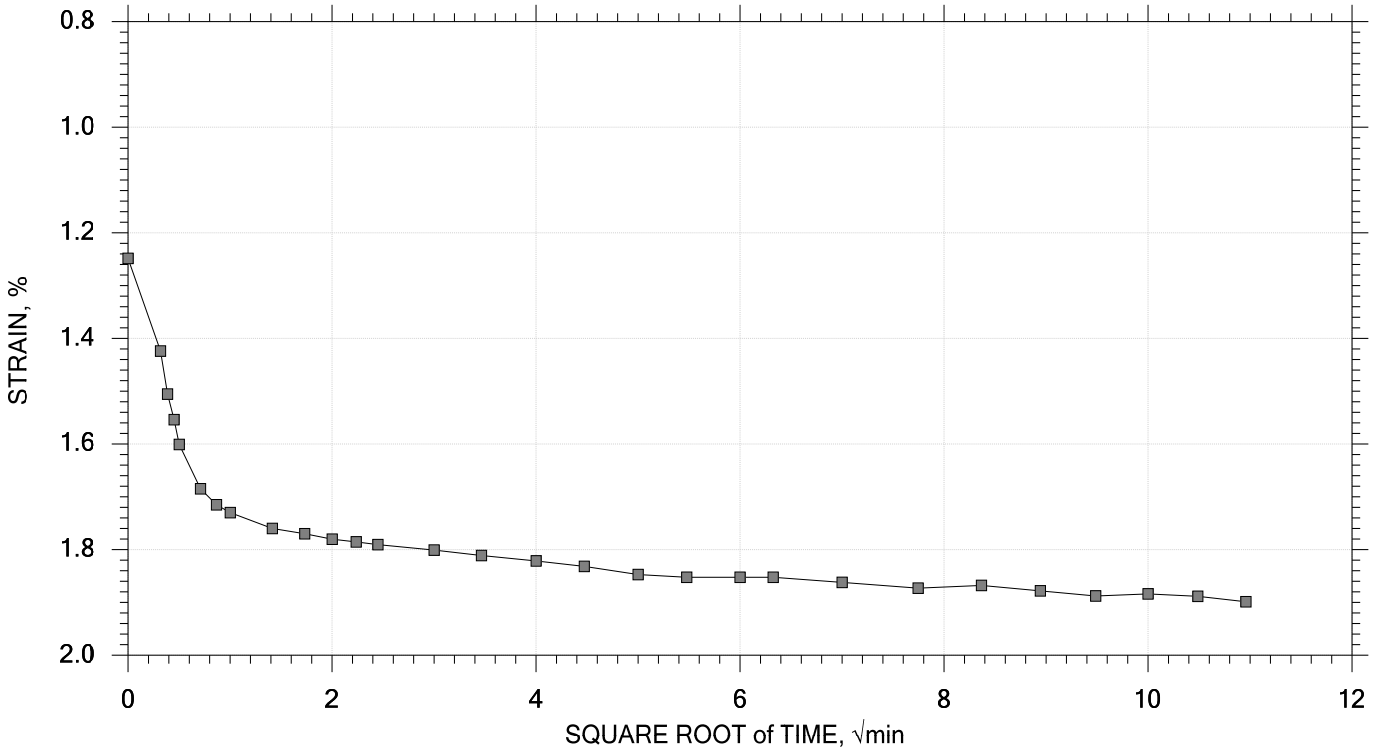
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 4 of 19

Stress: 0.5 tsf





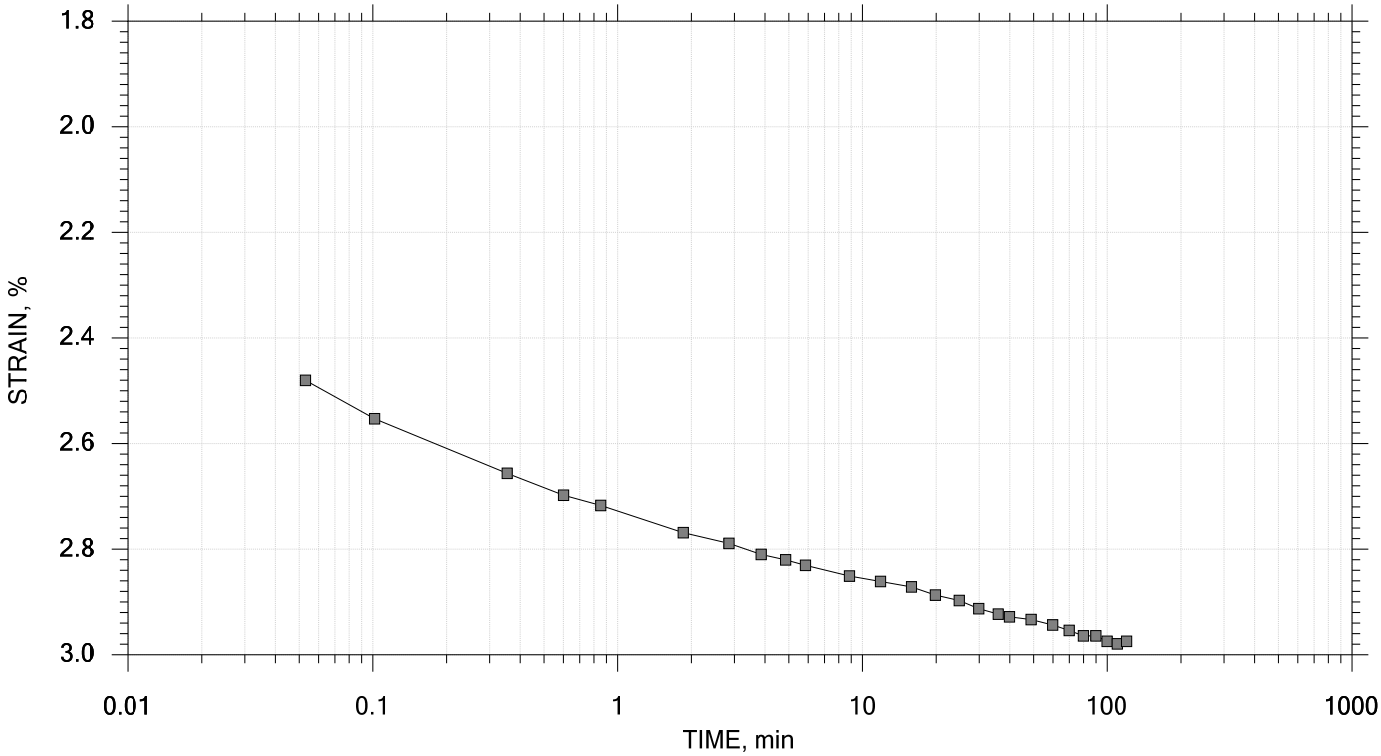
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

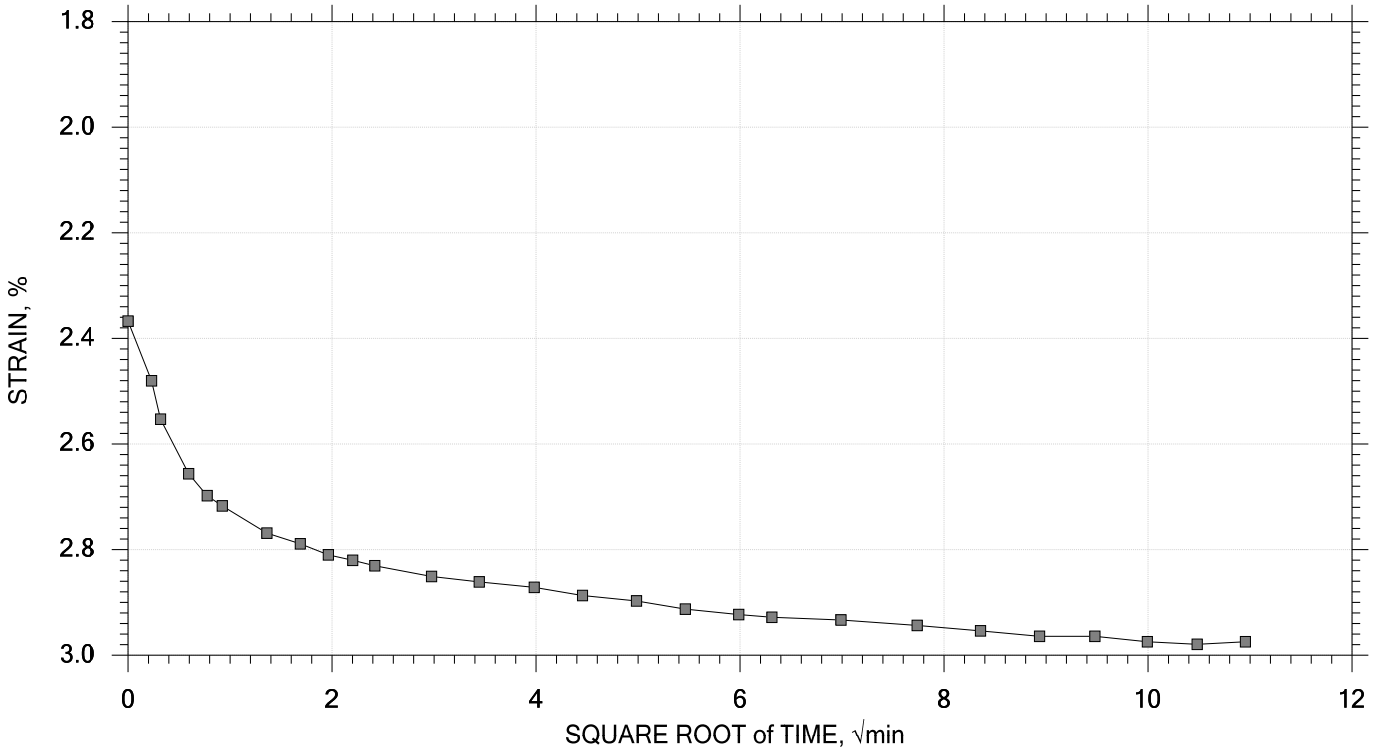
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 5 of 19

Stress: 1 tsf





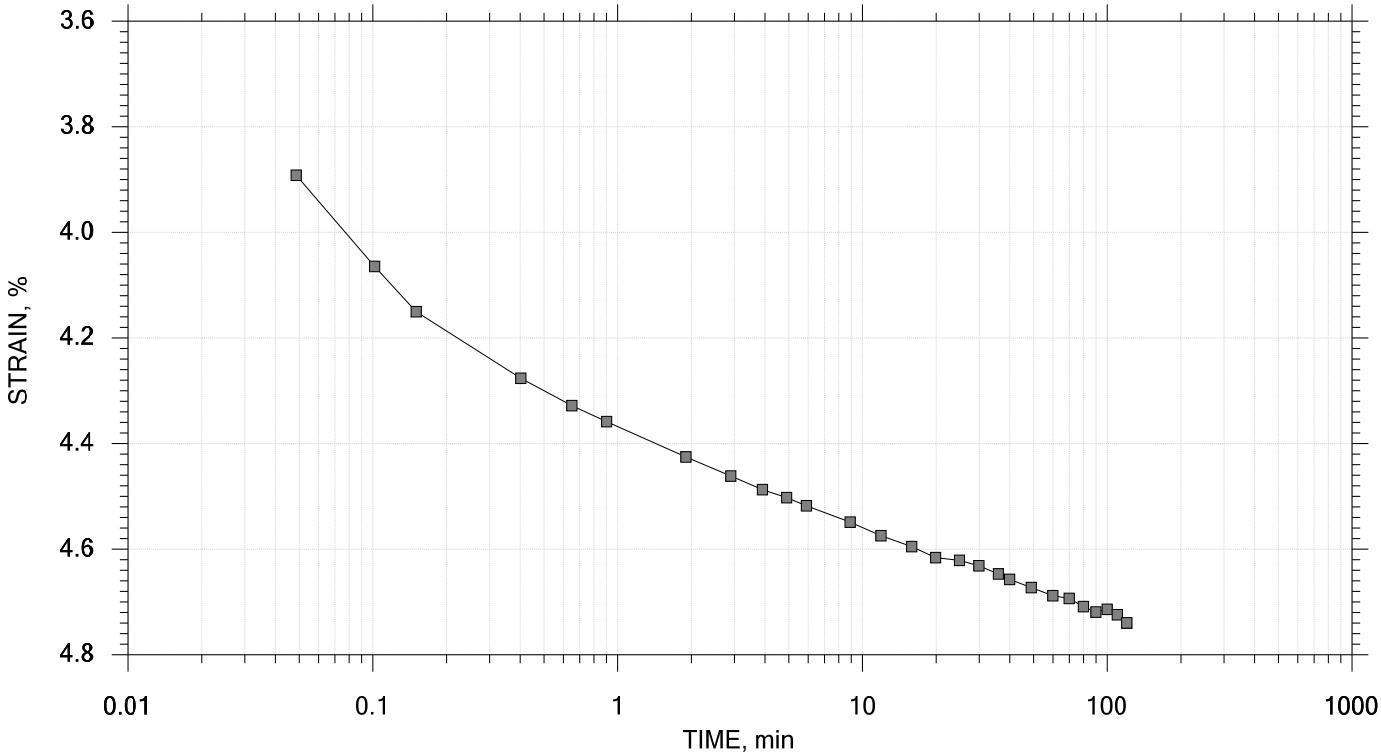
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

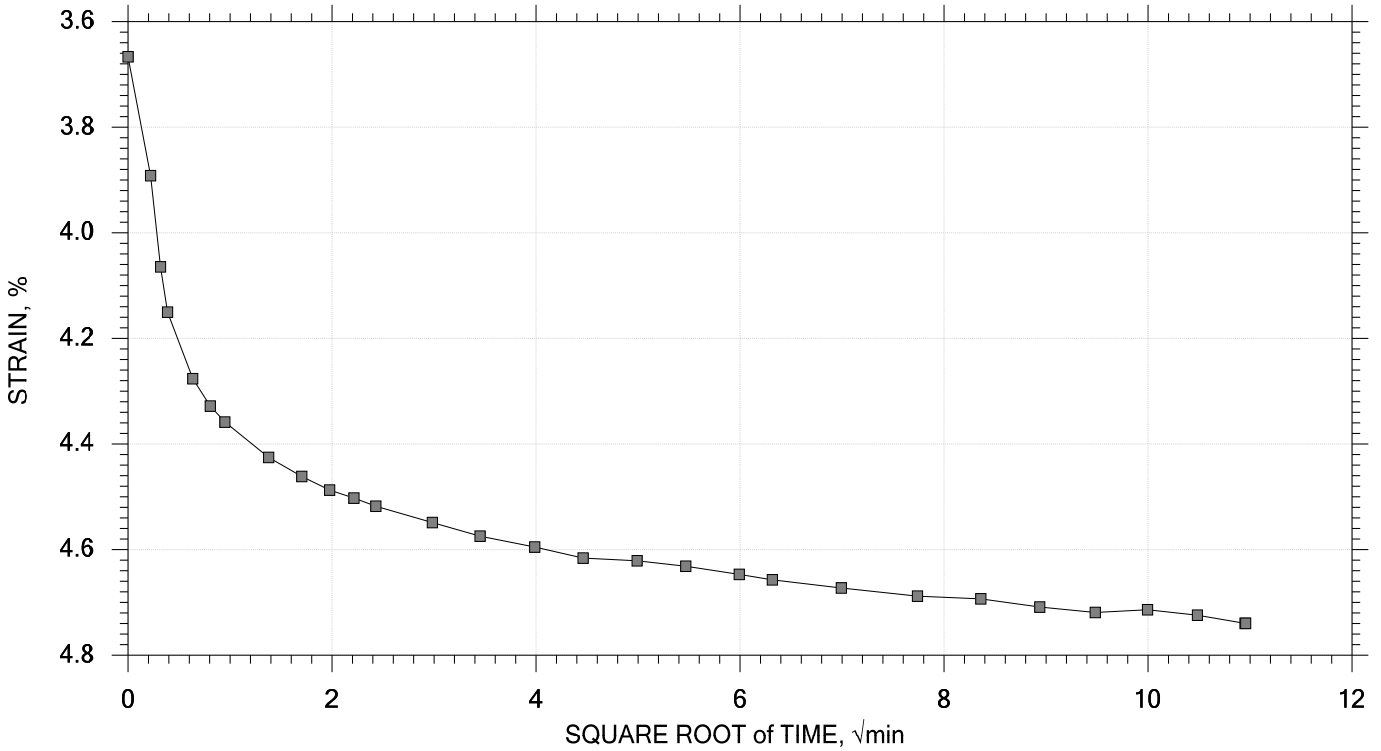
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 6 of 19

Stress: 2 tsf





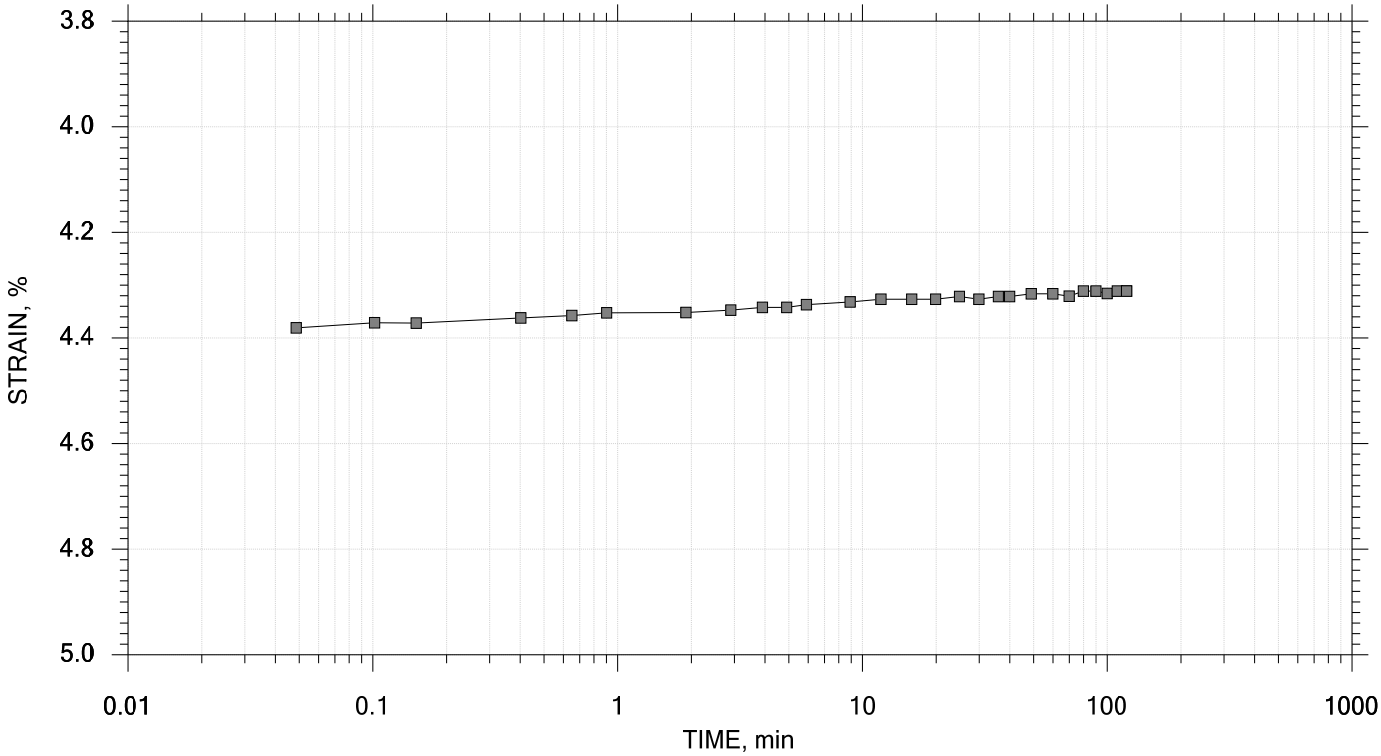
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

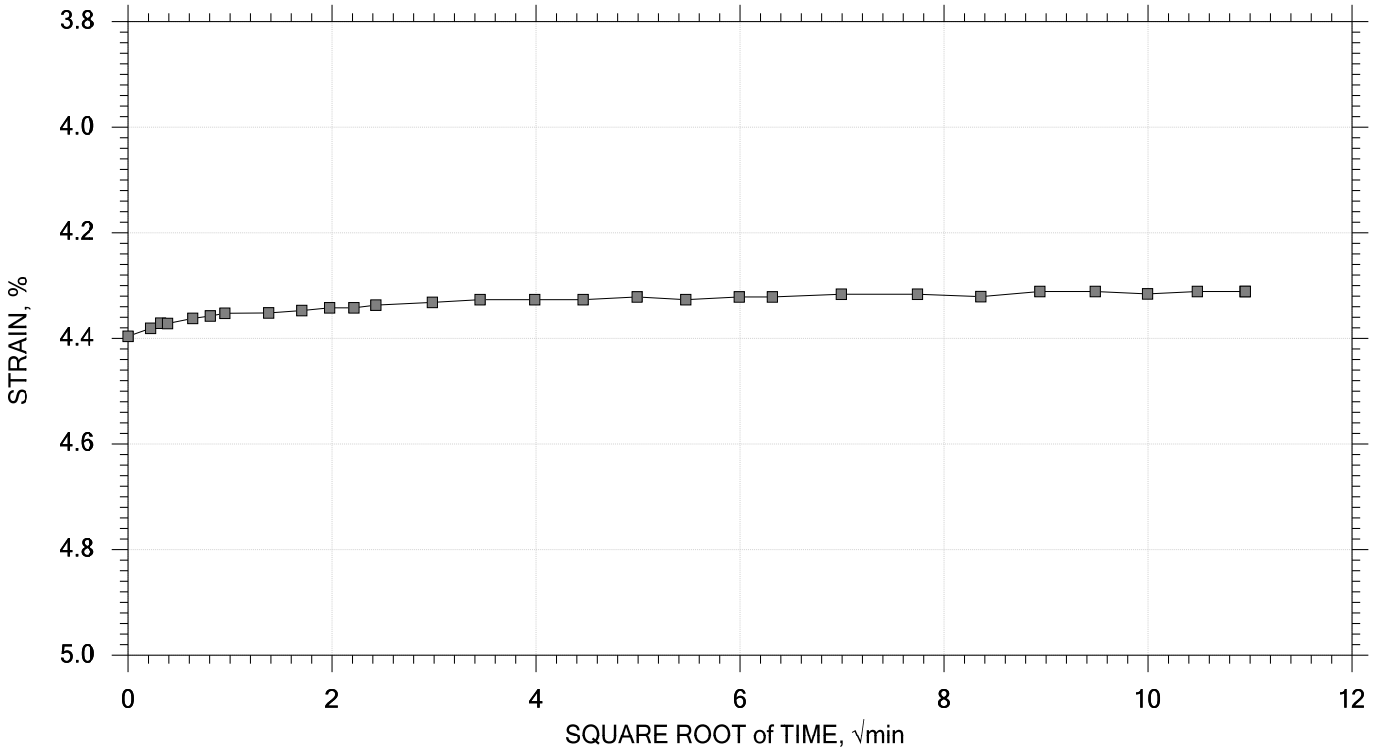
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 7 of 19

Stress: 0.5 tsf





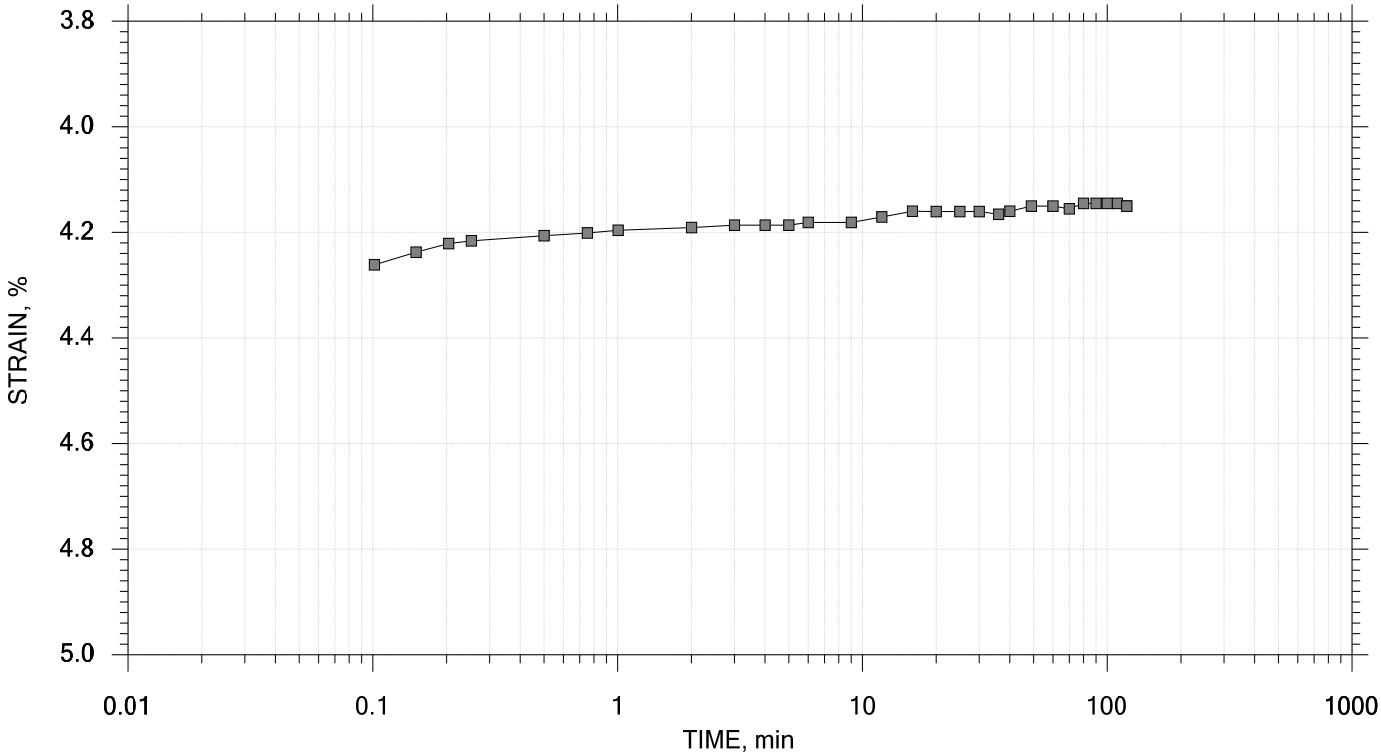
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

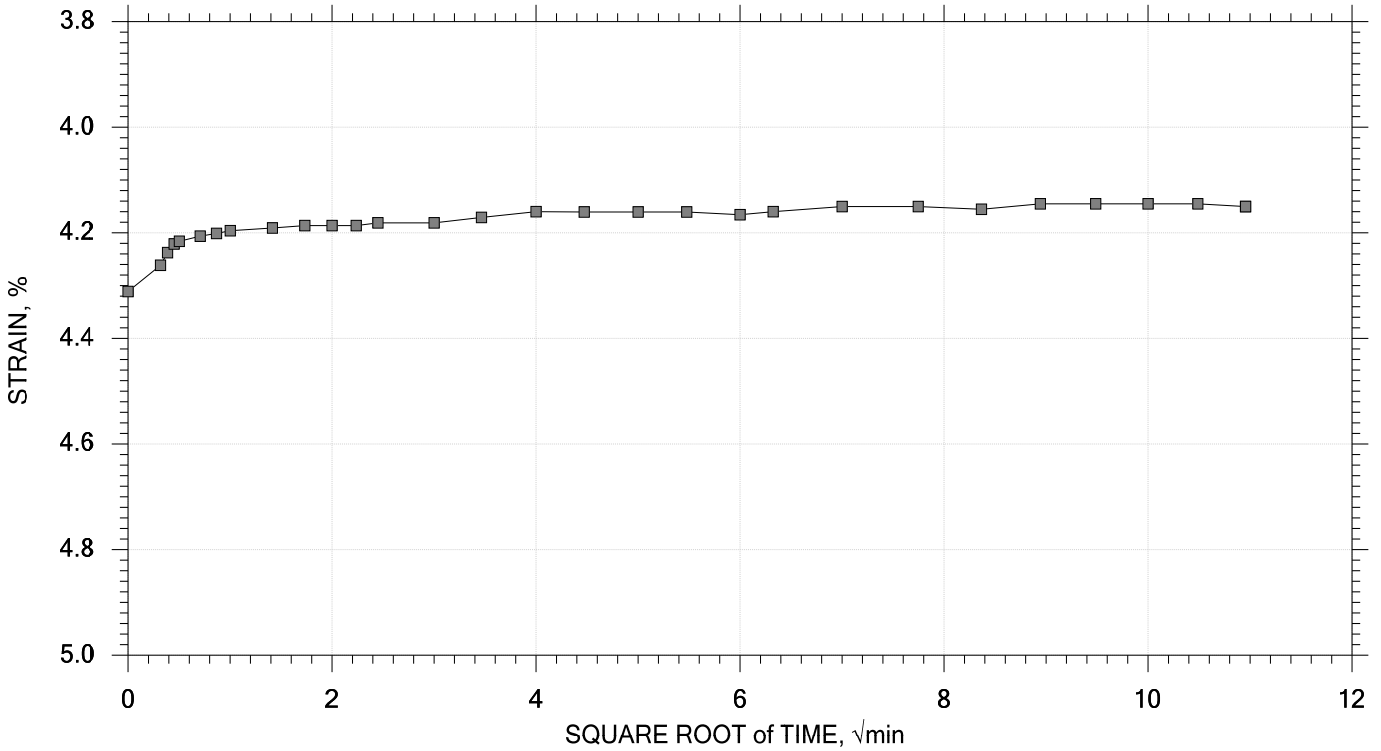
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 8 of 19

Stress: 0.25 tsf





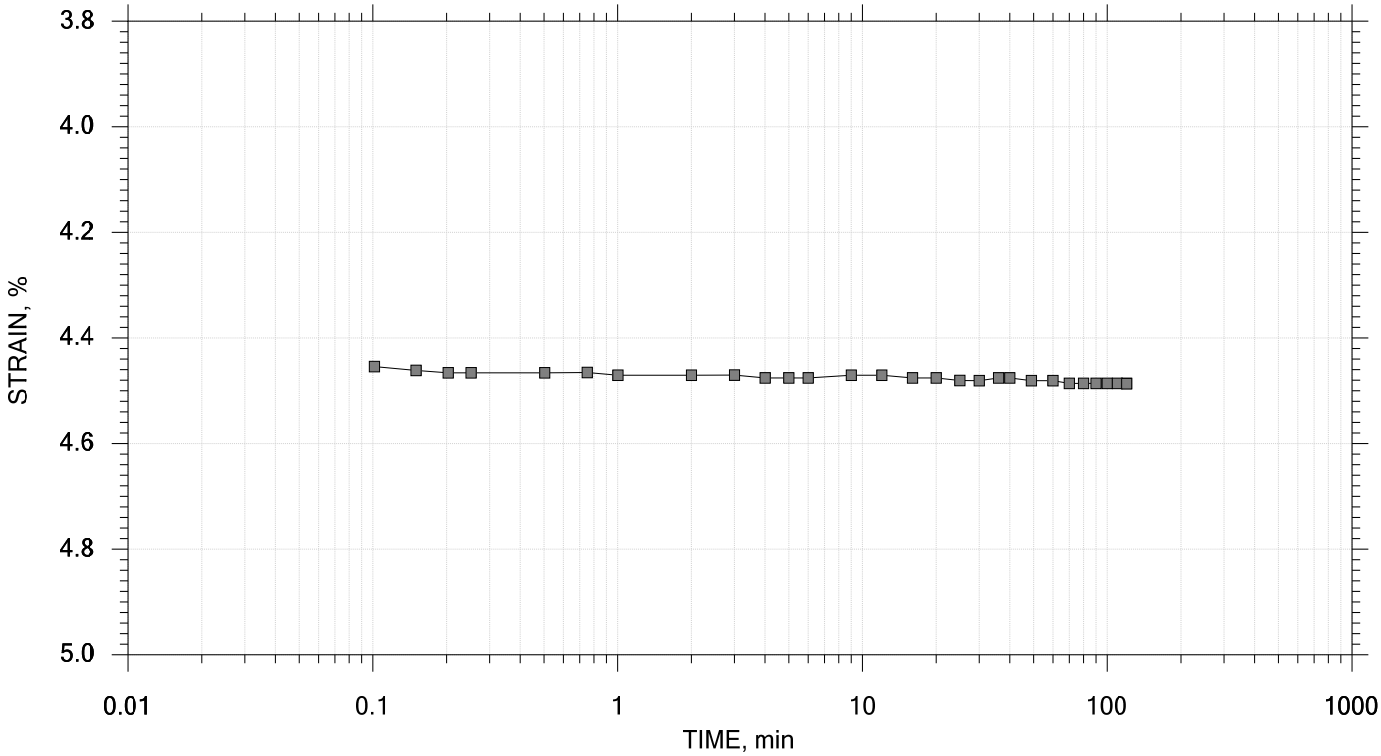
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

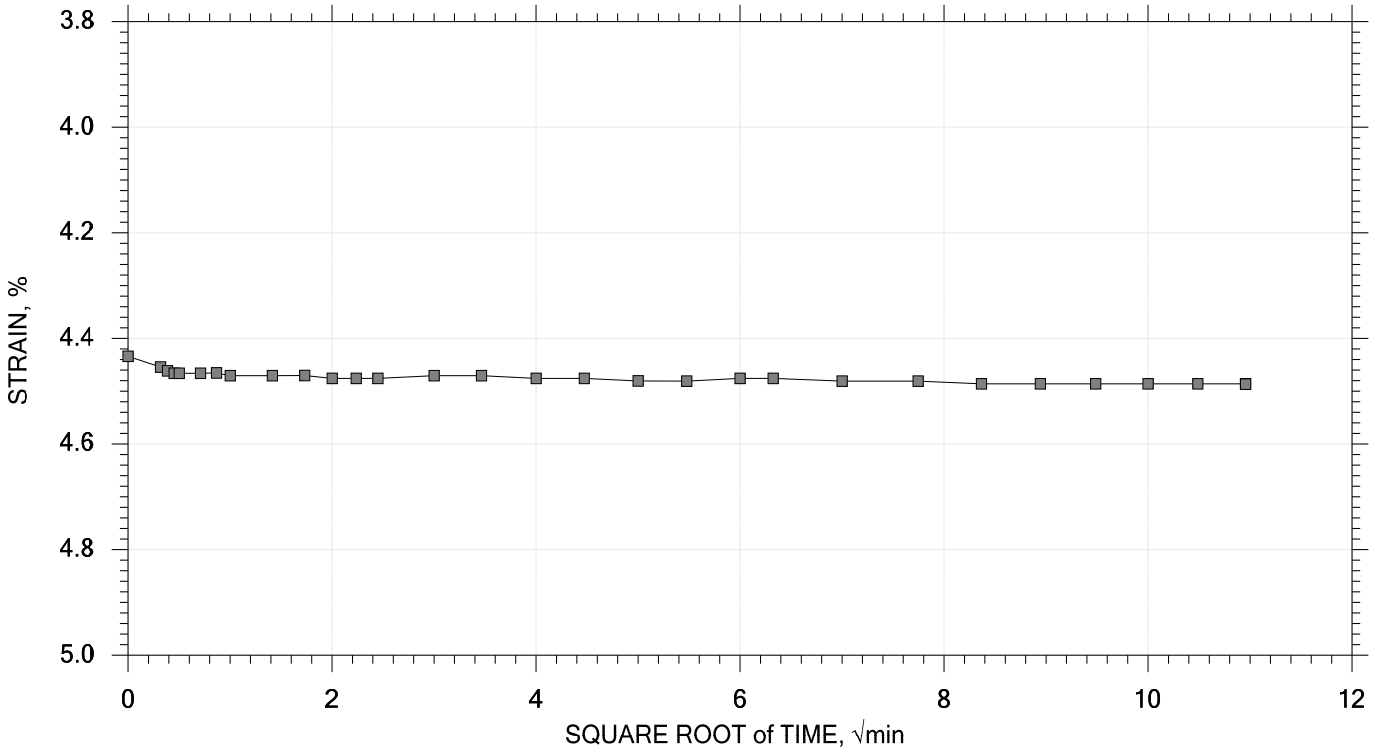
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 9 of 19

Stress: 0.5 tsf





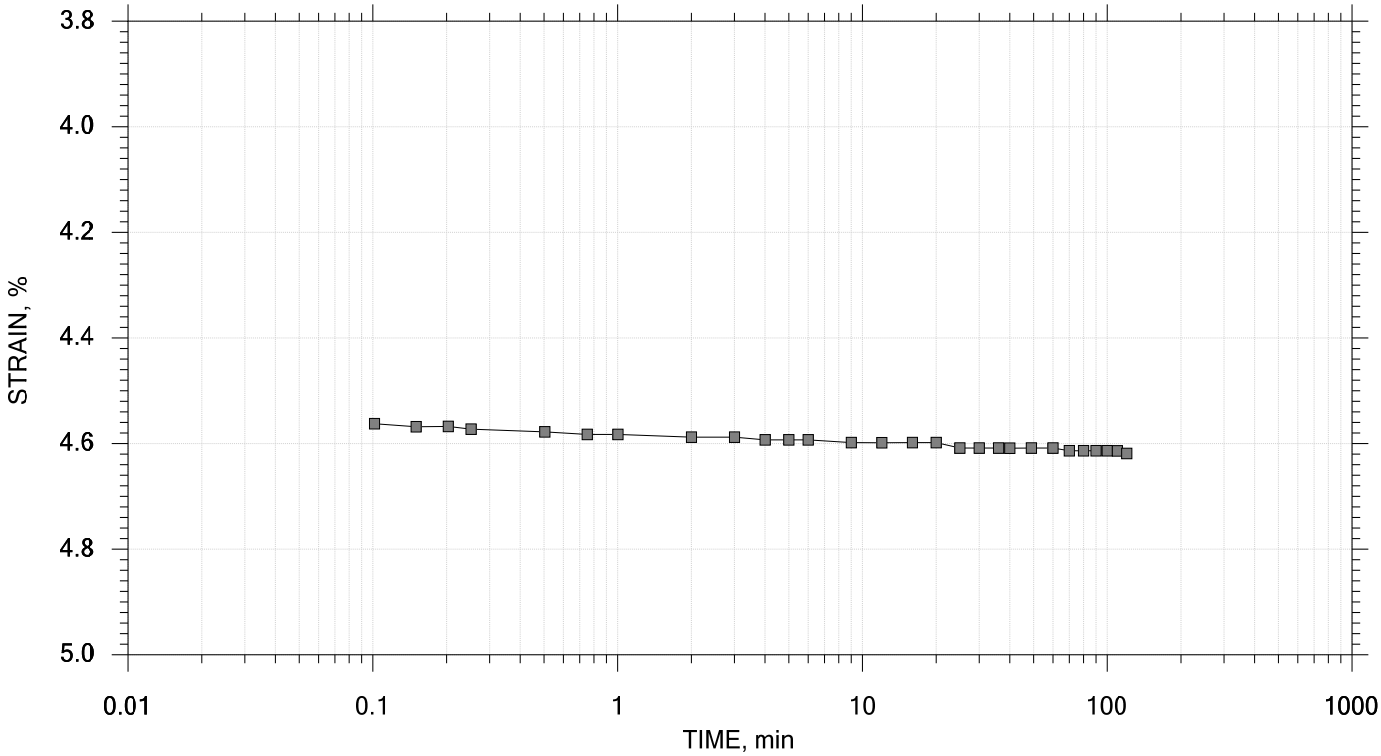
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

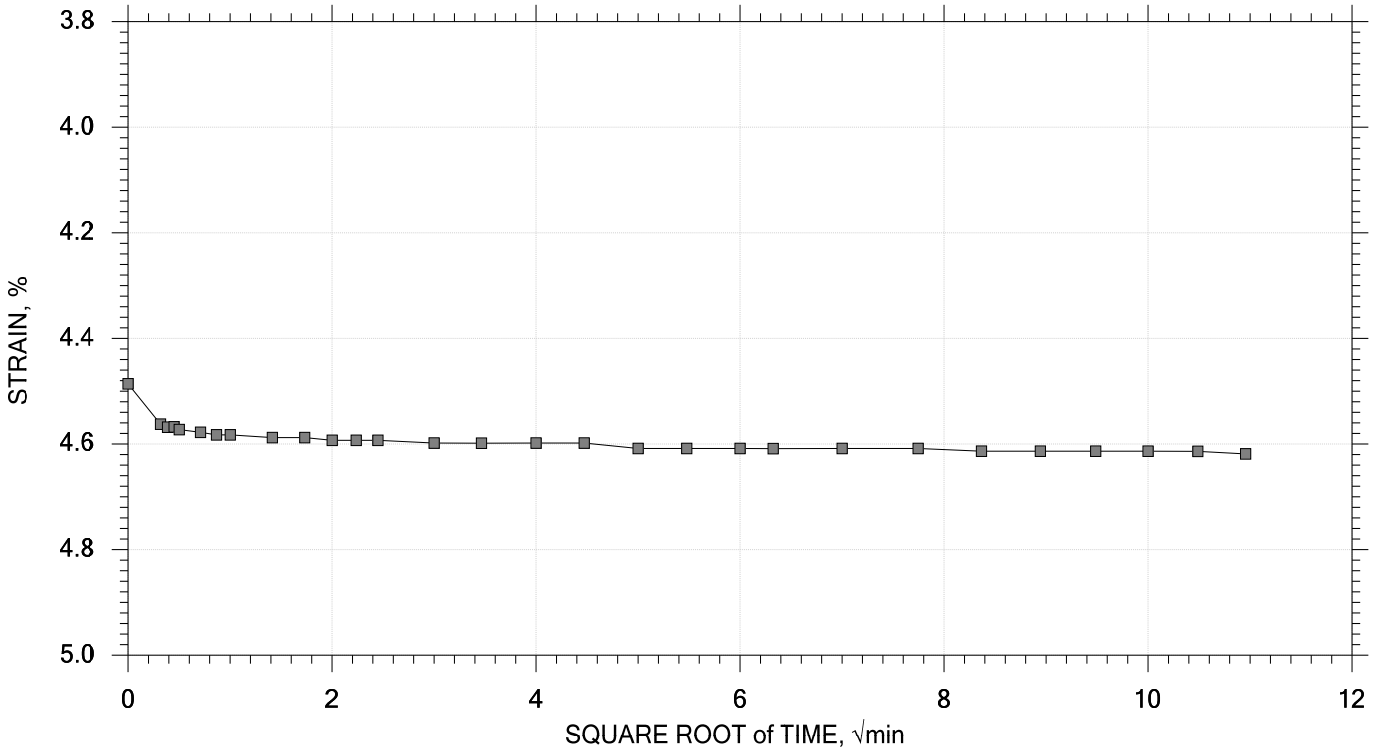
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 10 of 19

Stress: 1 tsf





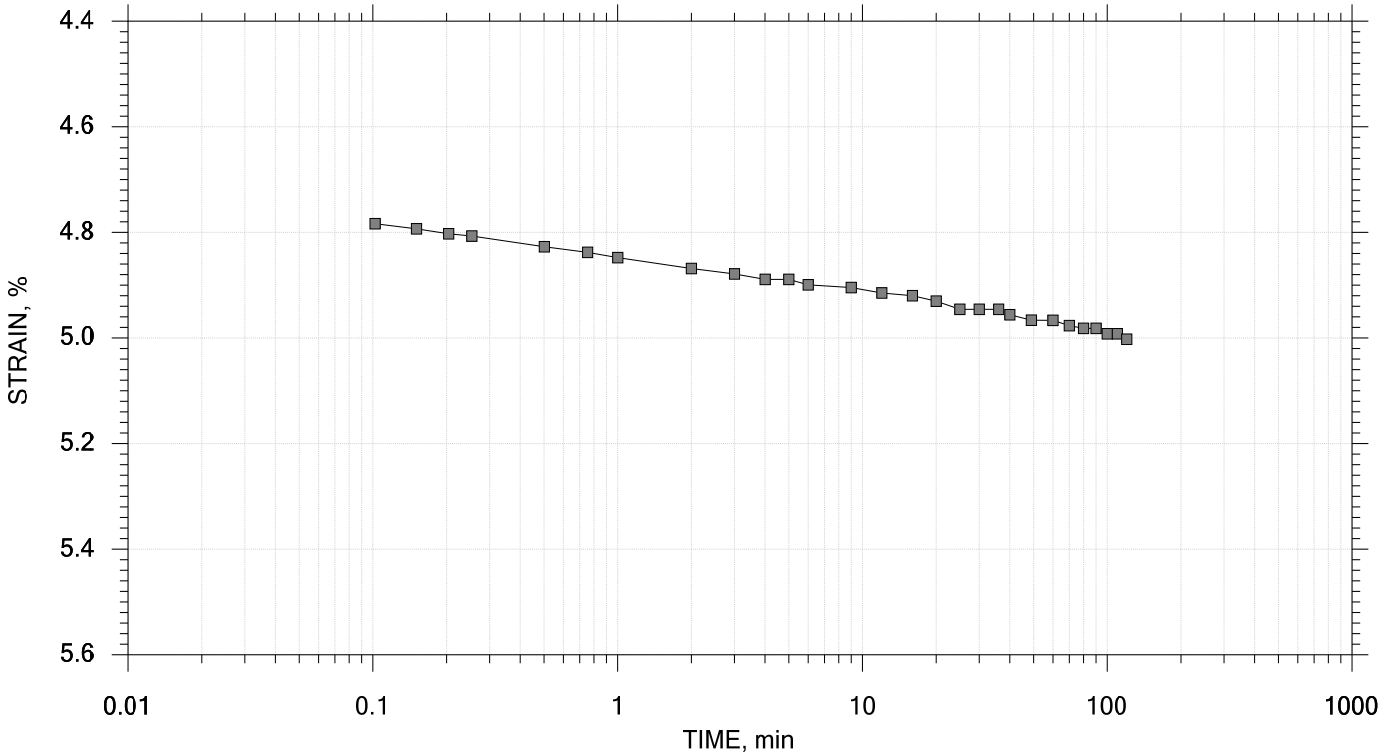
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

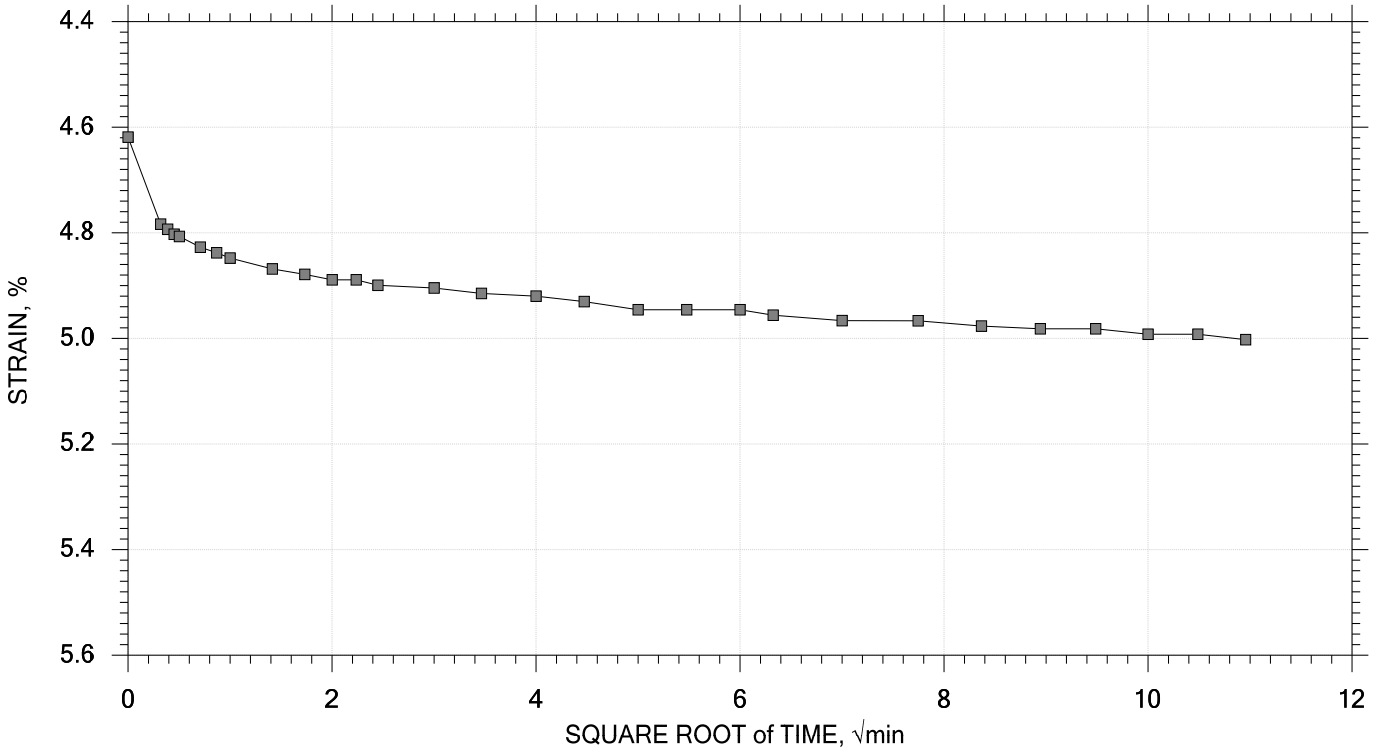
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 11 of 19

Stress: 2 tsf





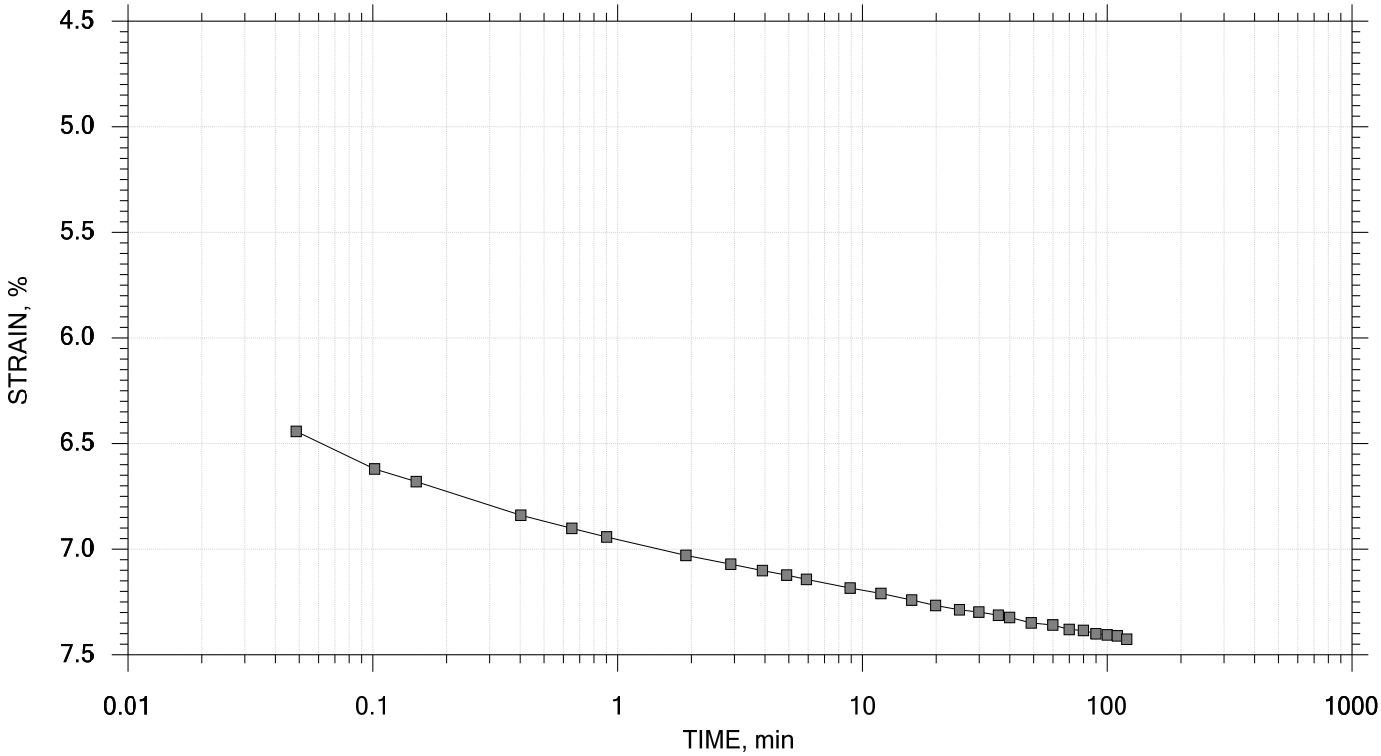
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

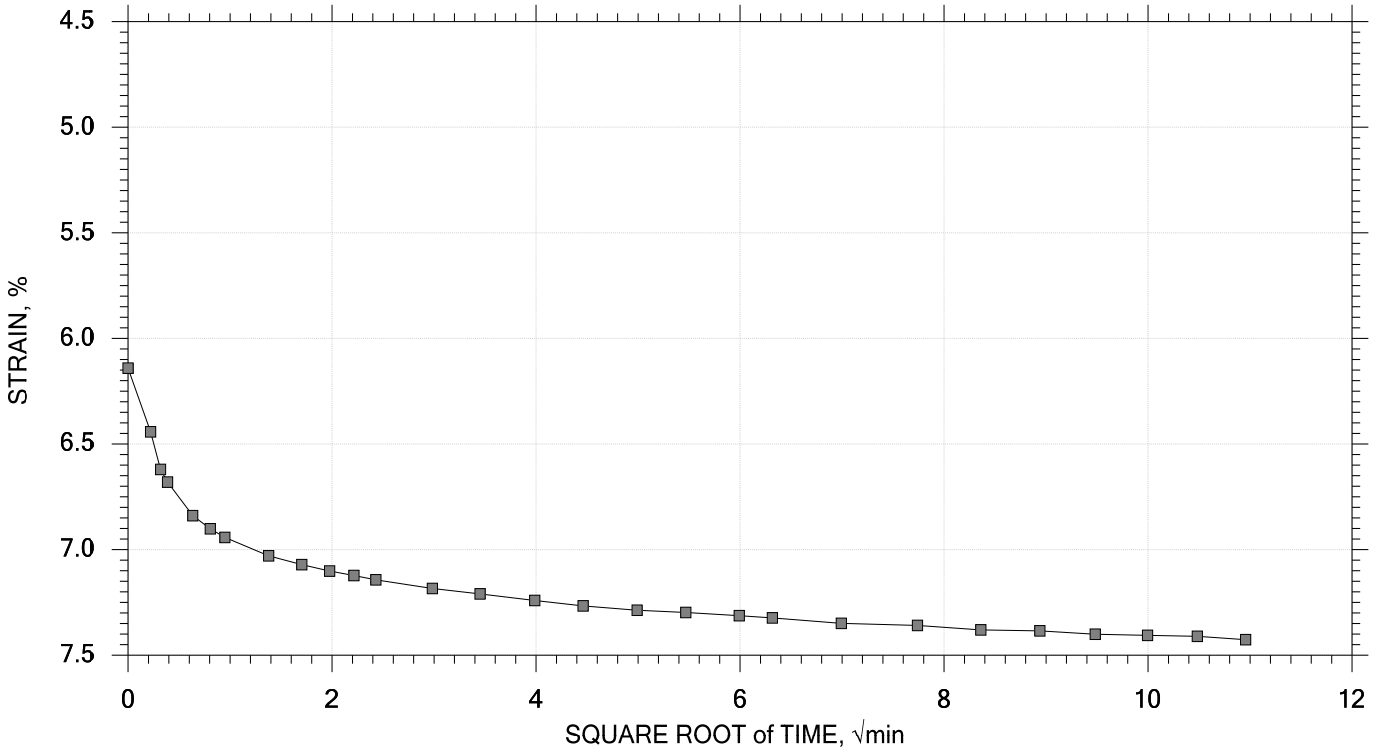
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 12 of 19

Stress: 4 tsf





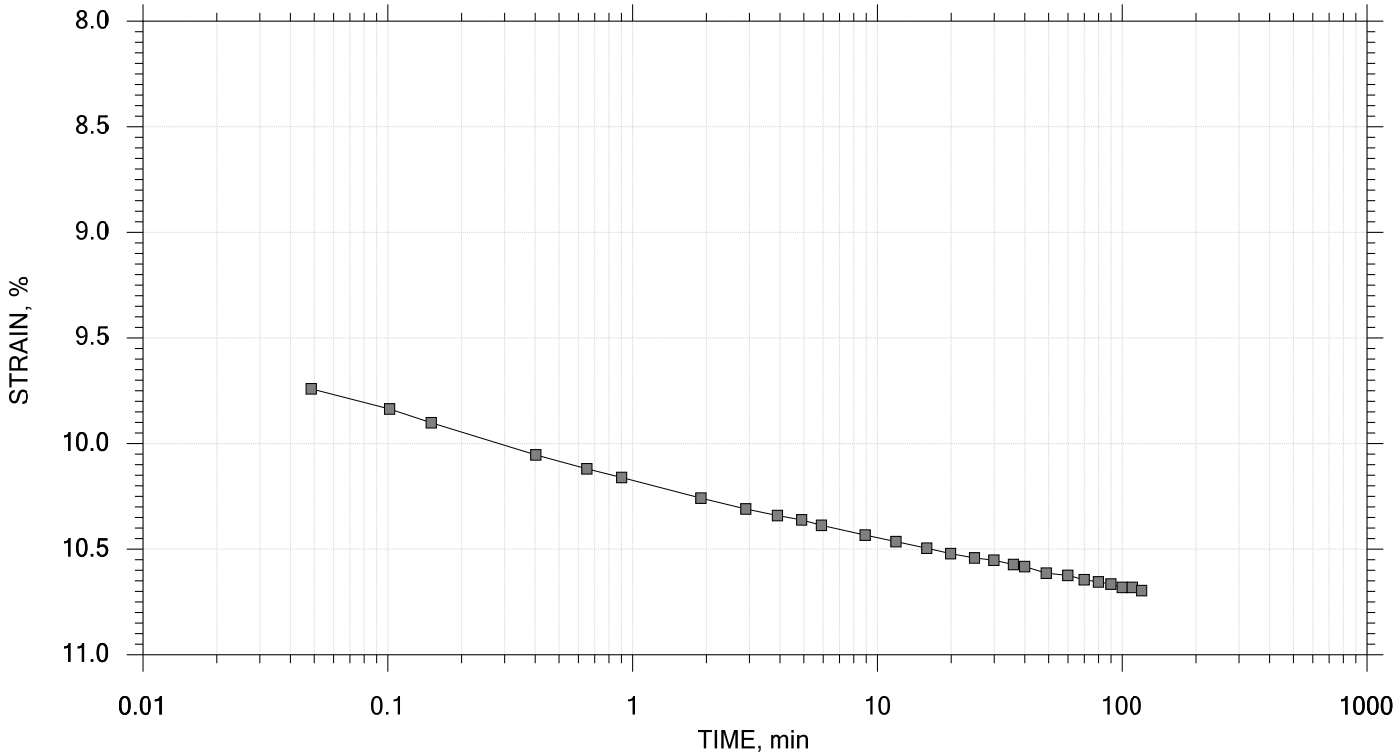
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

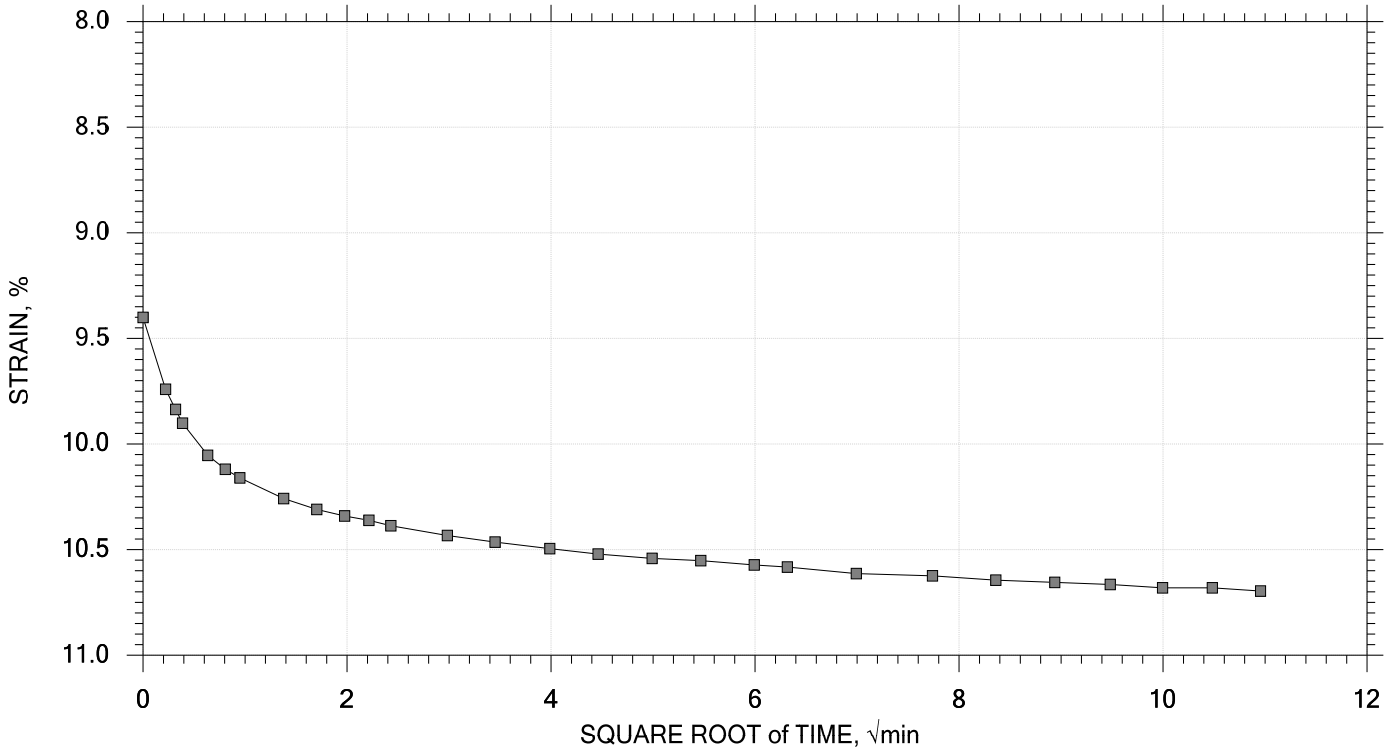
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 13 of 19

Stress: 8 tsf





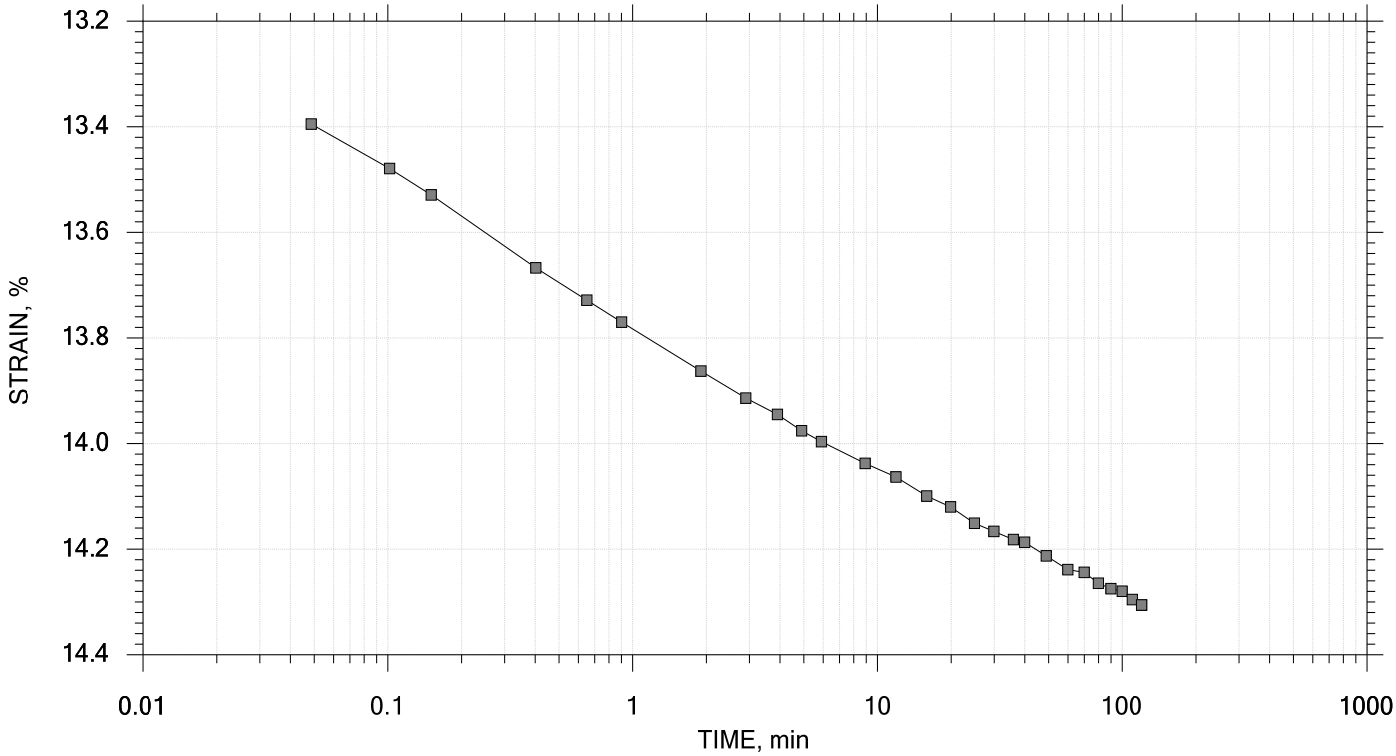
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

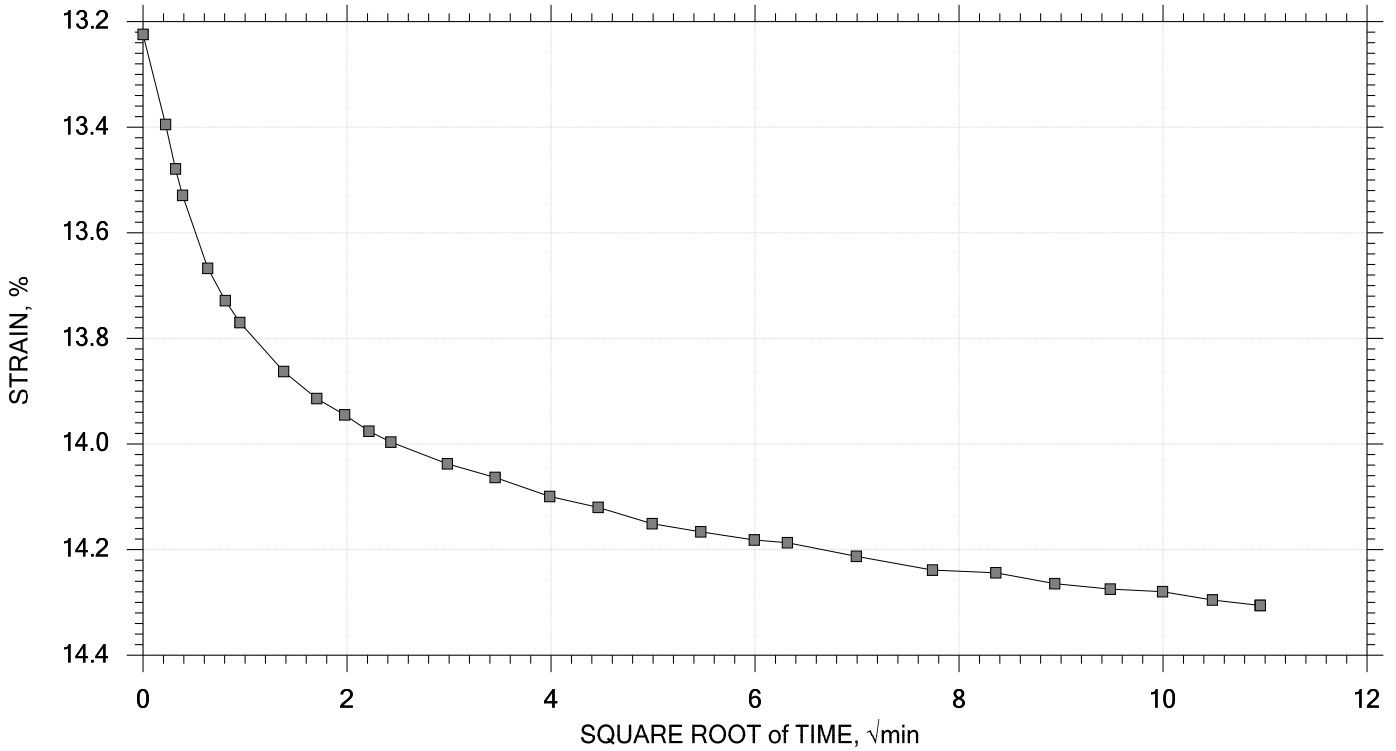
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 14 of 19

Stress: 16 tsf





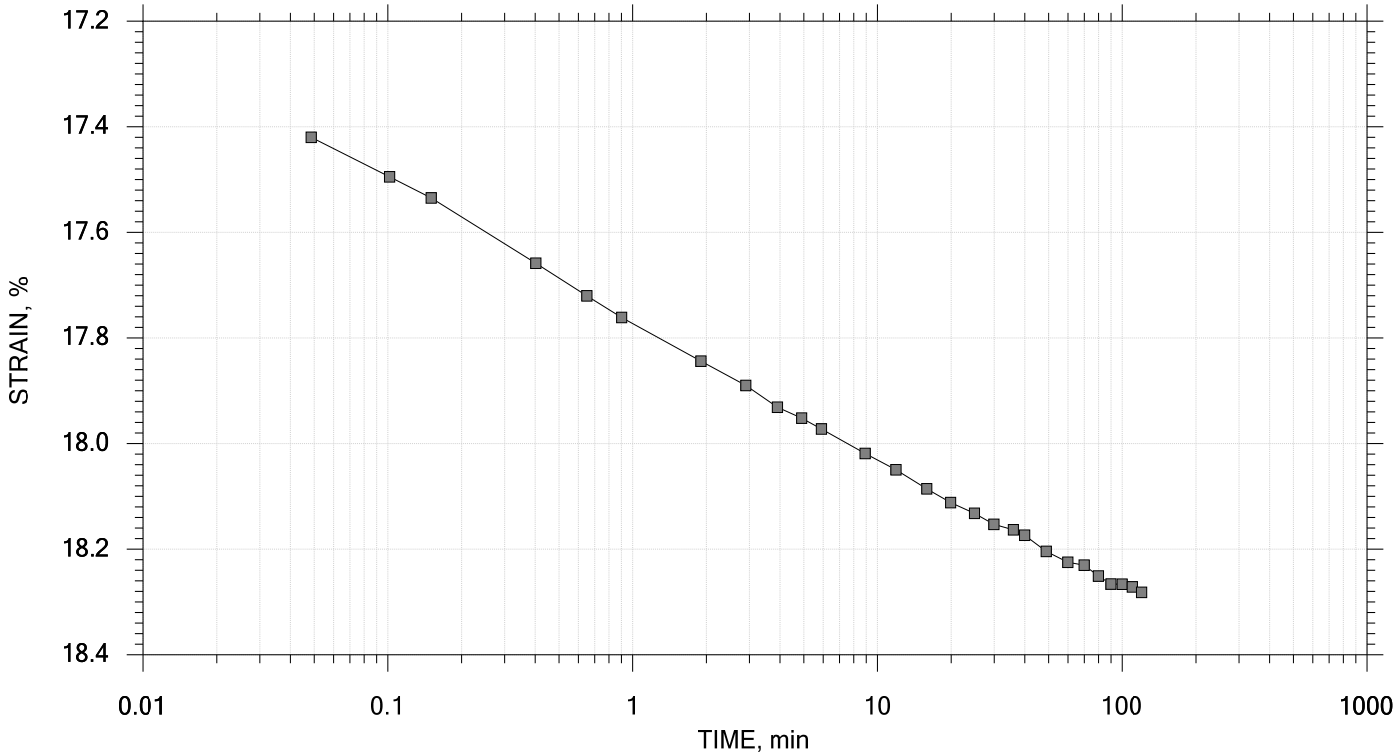
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

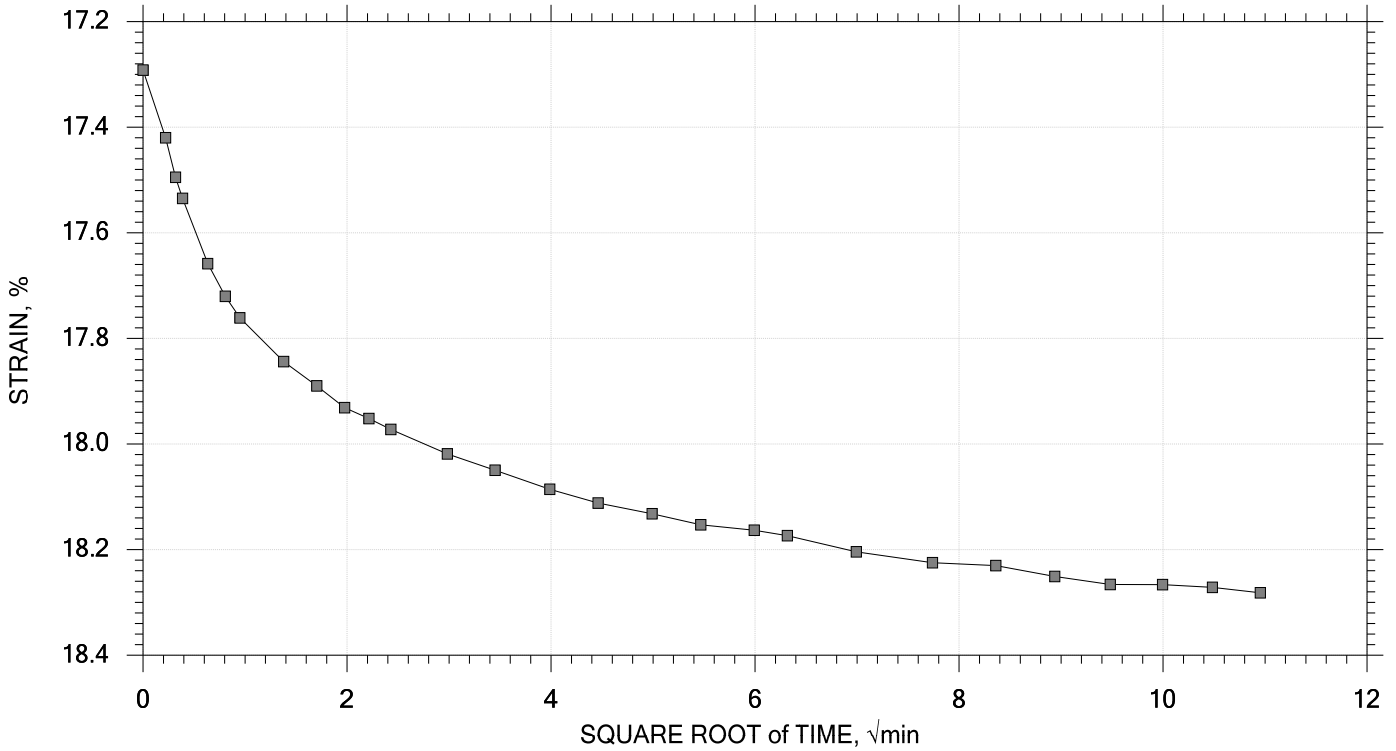
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 15 of 19

Stress: 32 tsf





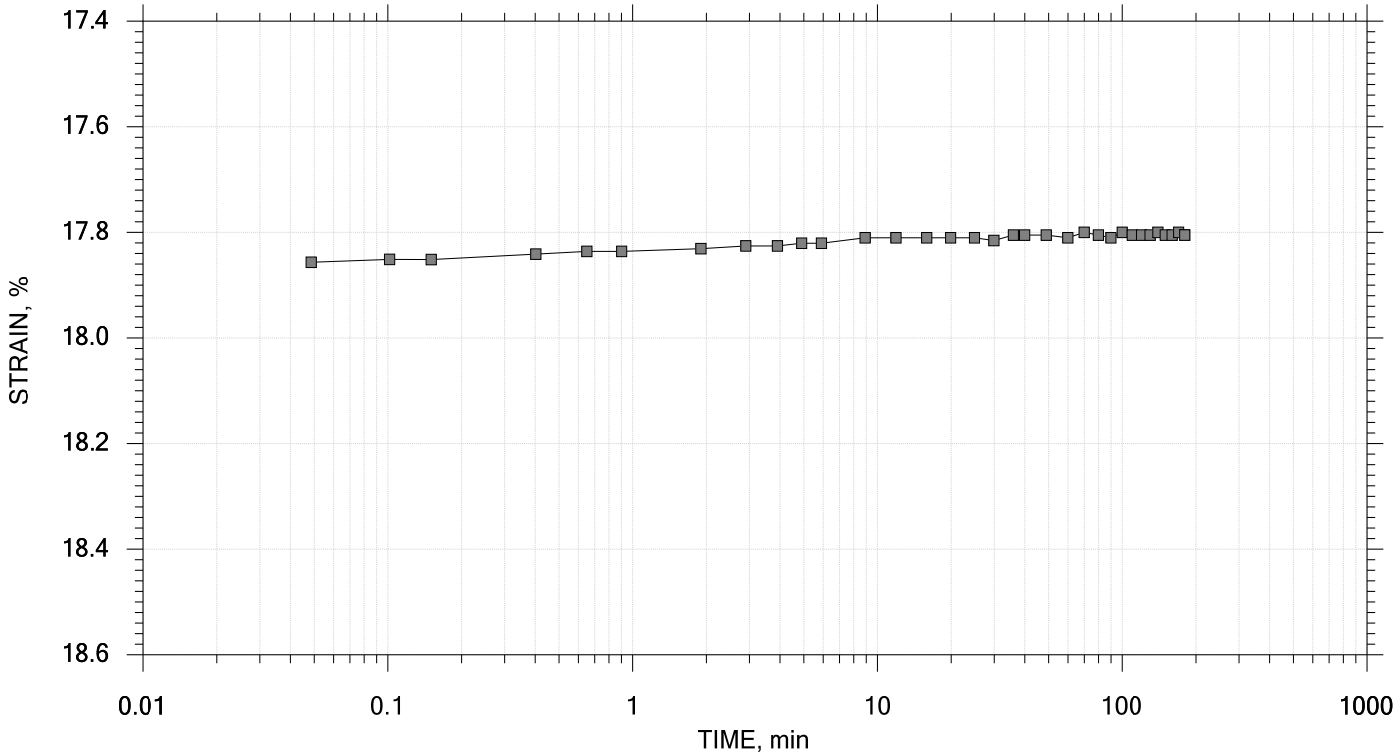
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

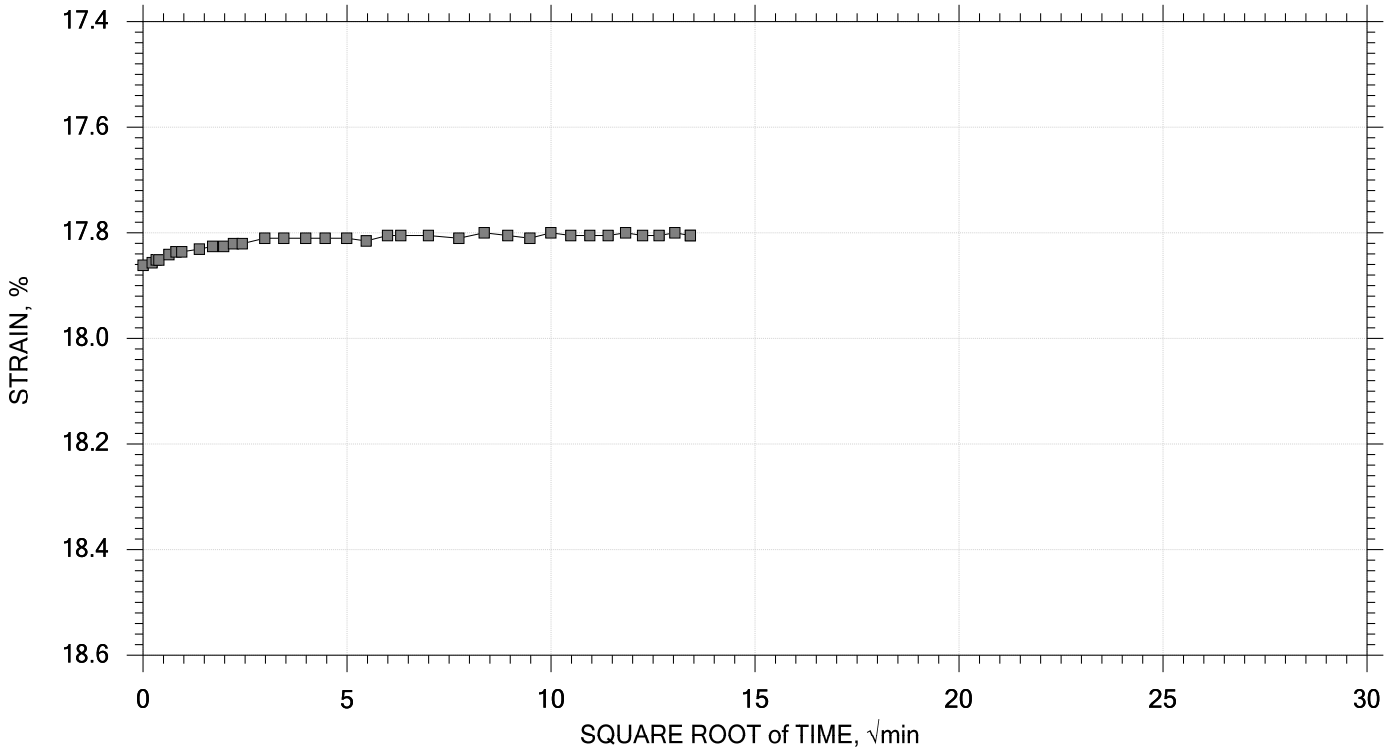
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 16 of 19

Stress: 8 tsf





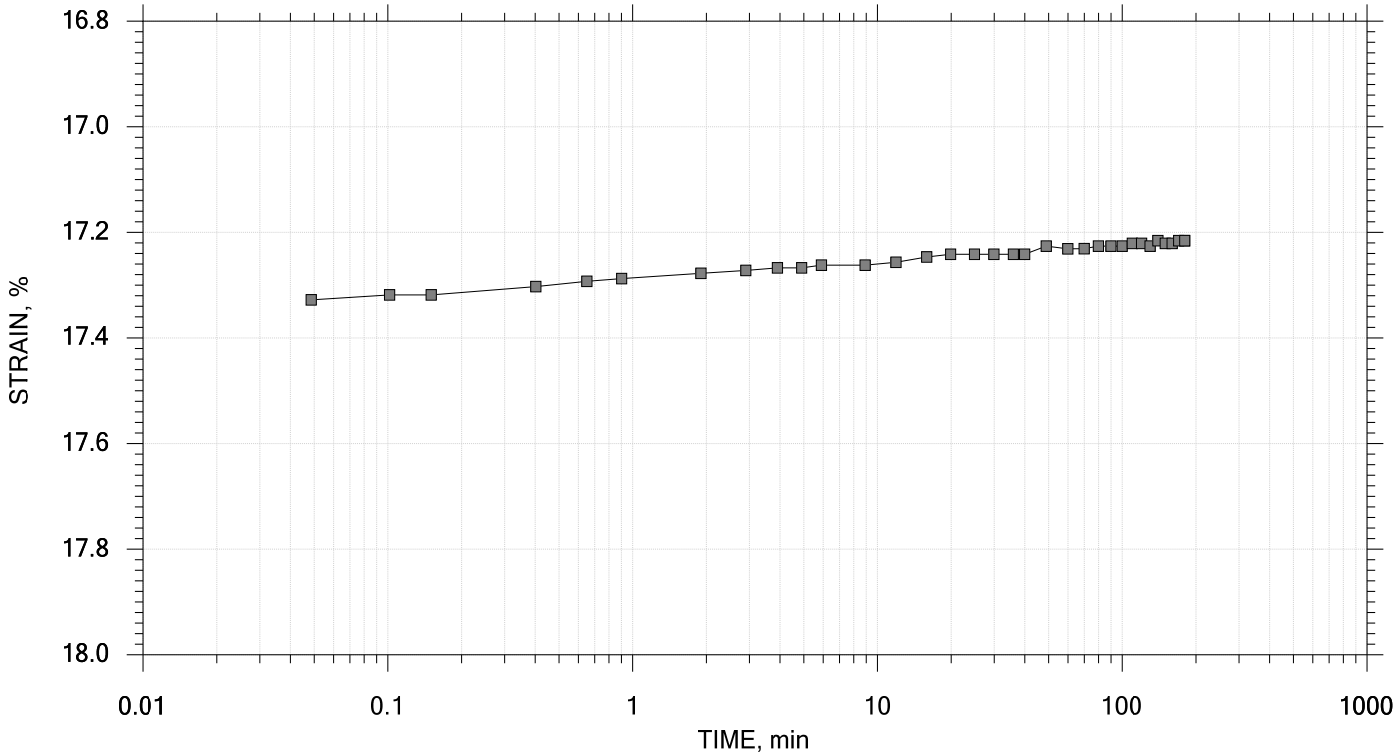
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

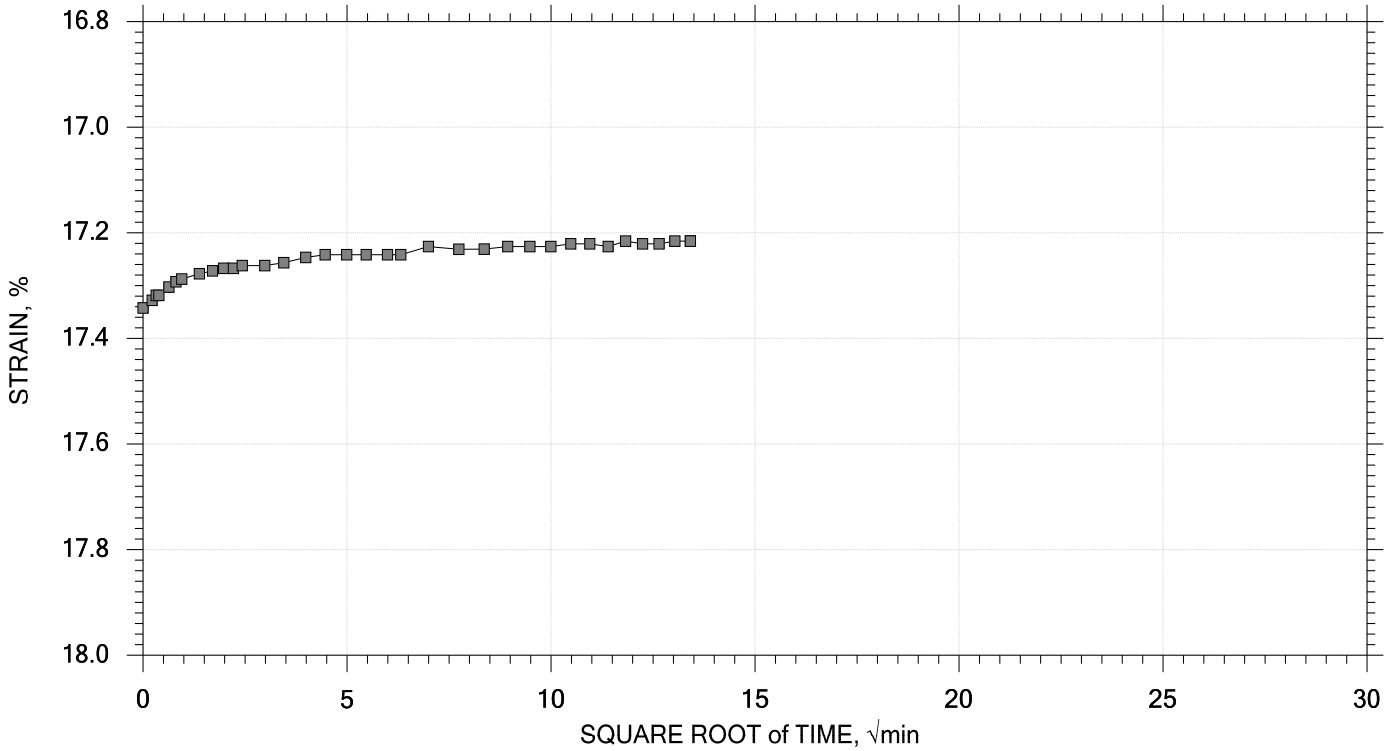
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 17 of 19

Stress: 2 tsf





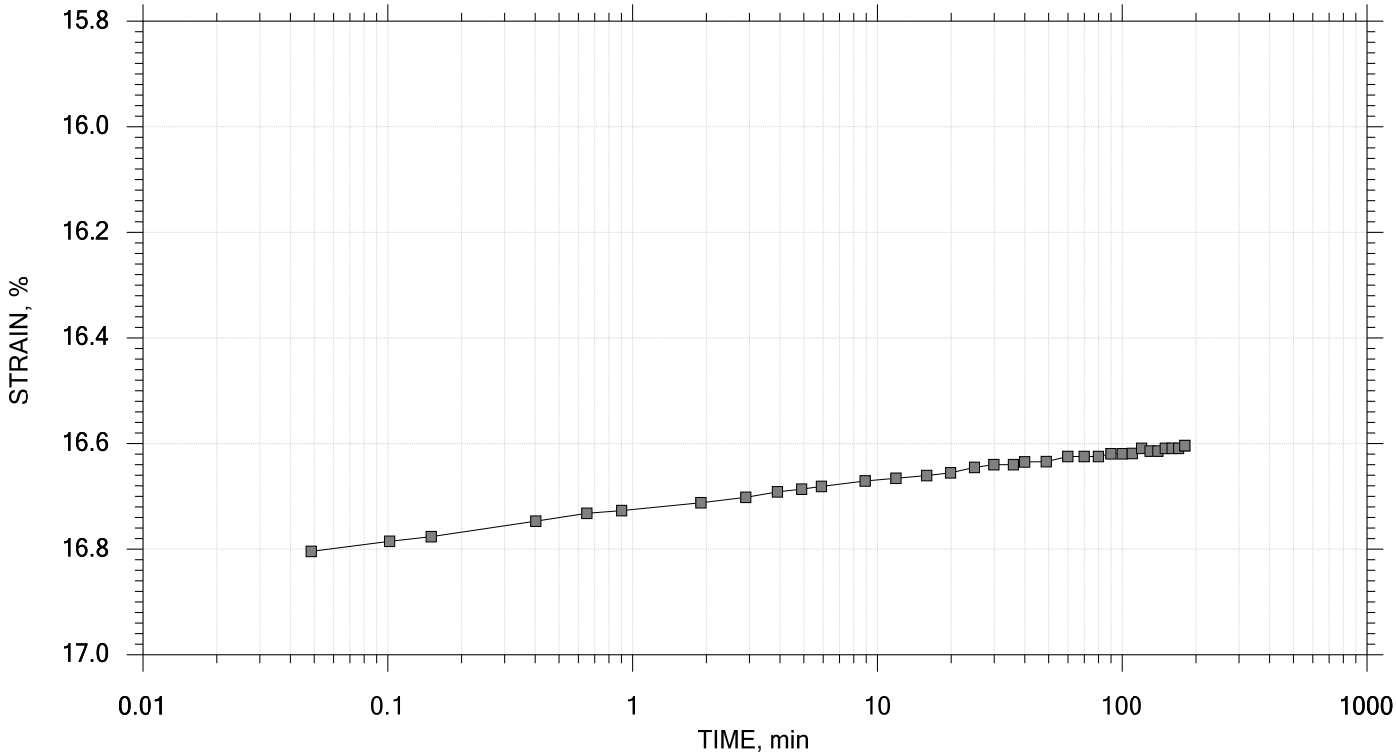
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

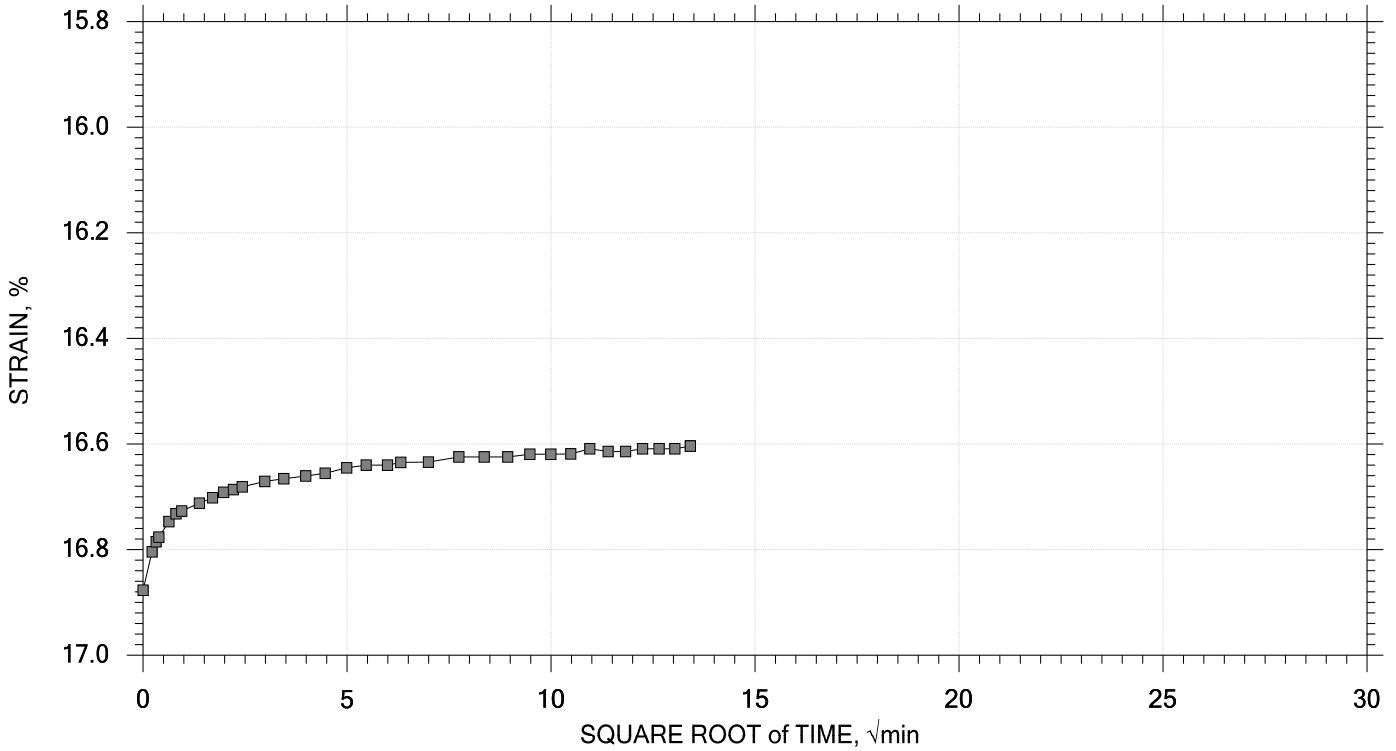
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 18 of 19

Stress: 0.5 tsf





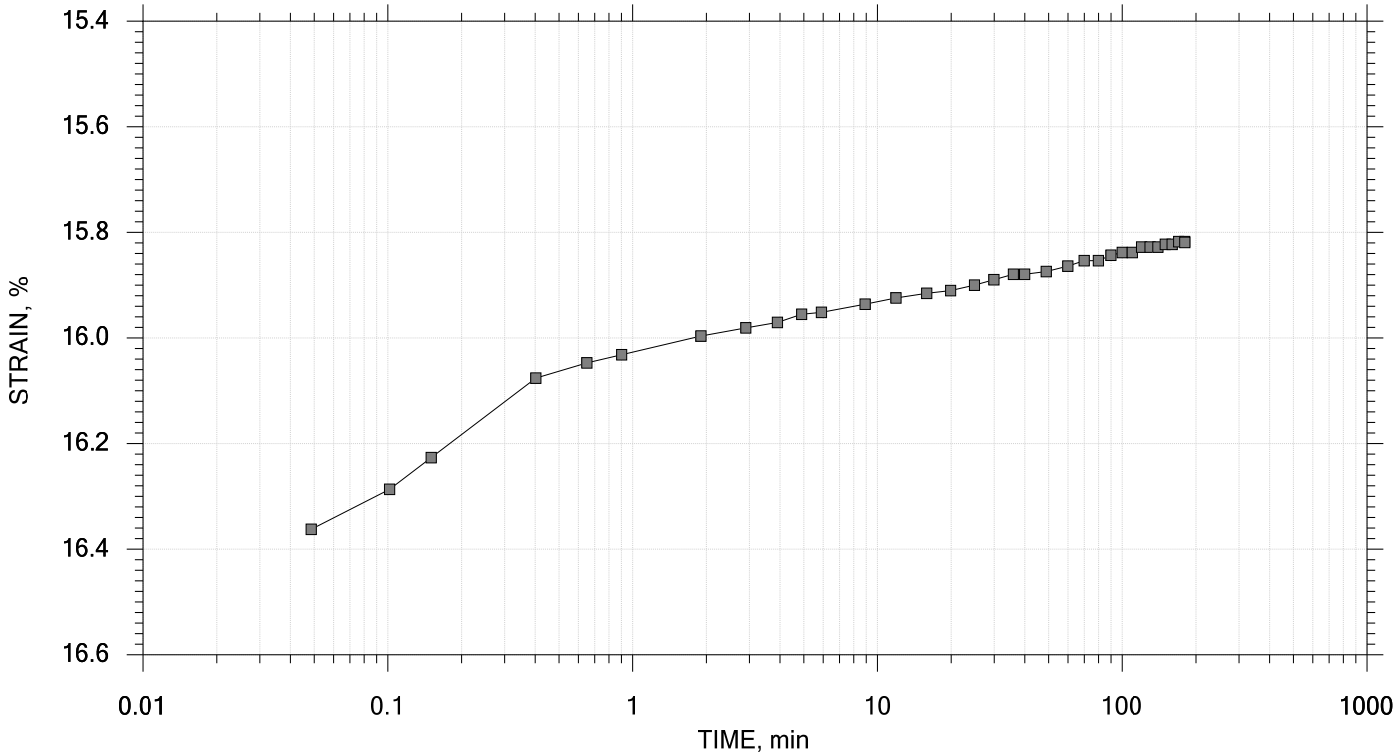
GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

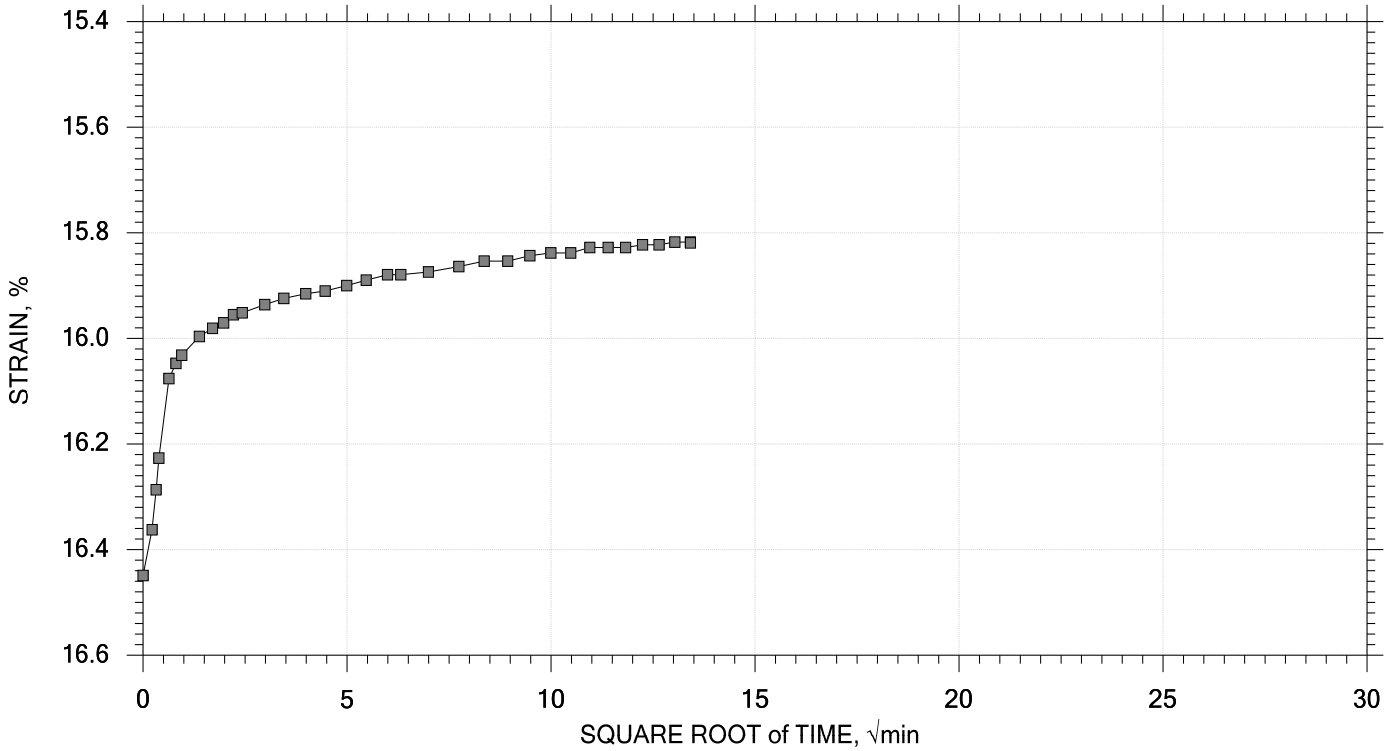
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 19 of 19

Stress: 0.125 tsf

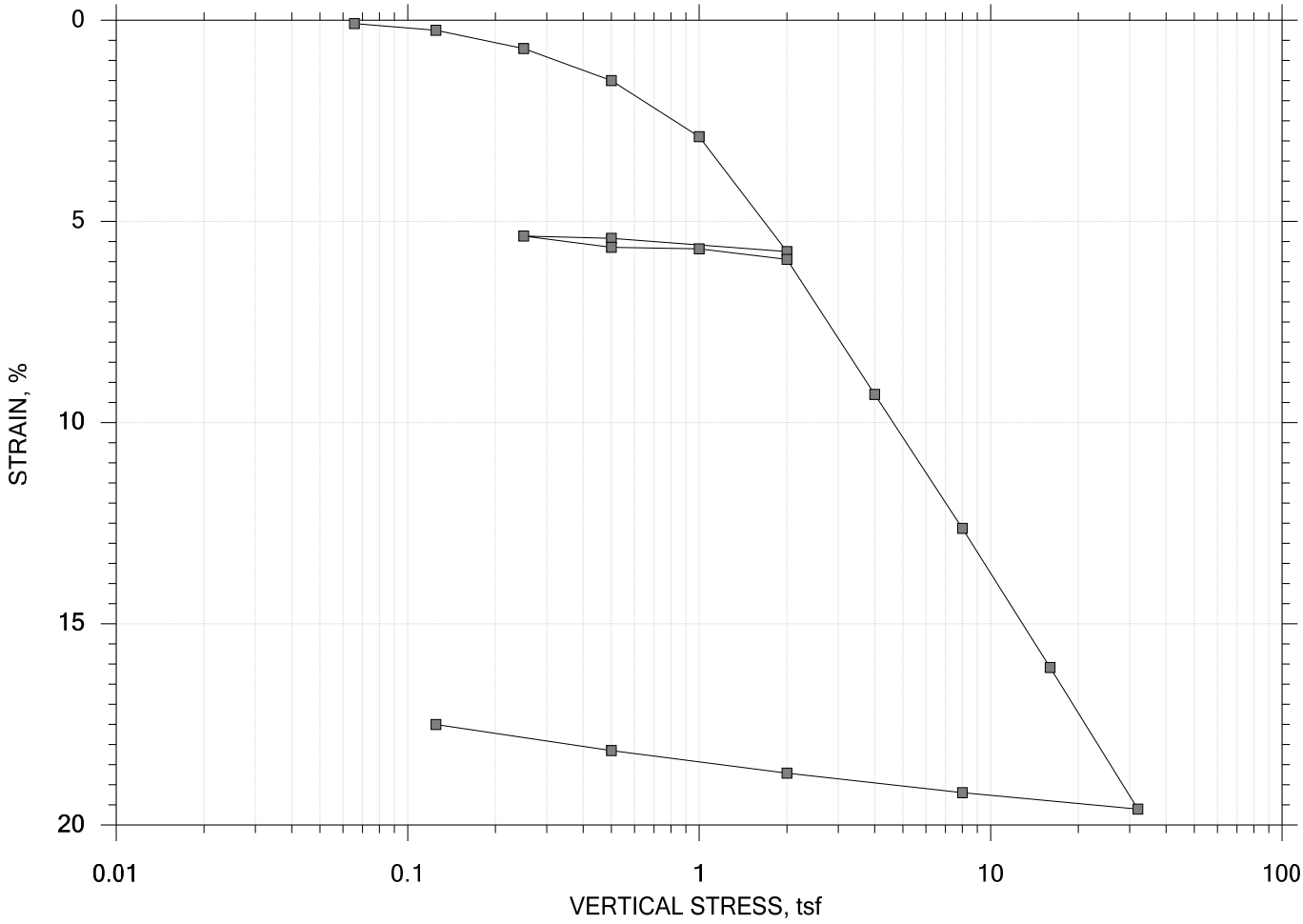


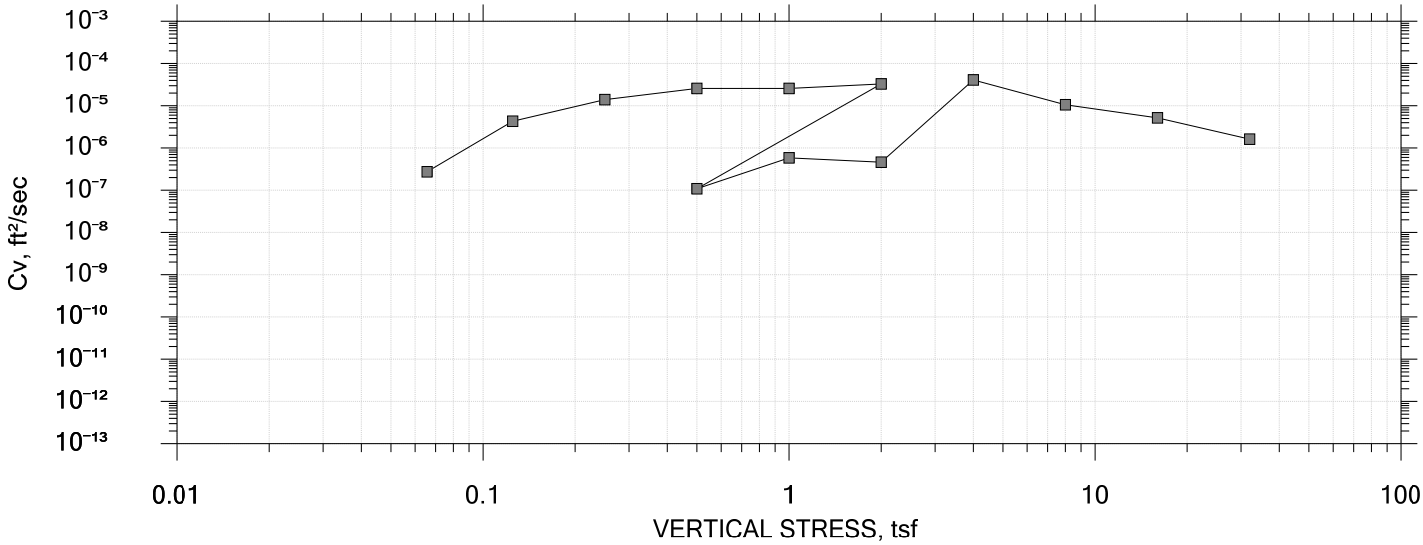


GeoTesting EXPRESS	Project: Dynergy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B01	Tested By: jm	Checked By: mcm
	Sample No.: 3	Test Date: 12/1/17	Test No.: IP-1
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, very dark gray silt (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0671 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT

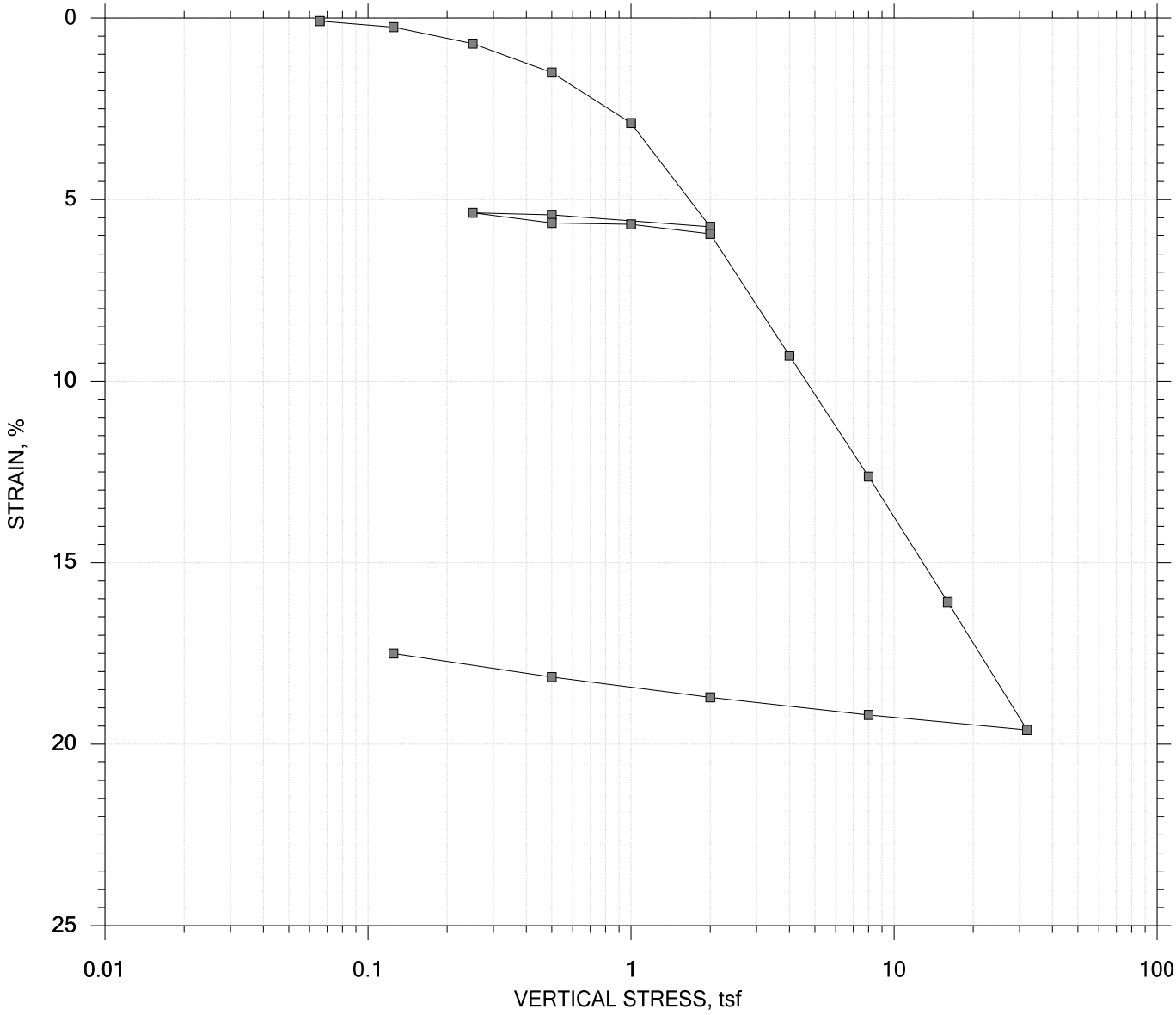




GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT



				Before Test	After Test
Current Vertical Effective Stress: ---			Water Content, %	50.70	36.45
Preconsolidation Stress: ---			Dry Unit Weight, pcf	65.532	79.436
Compression Ratio: ---			Saturation, %	95.43	100.00
Diameter: 2.5 in		Height: 1 in	Void Ratio	1.26	0.87
LL: ---	PL: ---	PI: ---	GS: 2.37		

GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: Dynegy Hennepin West Ash Pond | Location: Hennepin, IL | Project No.: GTX-307367
Boring No.: GS-B02 | Tested By: jm | Checked By: mcm
Sample No.: 1 (Tube) | Test Date: 12/15/17 | Depth: 5-7 ft
Test No.: IP-2 | Sample Type: Intact | Elevation: ---

Soil Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.
Remarks: System 2054, Swell Pressure = 0.0656 tsf

Estimated Specific Gravity: 2.37 | Liquid Limit: --- | Specimen Diameter: 2.50 in
Initial Void Ratio: 1.26 | Plastic Limit: --- | Initial Height: 1.00 in
Final Void Ratio: 0.865 | Plasticity Index: --- | Final Height: 0.82 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	bbb	RING	CB4	CB4
Wt. Container + Wet Soil, gm	121.47	135.36	123.33	123.33
Wt. Container + Dry Soil, gm	84.560	92.550	92.550	92.550
Wt. Container, gm	8.1500	8.1100	8.1100	8.1100
Wt. Dry Soil, gm	76.410	84.440	84.440	84.440
Water Content, %	48.31	50.70	36.45	36.45
Void Ratio	---	1.26	0.865	---
Degree of Saturation, %	---	95.43	100.00	---
Dry Unit Weight, pcf	---	65.532	79.436	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: Dynegy Hennepin West Ash Pond | Location: Hennepin, IL | Project No.: GTX-307367
Boring No.: GS-B02 | Tested By: jm | Checked By: mcm
Sample No.: 1 (Tube) | Test Date: 12/15/17 | Depth: 5-7 ft
Test No.: IP-2 | Sample Type: Intact | Elevation: ---

Soil Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.
Remarks: System 2054, Swell Pressure = 0.0656 tsf

Displacement at End of Increment

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt T90 min	Cv ft²/sec	Mv 1/tsf	k cm/sec
1	0.0656	0.0008086	1.26	0.0809	85.144	2.88e-007	1.23e-002	3.38e-009
2	0.125	0.002469	1.26	0.247	5.901	4.14e-006	2.79e-002	1.10e-007
3	0.250	0.007021	1.24	0.702	2.768	8.78e-006	3.64e-002	3.04e-007
4	0.500	0.01497	1.23	1.50	1.126	2.13e-005	3.18e-002	6.45e-007
5	1.00	0.02892	1.20	2.89	1.125	2.09e-005	2.79e-002	5.54e-007
6	2.00	0.05750	1.13	5.75	0.821	2.73e-005	2.86e-002	7.43e-007
7	0.500	0.05419	1.14	5.42	24.902	8.78e-007	2.20e-003	1.84e-009
8	0.250	0.05361	1.14	5.36	24.902	8.82e-007	2.31e-003	1.94e-009
9	0.500	0.05641	1.13	5.64	100.969	2.17e-007	1.12e-002	2.31e-009
10	1.00	0.05680	1.13	5.68	52.243	4.18e-007	7.96e-004	3.16e-010
11	2.00	0.05940	1.13	5.94	35.050	6.21e-007	2.60e-003	1.54e-009
12	4.00	0.09297	1.05	9.30	0.885	2.37e-005	1.68e-002	3.78e-007
13	8.00	0.1263	0.975	12.6	3.607	5.39e-006	8.33e-003	4.27e-008
14	16.0	0.1608	0.897	16.1	5.362	3.36e-006	4.32e-003	1.38e-008
15	32.0	0.1961	0.818	19.6	10.193	1.62e-006	2.20e-003	3.40e-009
16	8.00	0.1920	0.827	19.2	135.435	1.18e-007	1.71e-004	1.91e-011
17	2.00	0.1871	0.838	18.7	7.008	2.30e-006	8.11e-004	1.77e-009
18	0.500	0.1815	0.850	18.2	6.502	2.51e-006	3.73e-003	8.92e-009
19	0.125	0.1750	0.865	17.5	3.162	5.24e-006	1.73e-002	8.60e-008

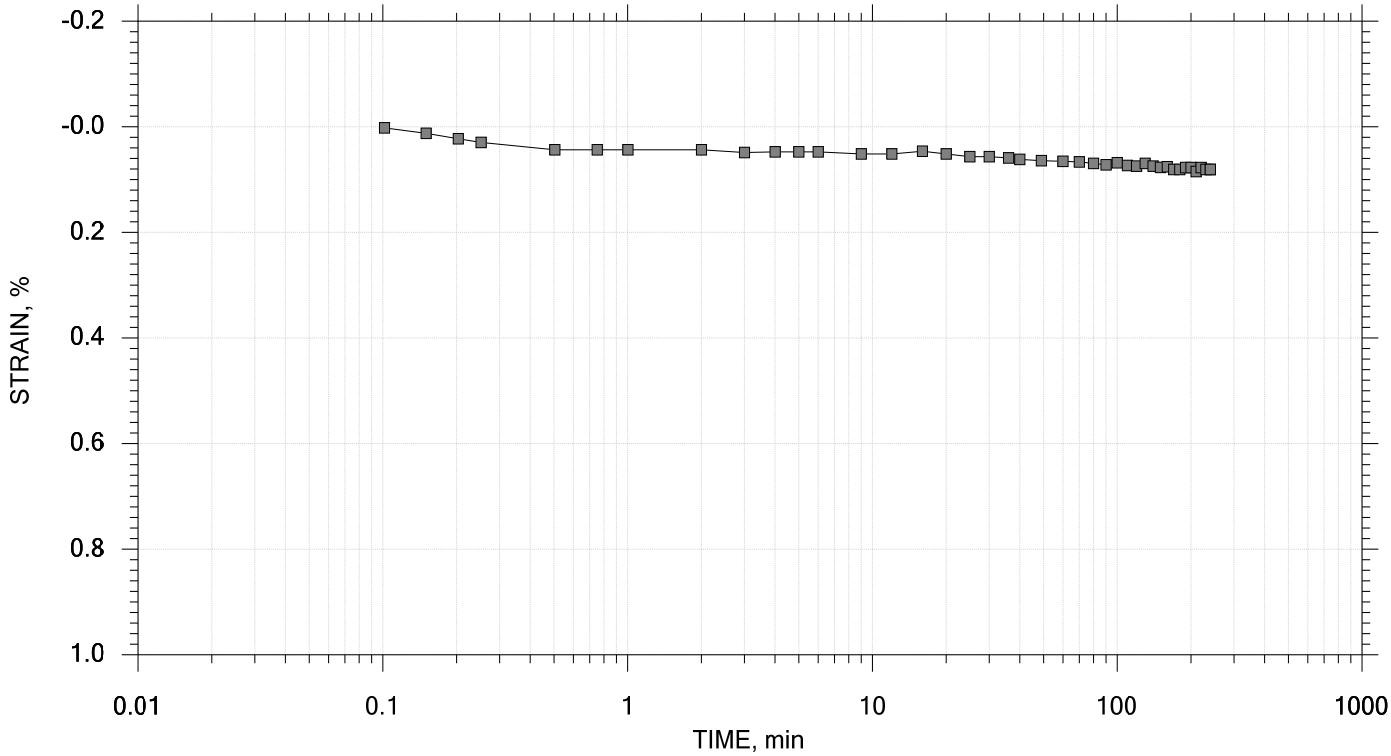
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/sec	Mv 1/tsf	k cm/sec	Ca %
1	0.0656	0.0008086	1.26	0.0809	0.000	0.00e+000	1.23e-002	0.00e+000	0.00e+000
2	0.125	0.002469	1.26	0.247	0.000	0.00e+000	2.79e-002	0.00e+000	0.00e+000
3	0.250	0.007021	1.24	0.702	0.198	2.85e-005	3.64e-002	9.87e-007	0.00e+000
4	0.500	0.01497	1.23	1.50	0.184	3.03e-005	3.18e-002	9.15e-007	0.00e+000
5	1.00	0.02892	1.20	2.89	0.171	3.19e-005	2.79e-002	8.47e-007	0.00e+000
6	2.00	0.05750	1.13	5.75	0.158	3.30e-005	2.86e-002	8.97e-007	0.00e+000
7	0.500	0.05419	1.14	5.42	0.000	0.00e+000	2.20e-003	0.00e+000	0.00e+000
8	0.250	0.05361	1.14	5.36	0.000	0.00e+000	2.31e-003	0.00e+000	0.00e+000
9	0.500	0.05641	1.13	5.64	0.000	0.00e+000	1.12e-002	0.00e+000	0.00e+000
10	1.00	0.05680	1.13	5.68	0.000	0.00e+000	7.96e-004	0.00e+000	0.00e+000
11	2.00	0.05940	1.13	5.94	0.000	0.00e+000	2.60e-003	0.00e+000	0.00e+000
12	4.00	0.09297	1.05	9.30	0.078	6.27e-005	1.68e-002	1.00e-006	0.00e+000
13	8.00	0.1263	0.975	12.6	0.098	4.62e-005	8.33e-003	3.66e-007	0.00e+000
14	16.0	0.1608	0.897	16.1	0.453	9.22e-006	4.32e-003	3.79e-008	0.00e+000
15	32.0	0.1961	0.818	19.6	0.000	0.00e+000	2.20e-003	0.00e+000	0.00e+000
16	8.00	0.1920	0.827	19.2	0.000	0.00e+000	1.71e-004	0.00e+000	0.00e+000
17	2.00	0.1871	0.838	18.7	0.000	0.00e+000	8.11e-004	0.00e+000	0.00e+000
18	0.500	0.1815	0.850	18.2	0.000	0.00e+000	3.73e-003	0.00e+000	0.00e+000
19	0.125	0.1750	0.865	17.5	0.241	1.60e-005	1.73e-002	2.63e-007	0.00e+000

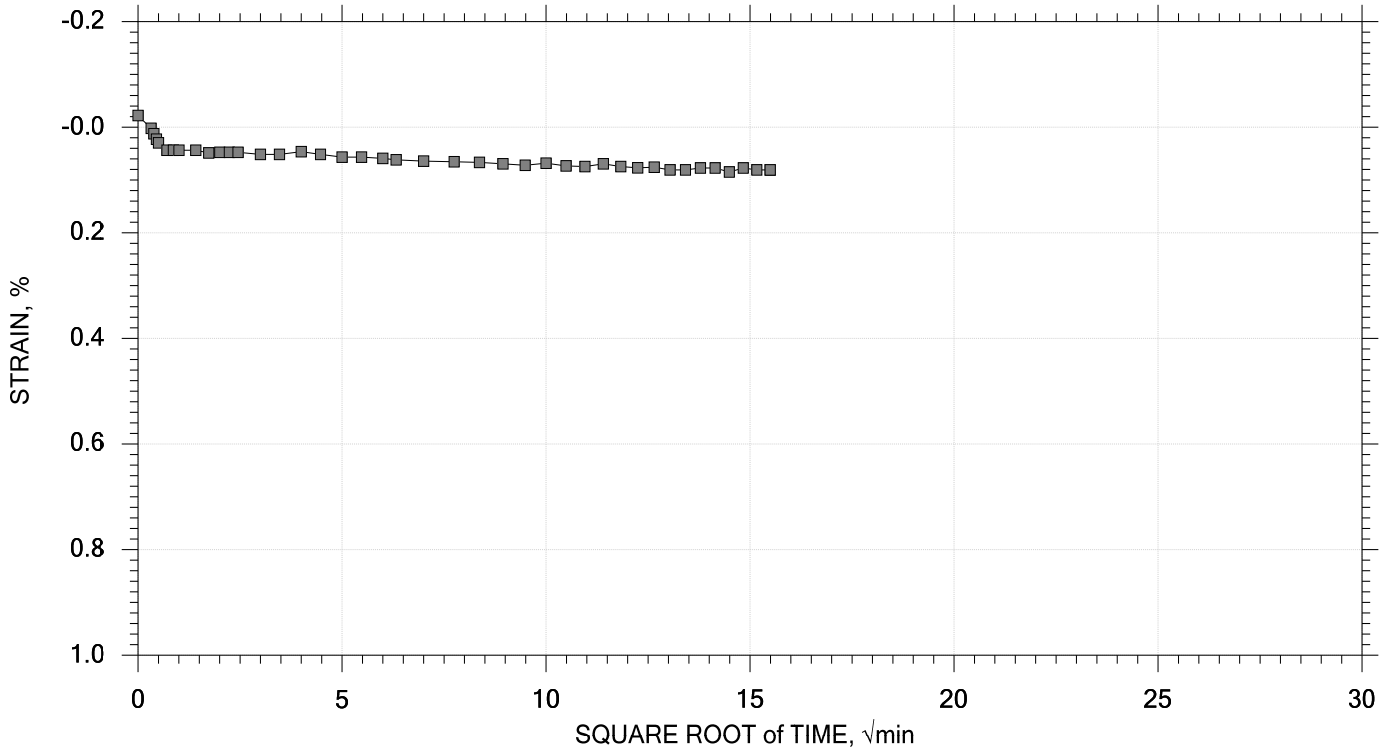
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Volume Step 1 of 19

Stress: 0.065595 tsf





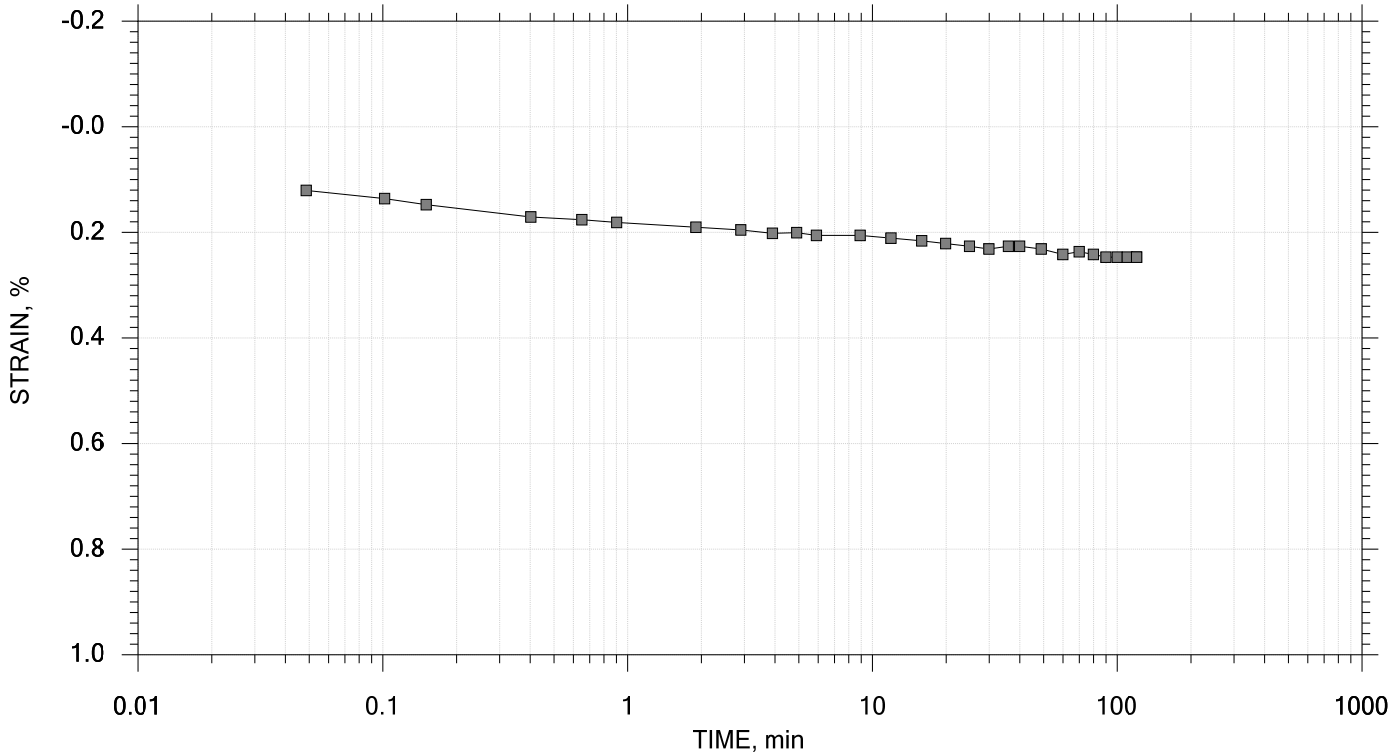
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

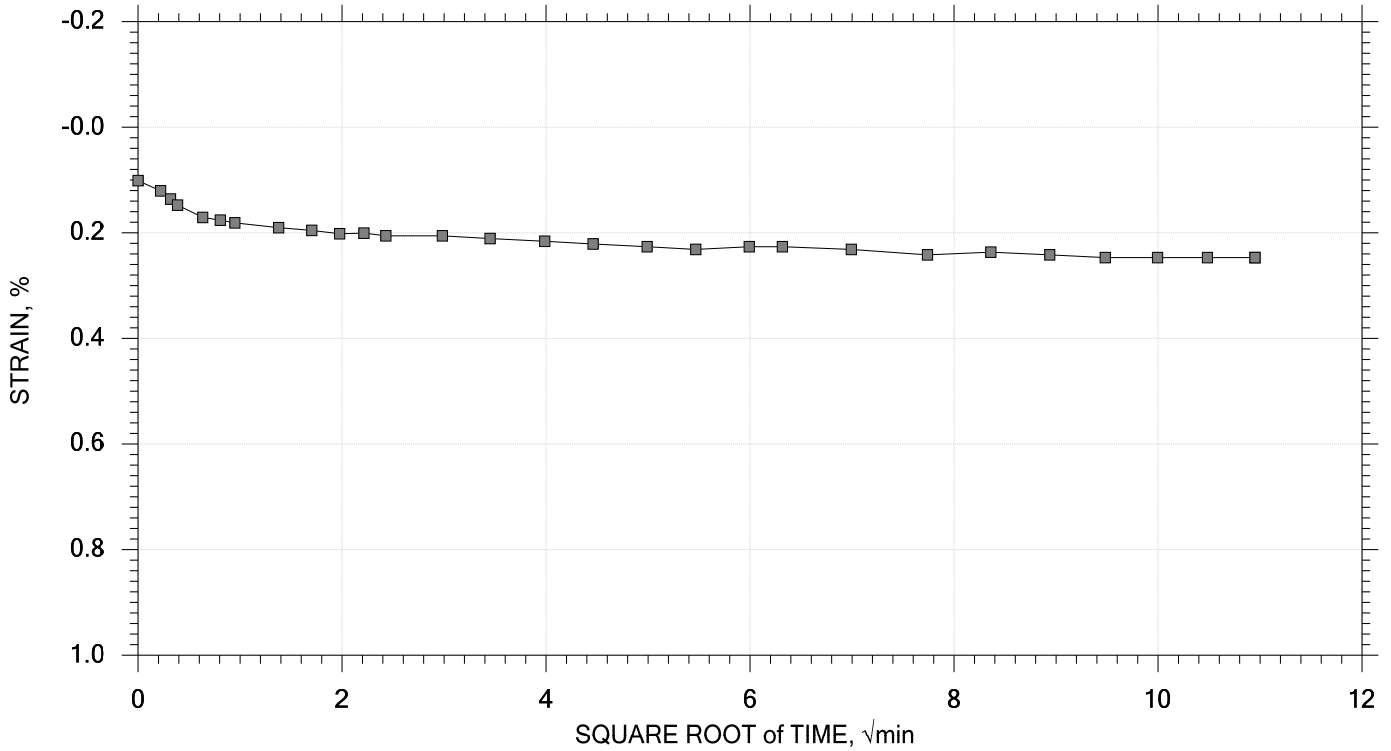
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 2 of 19

Stress: 0.125 tsf





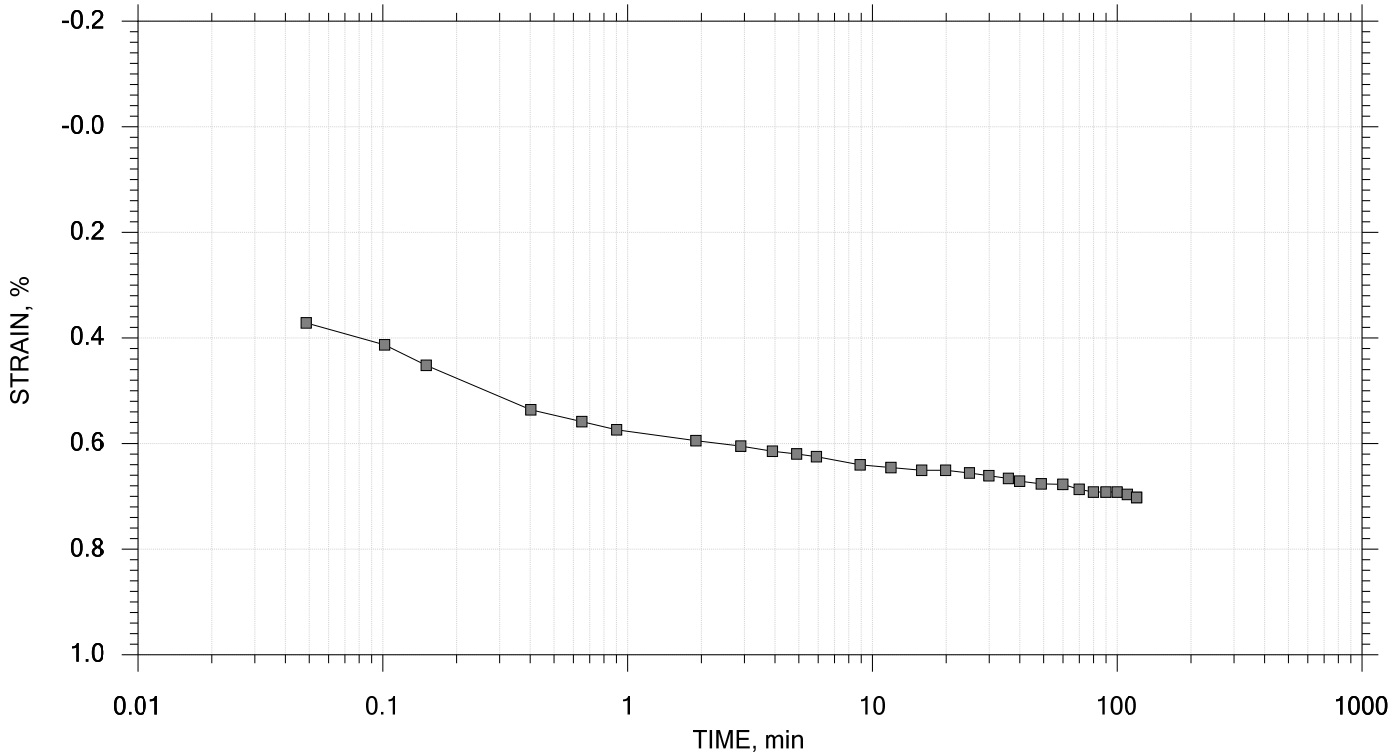
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

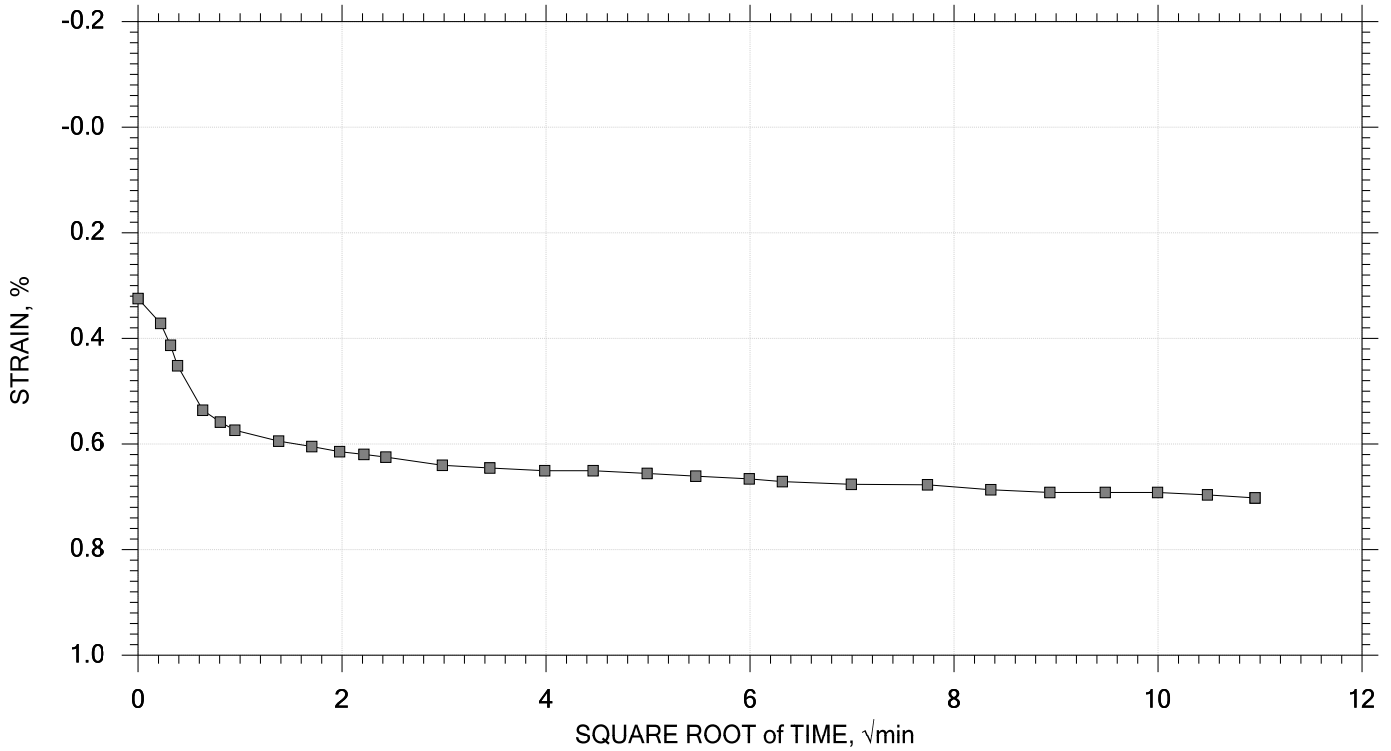
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 3 of 19

Stress: 0.25 tsf





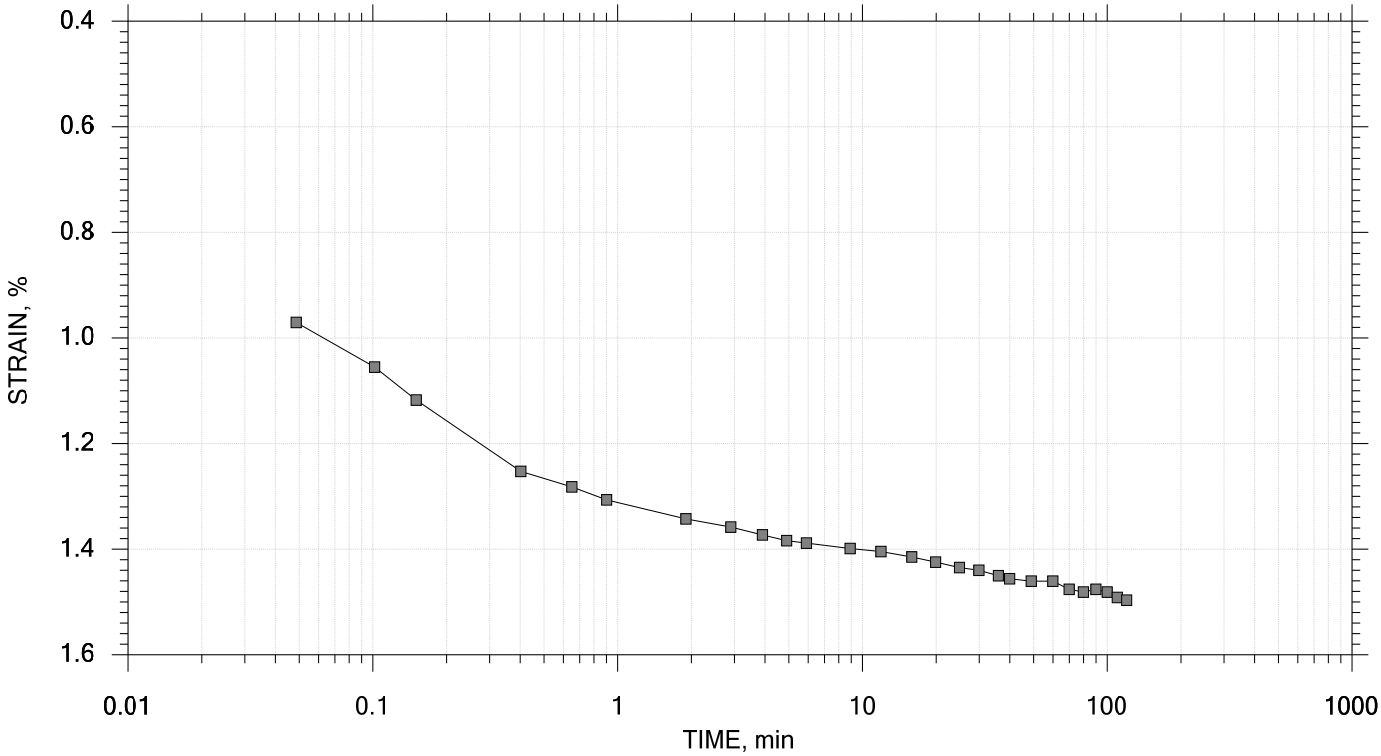
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

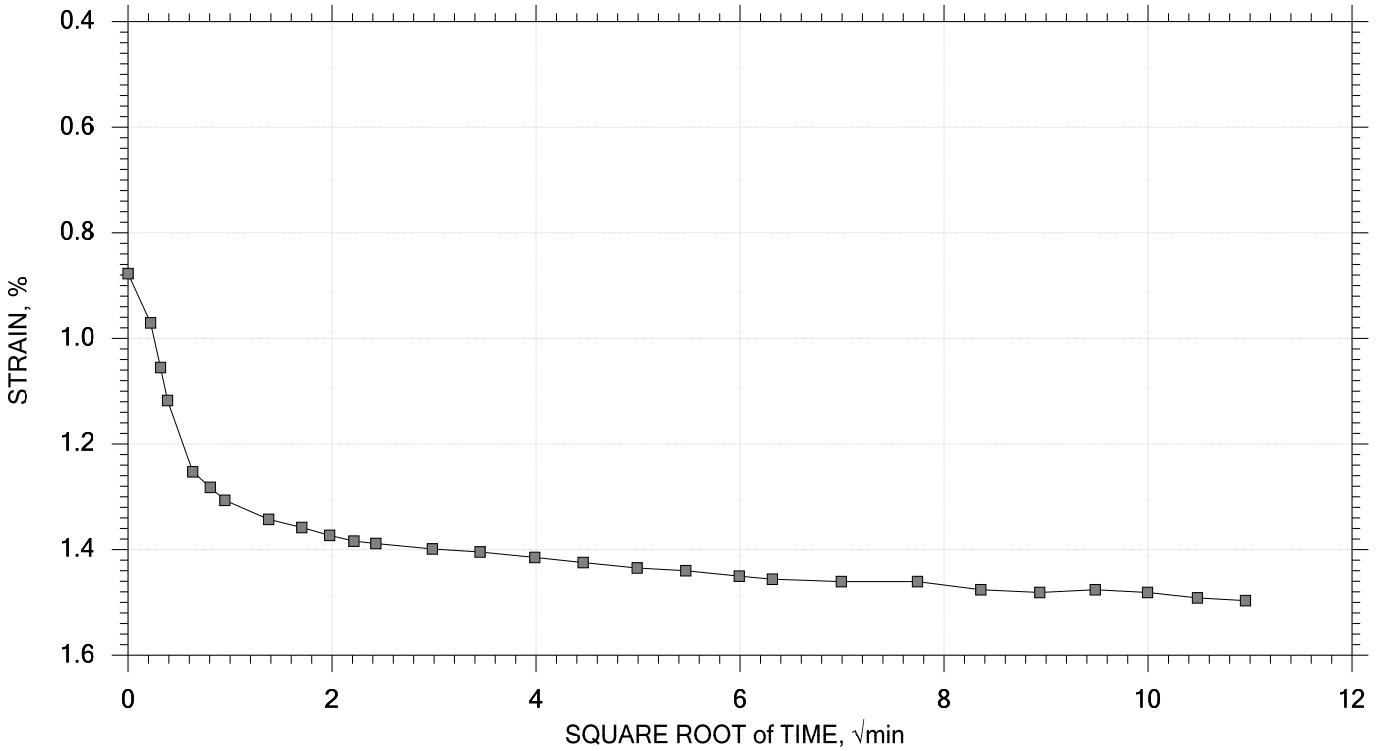
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 4 of 19

Stress: 0.5 tsf





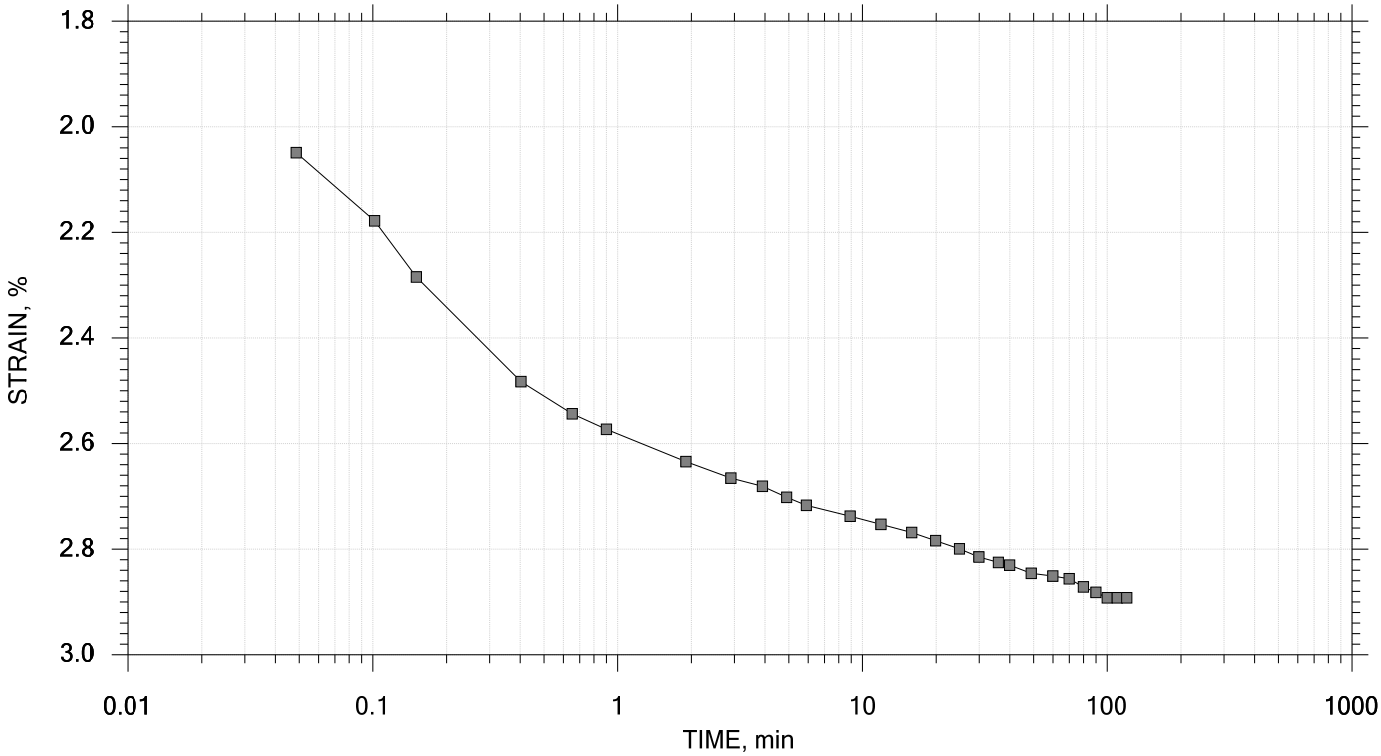
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

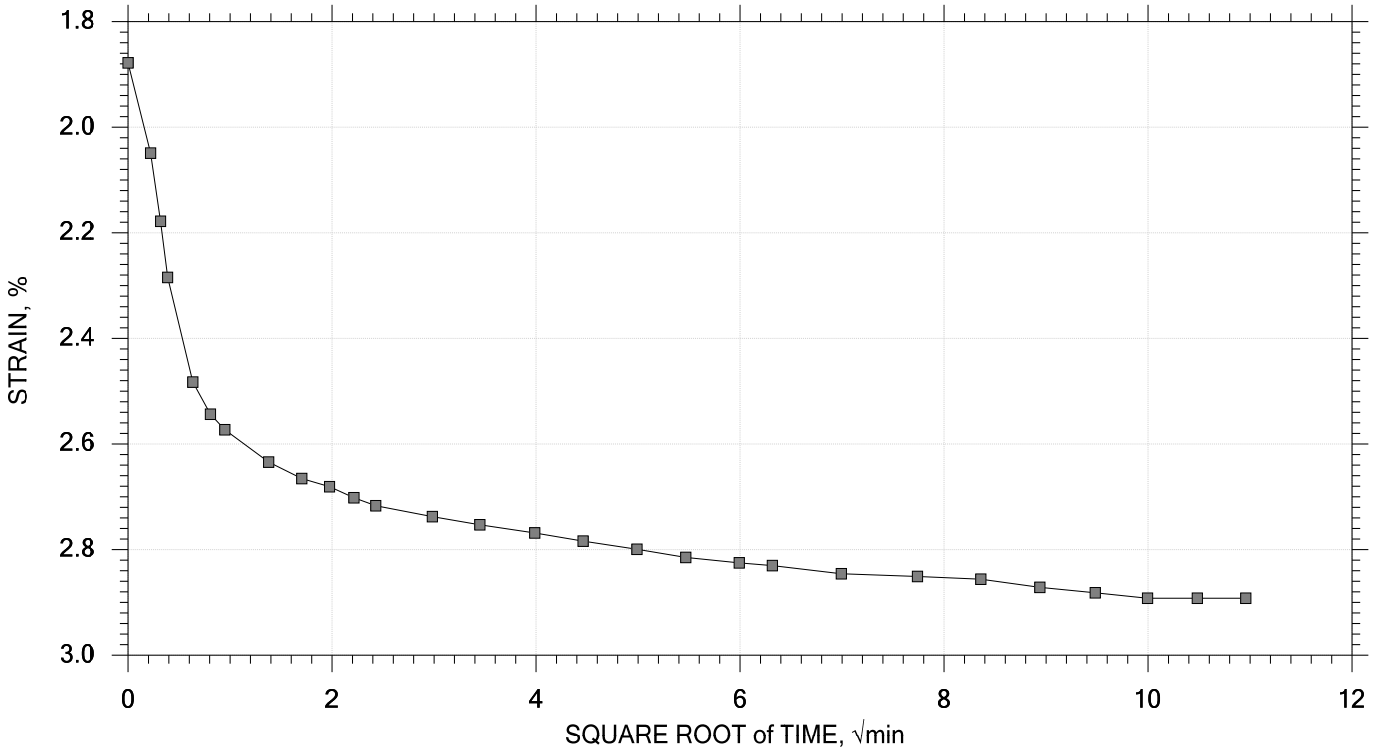
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 5 of 19

Stress: 1 tsf





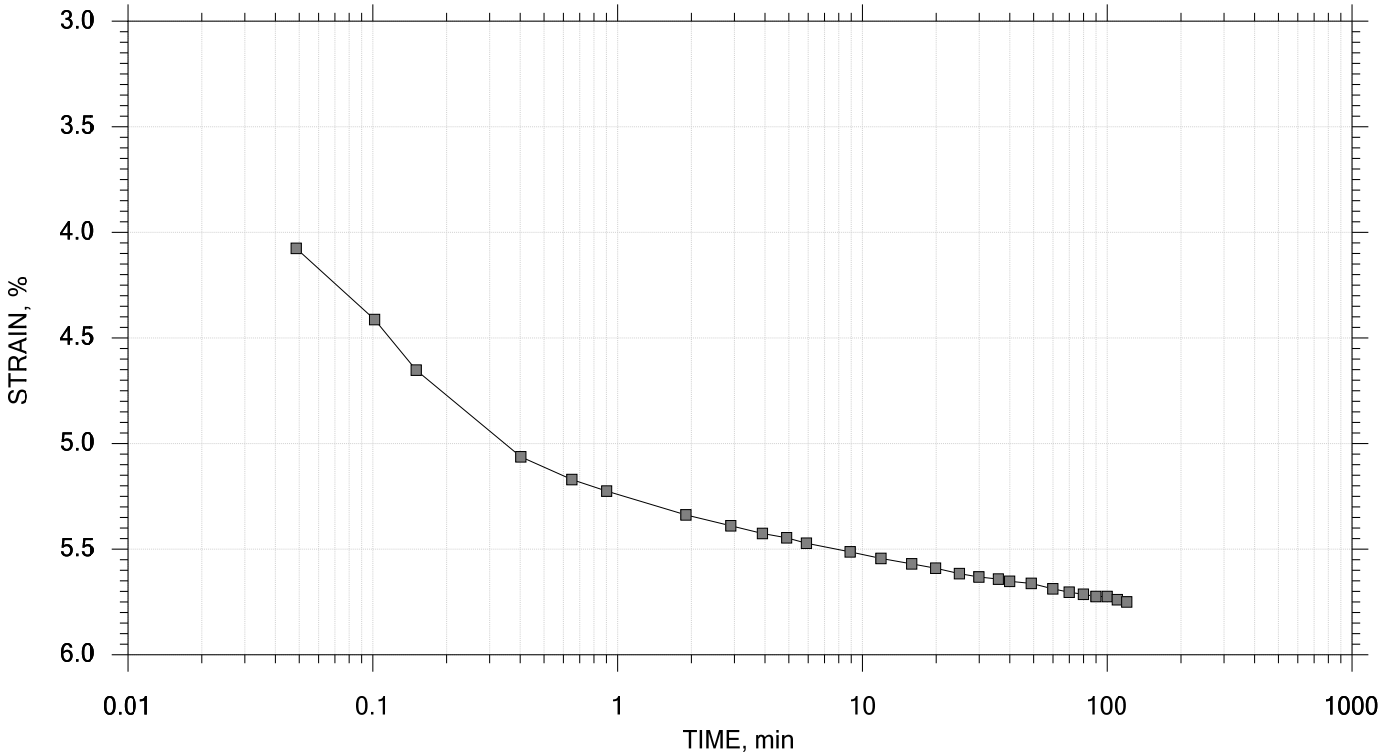
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

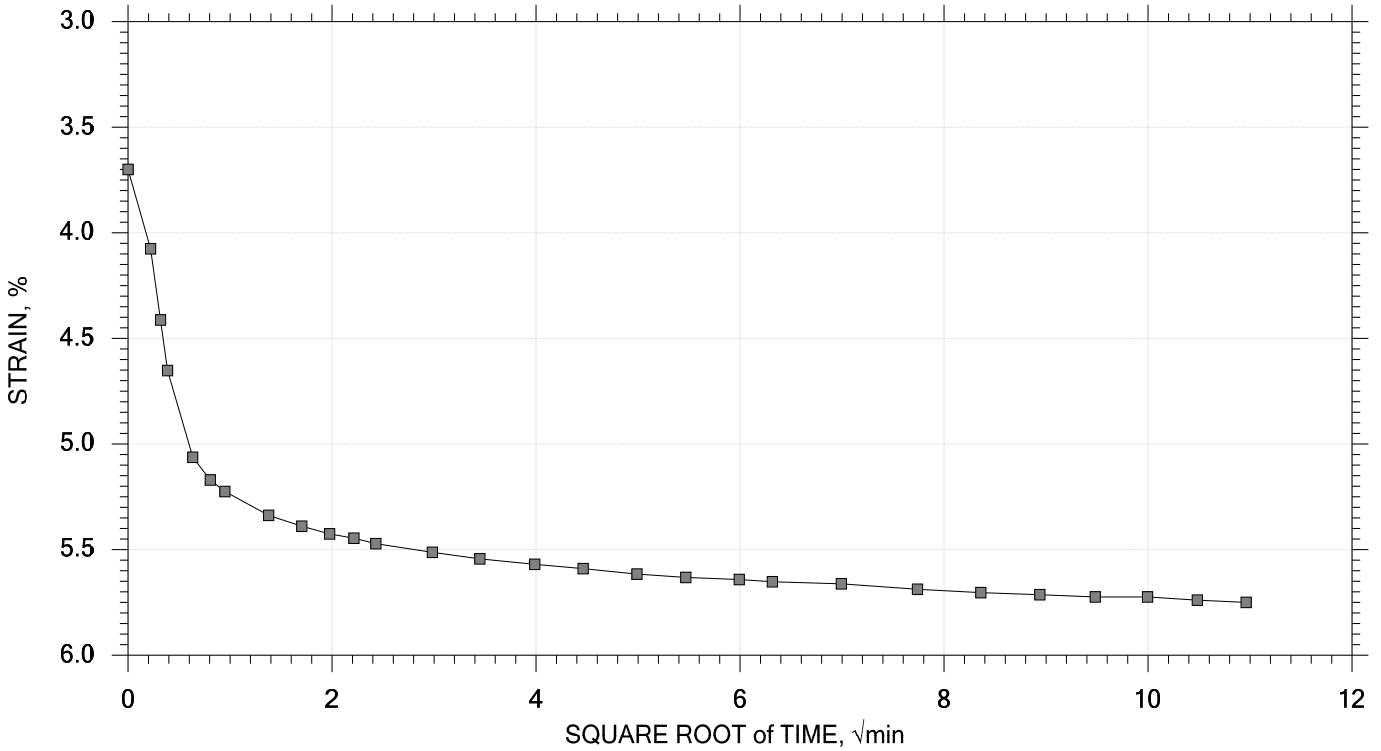
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 6 of 19

Stress: 2 tsf





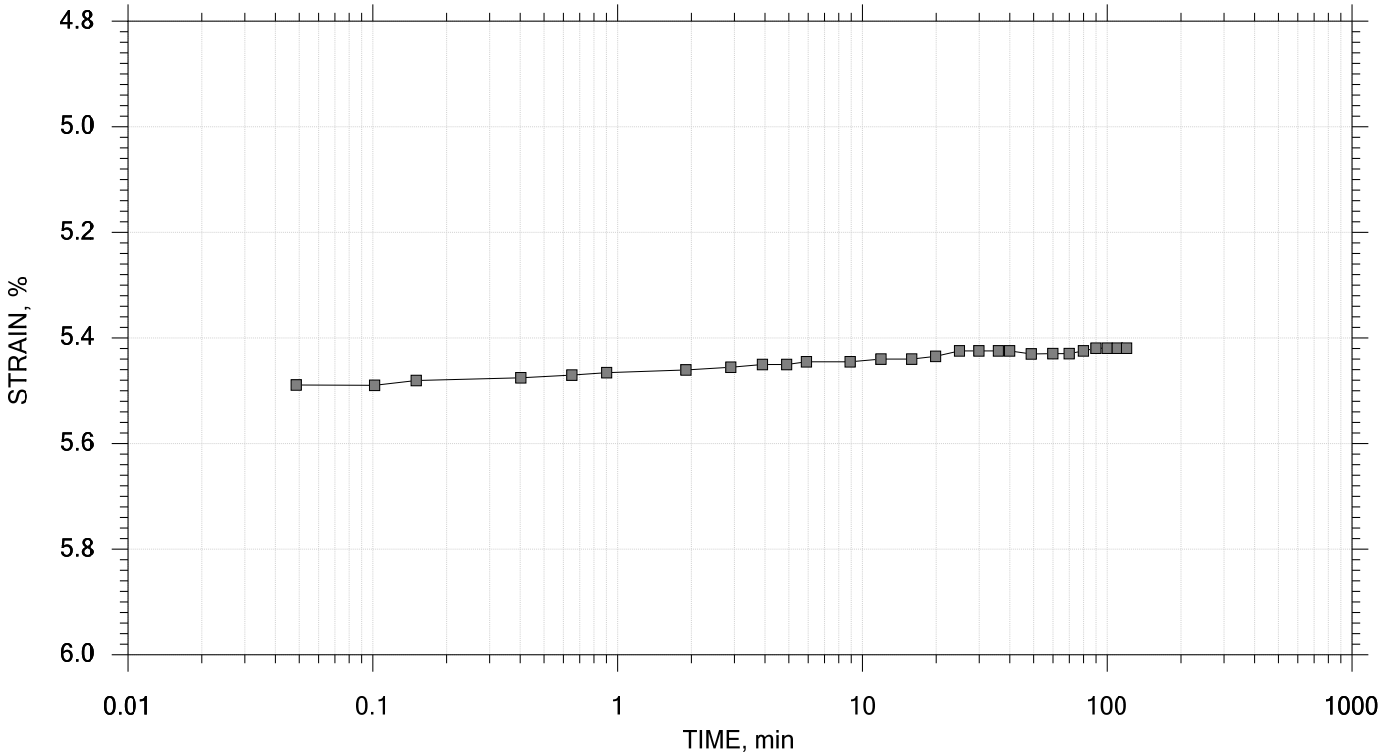
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

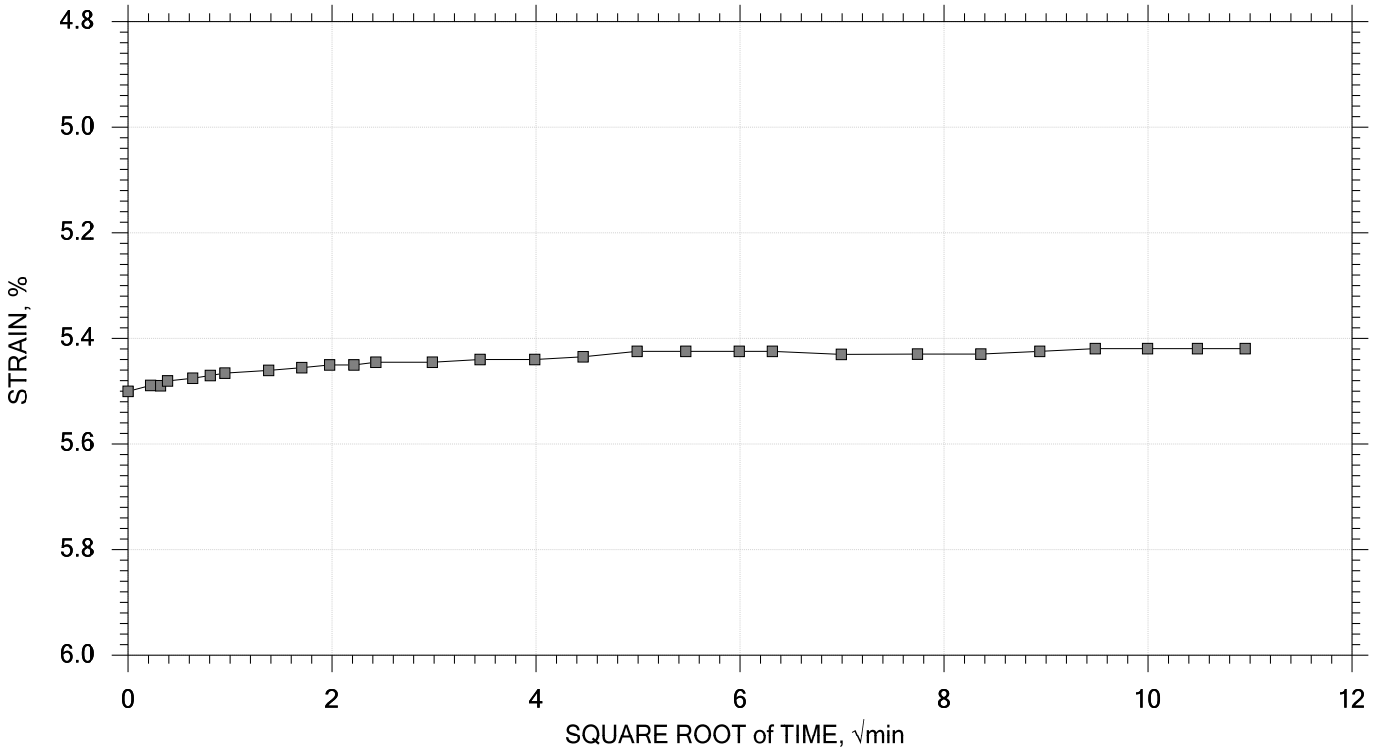
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 7 of 19

Stress: 0.5 tsf





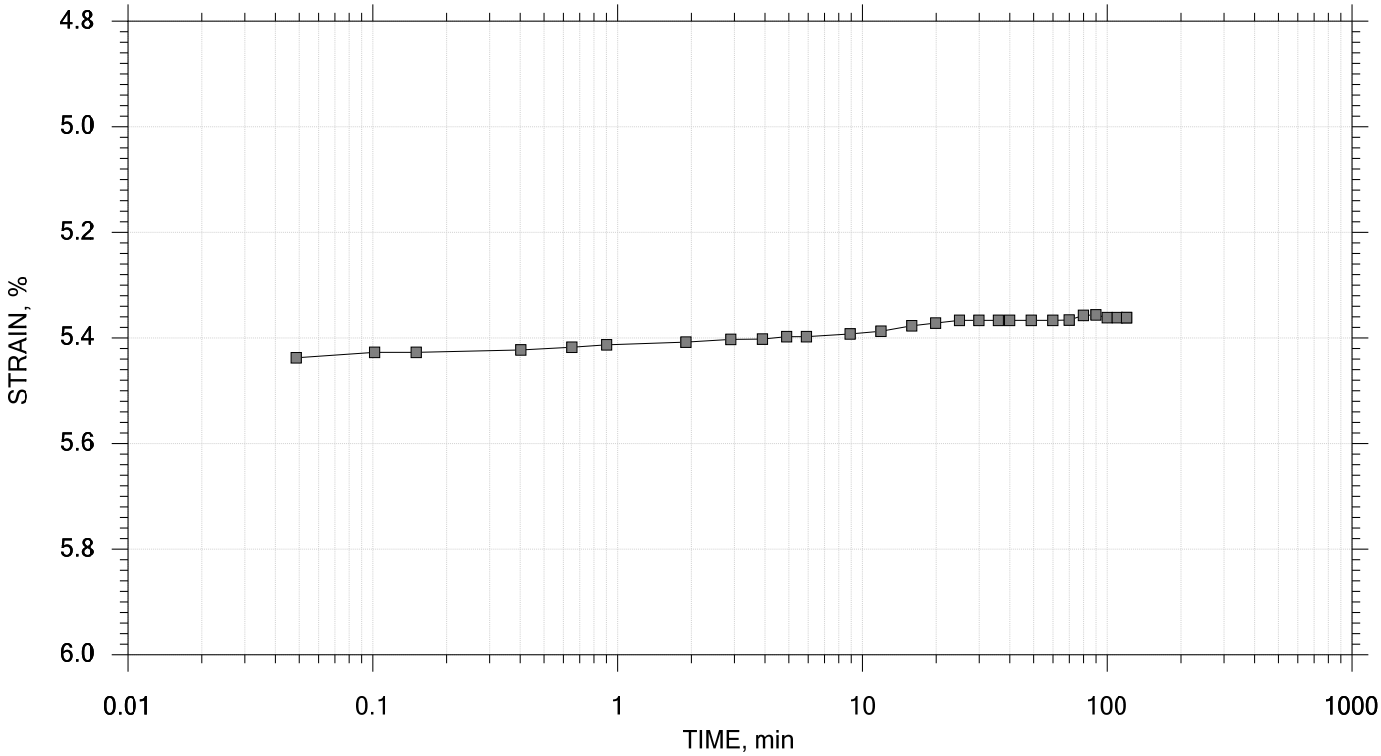
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

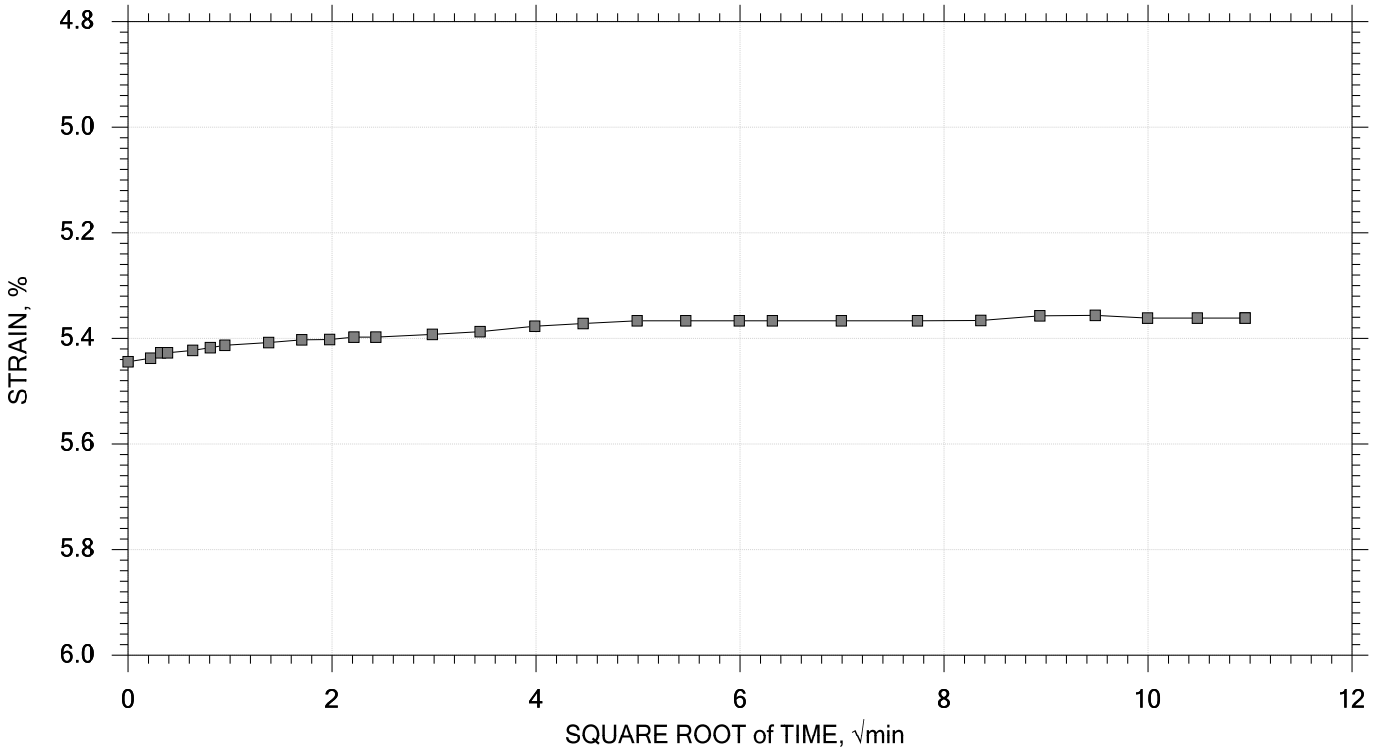
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 8 of 19

Stress: 0.25 tsf





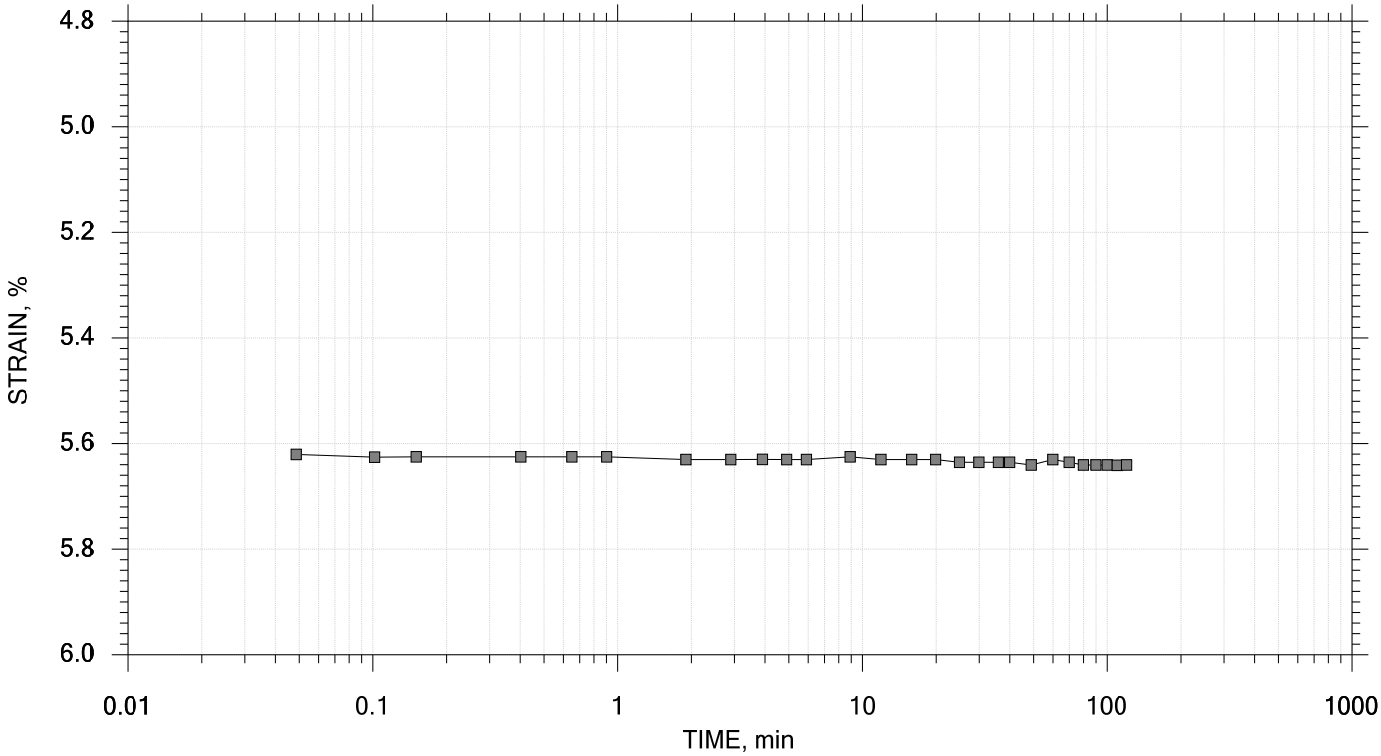
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

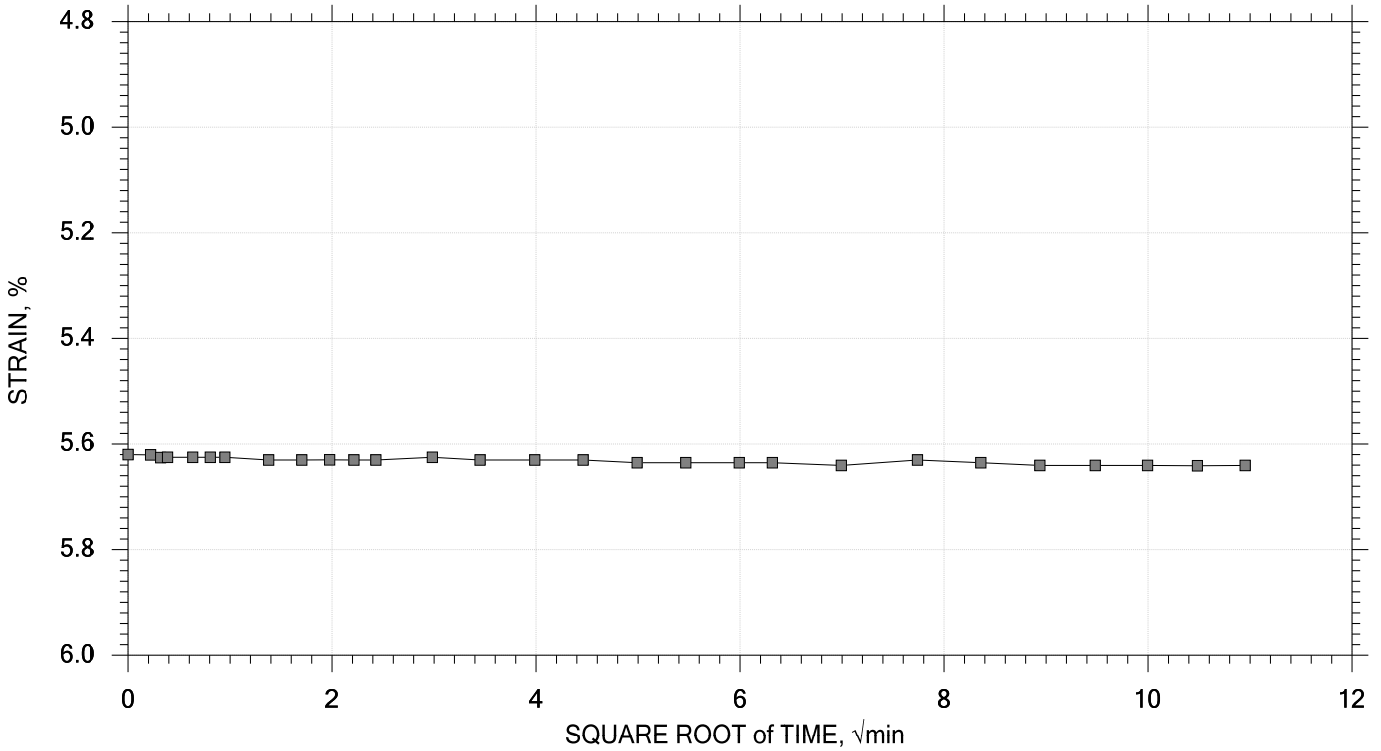
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 9 of 19

Stress: 0.5 tsf





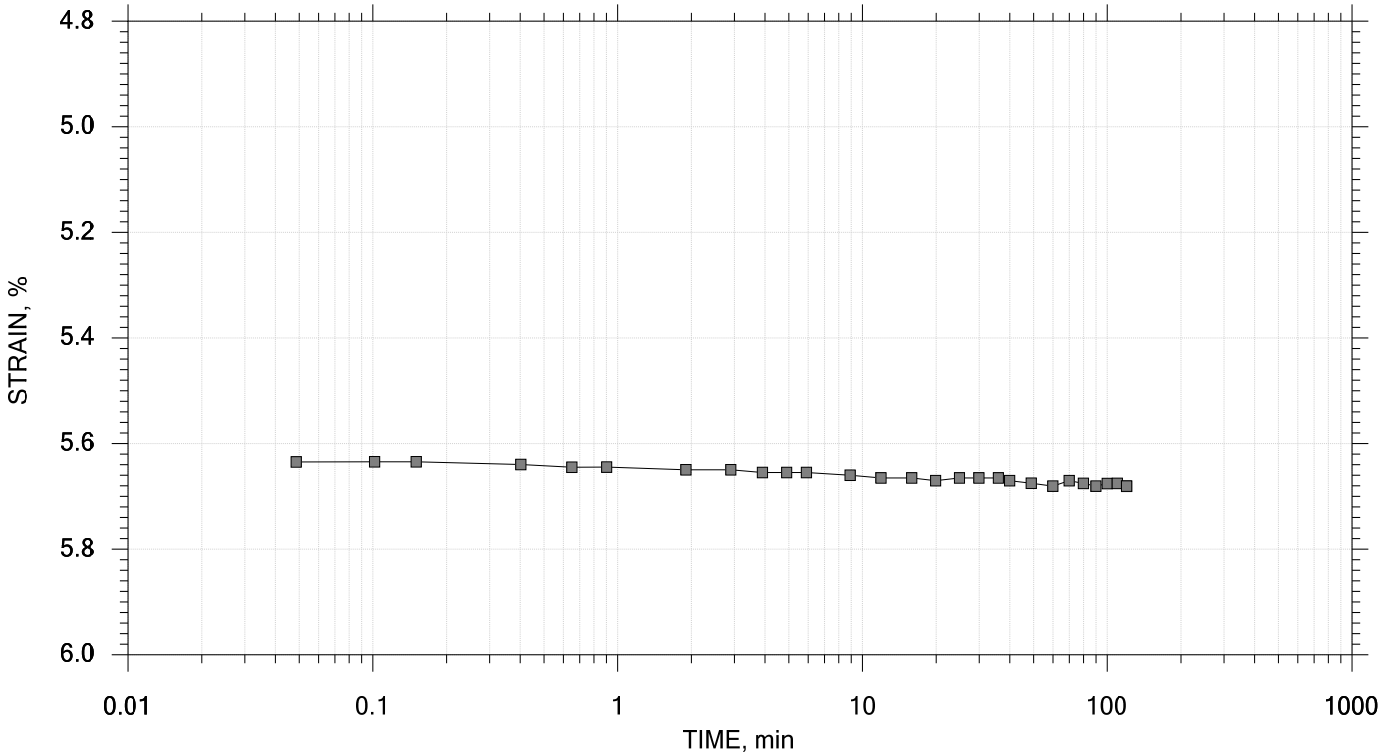
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

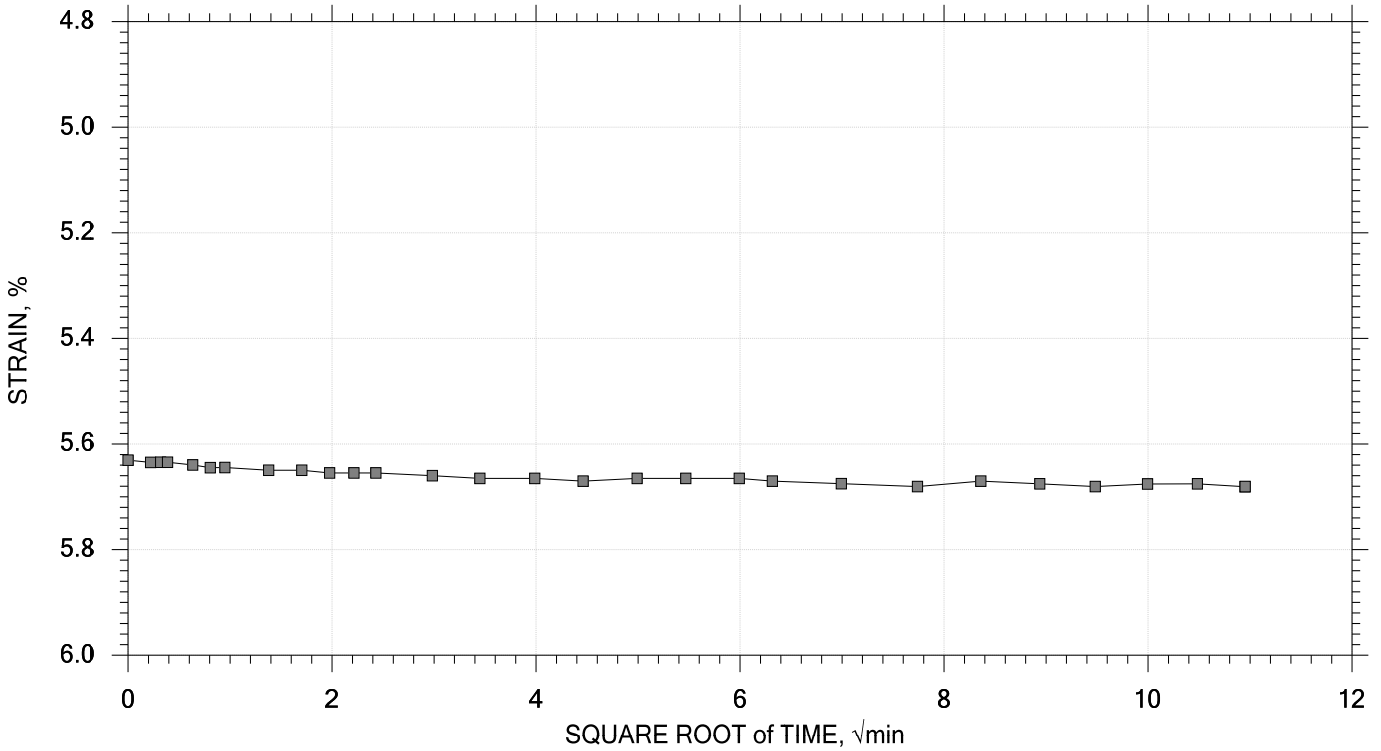
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 10 of 19

Stress: 1 tsf





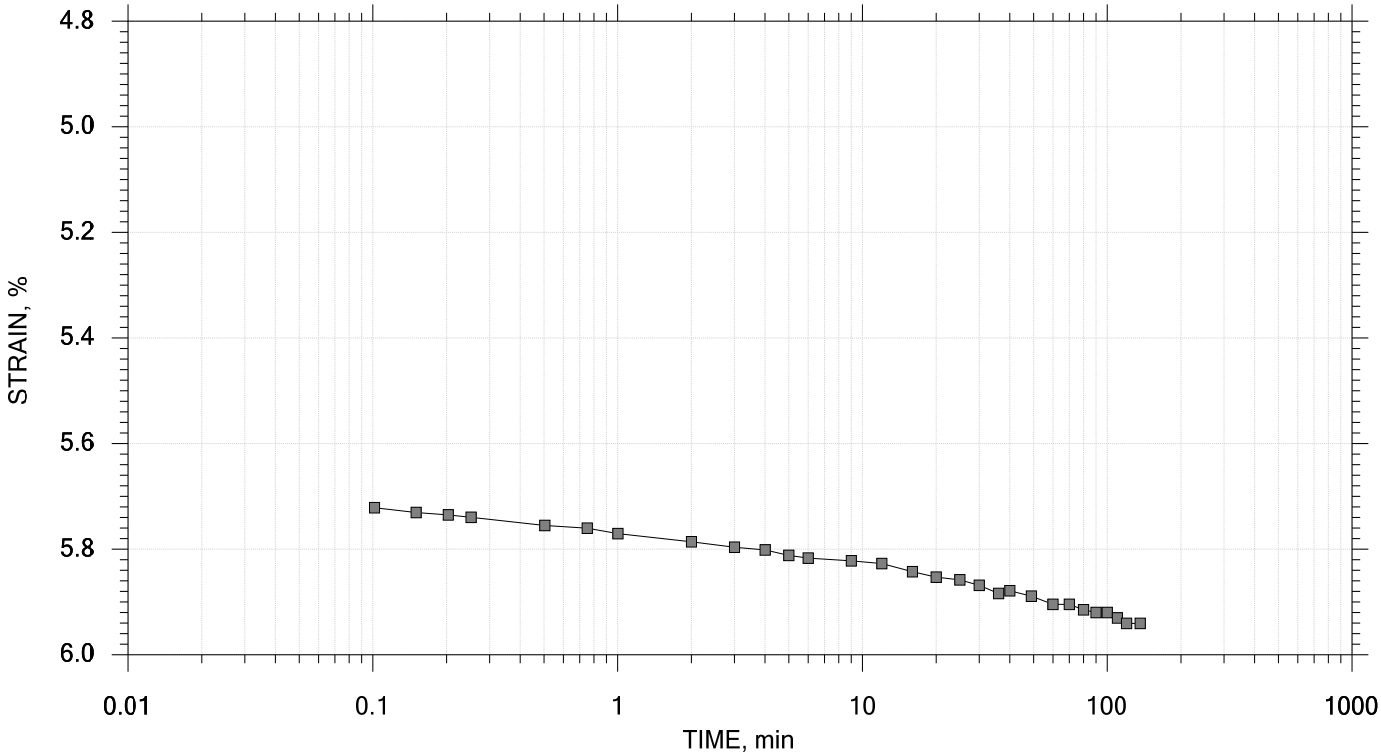
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

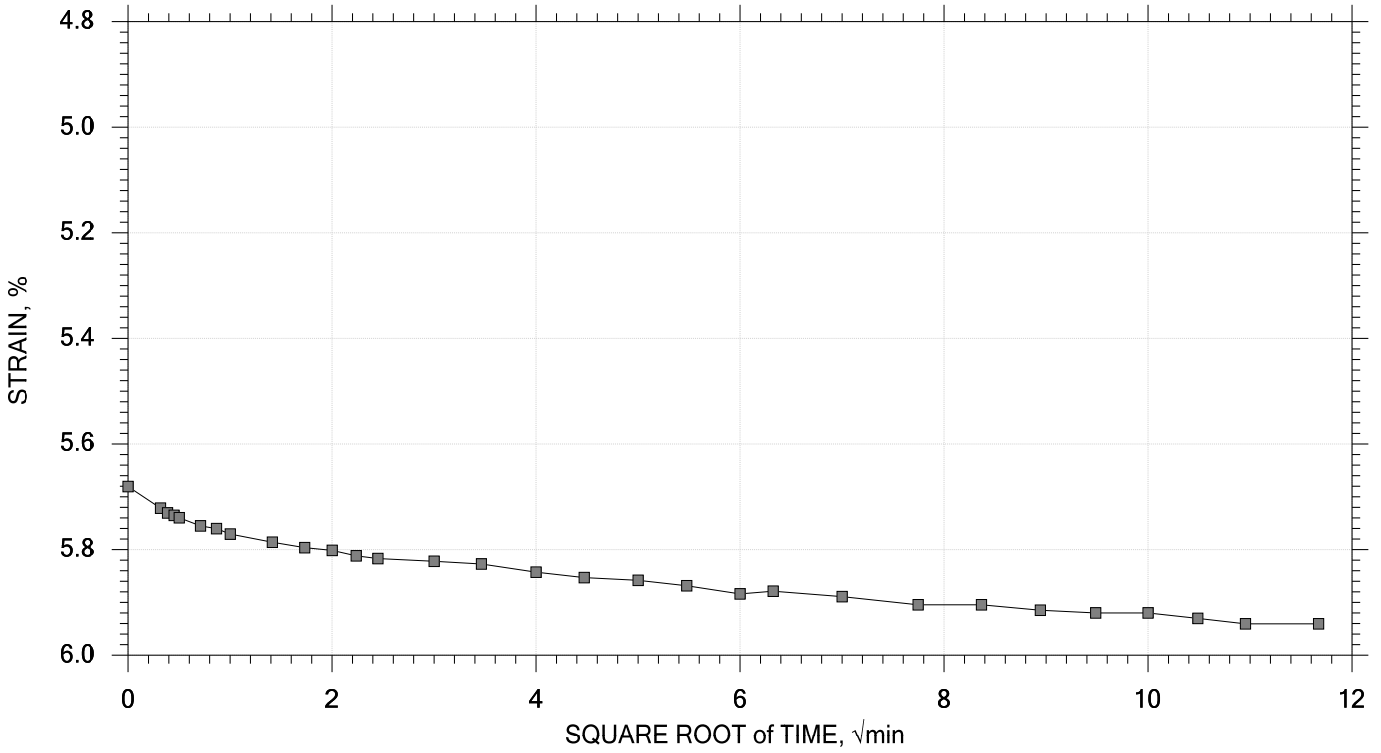
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 11 of 19

Stress: 2 tsf





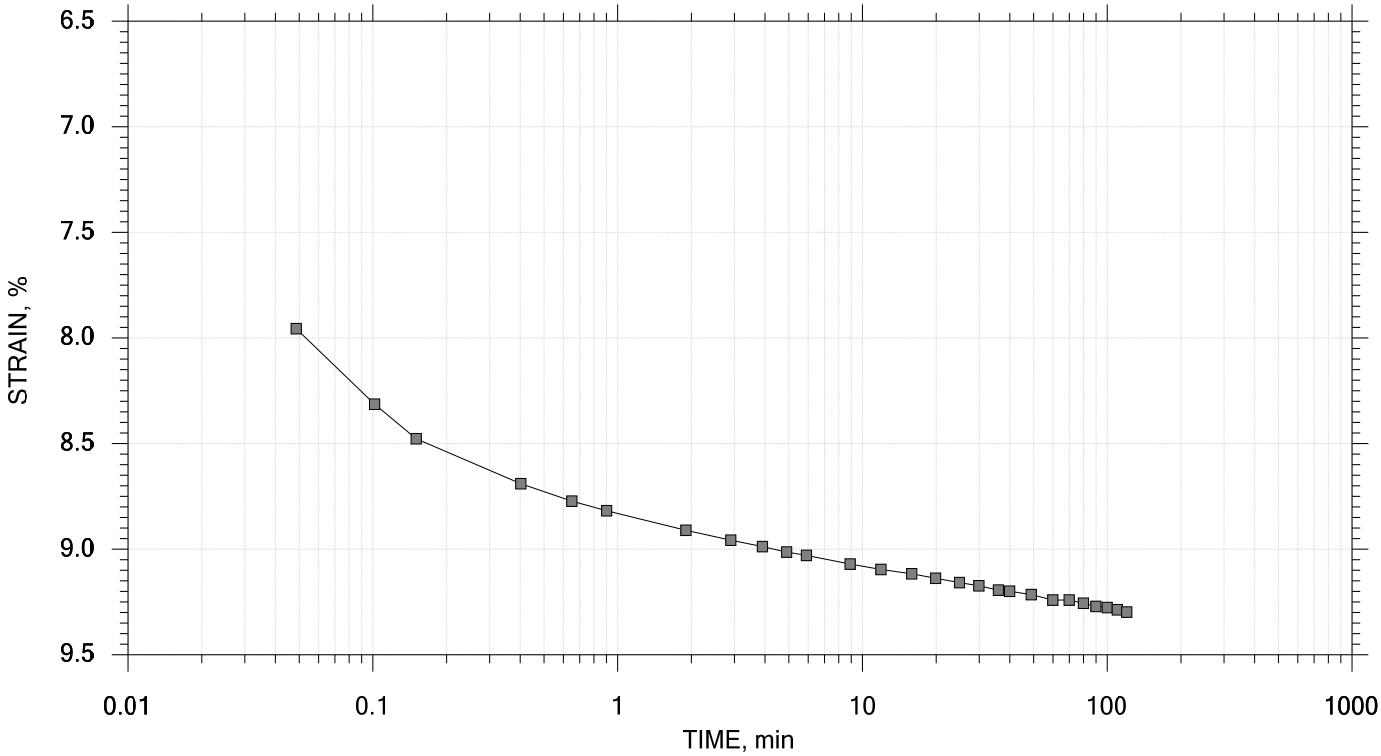
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

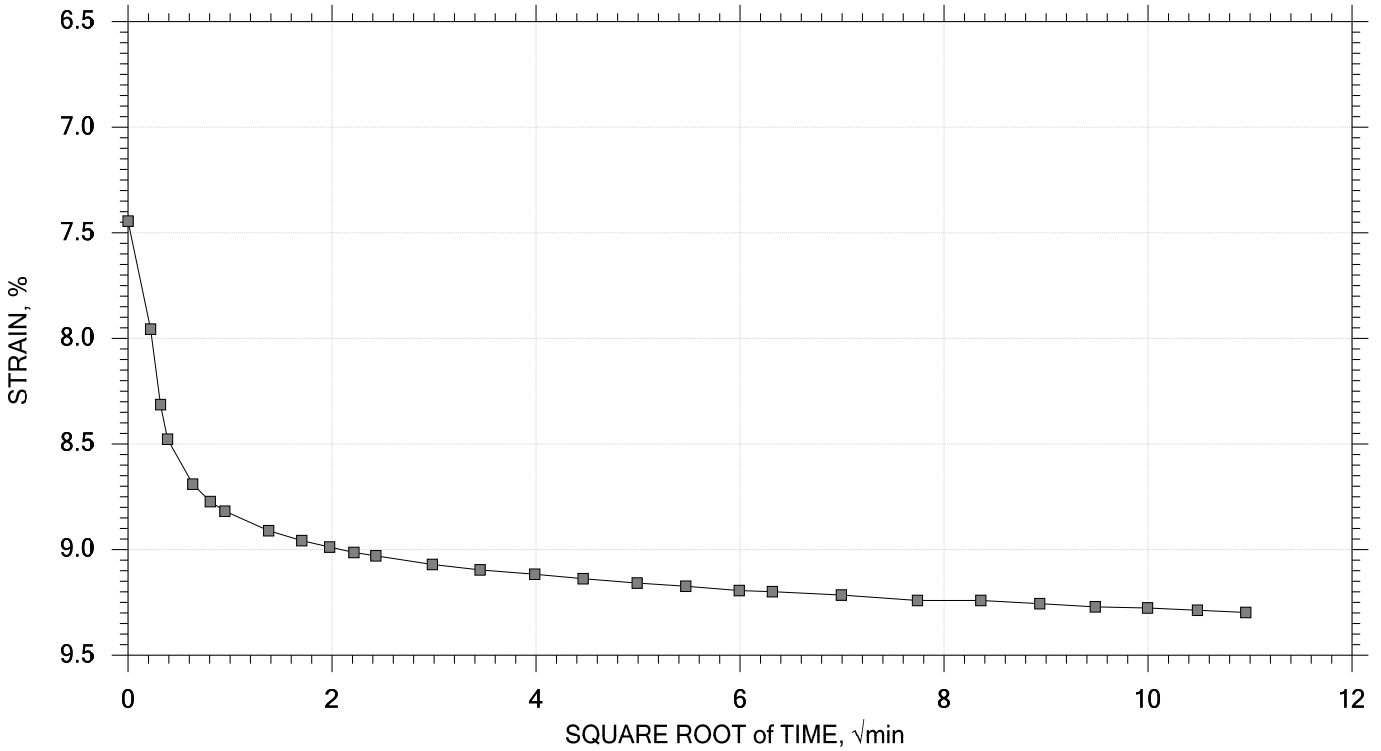
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 12 of 19

Stress: 4 tsf





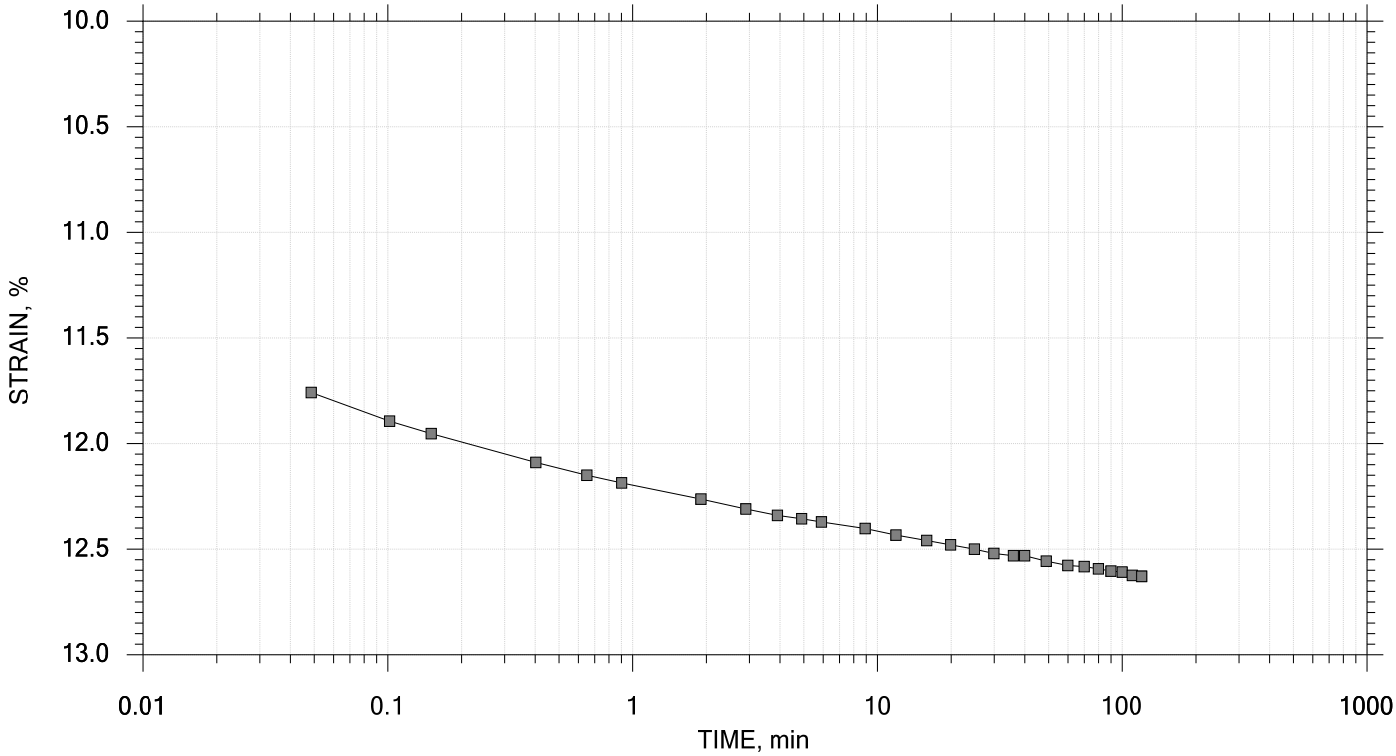
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

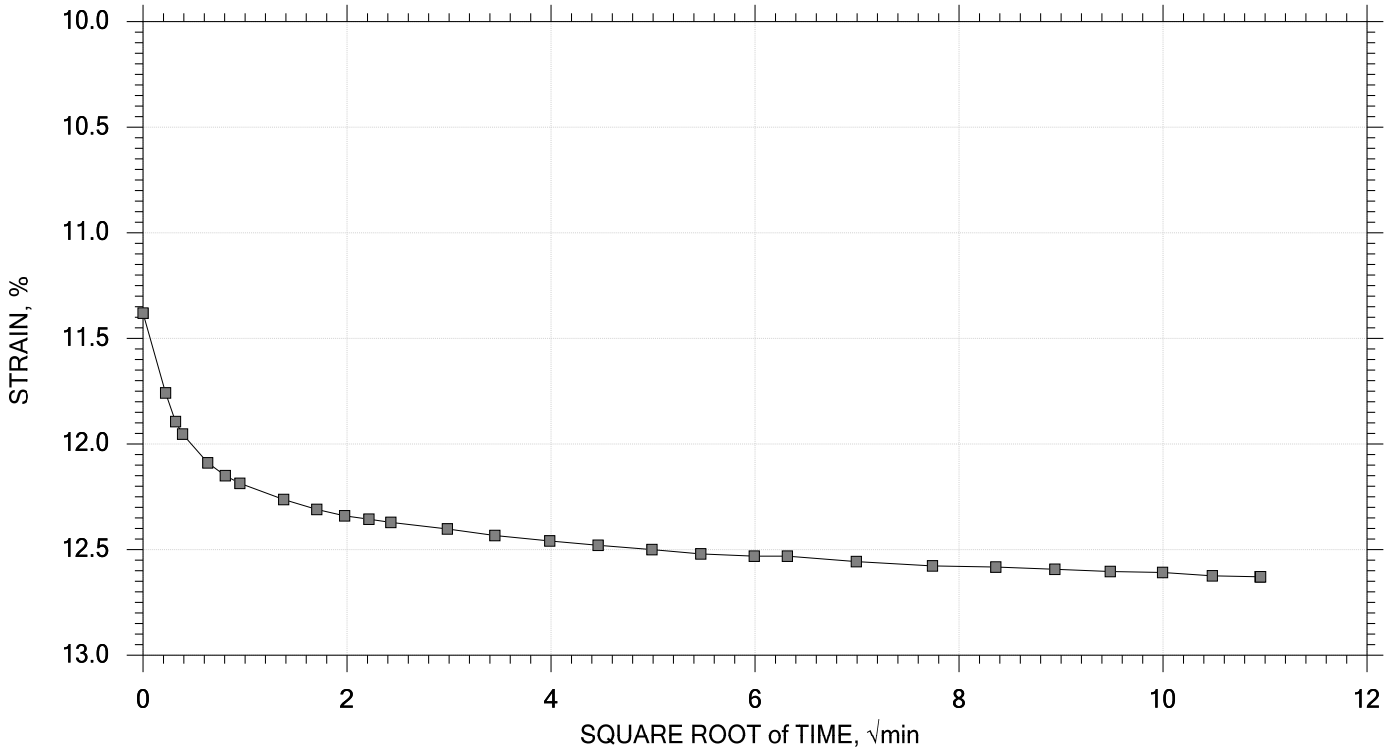
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 13 of 19

Stress: 8 tsf





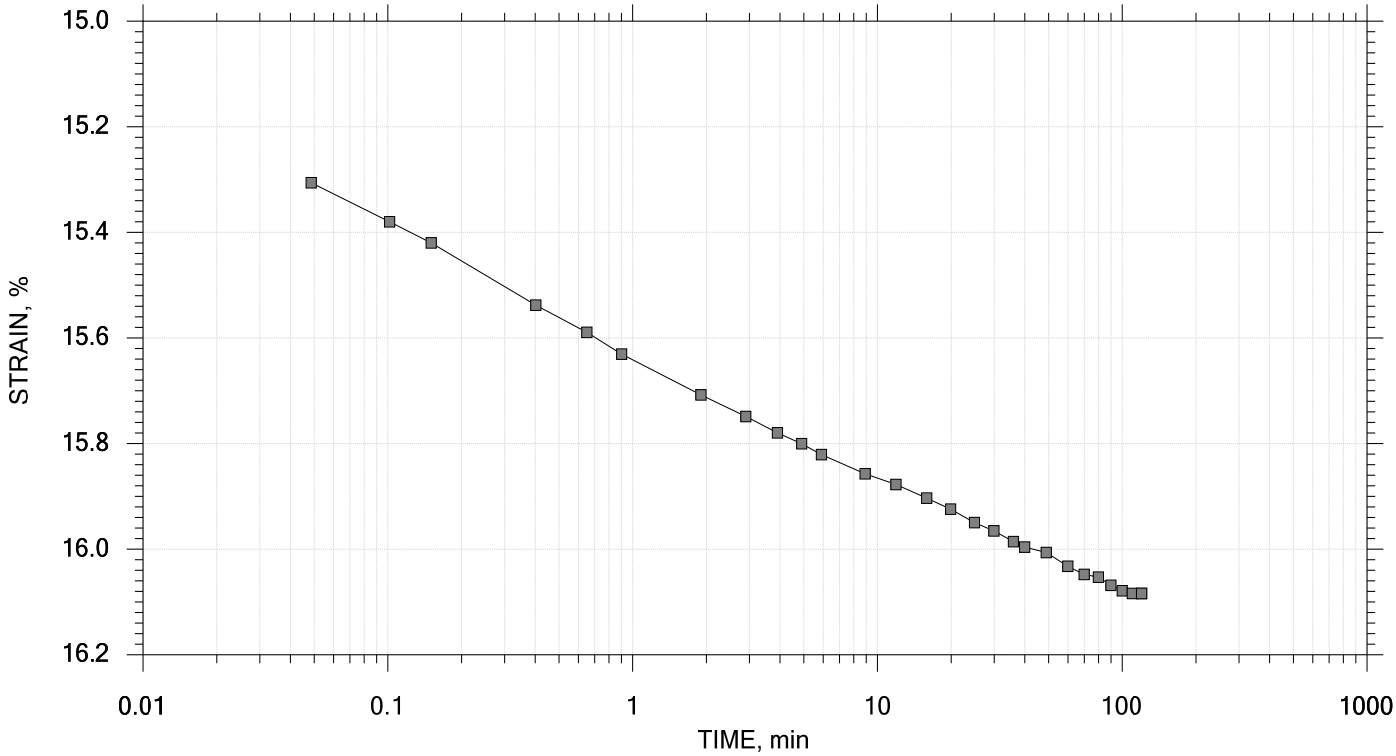
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

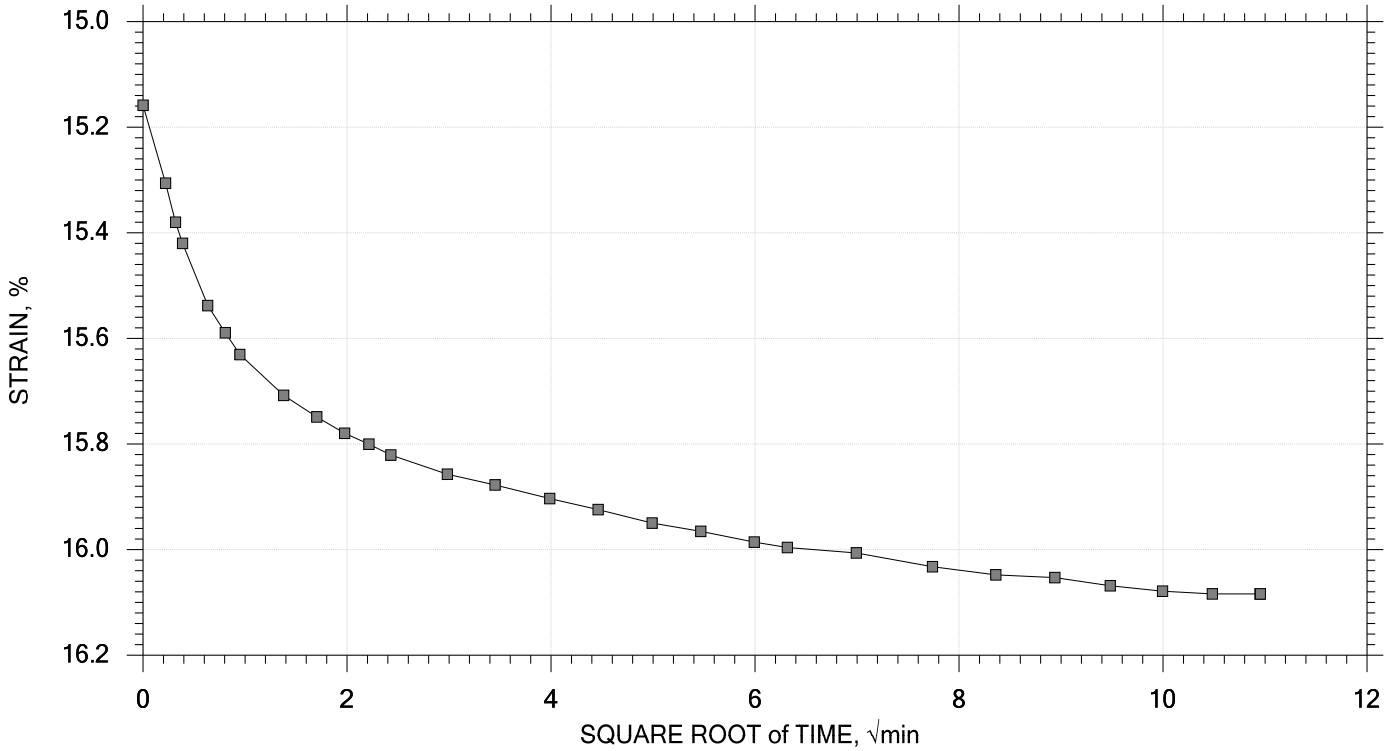
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 14 of 19

Stress: 16 tsf





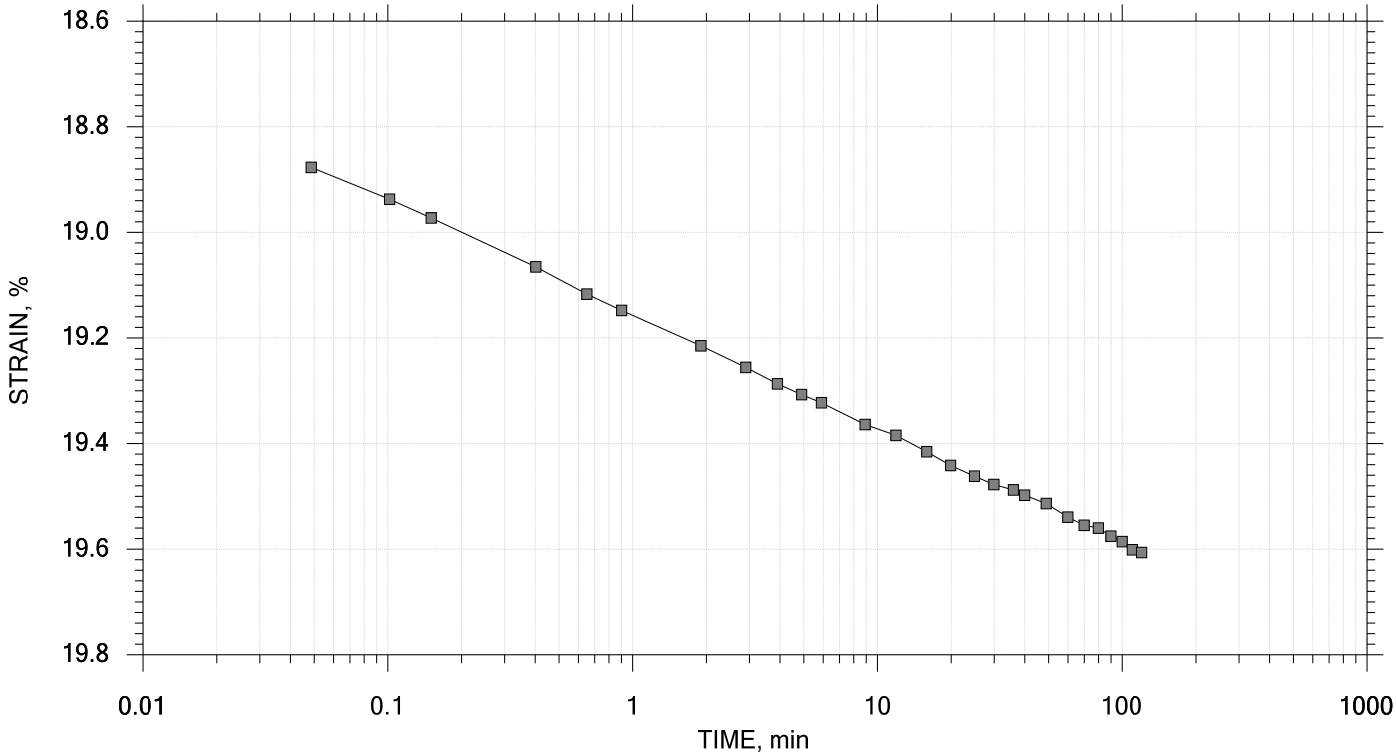
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

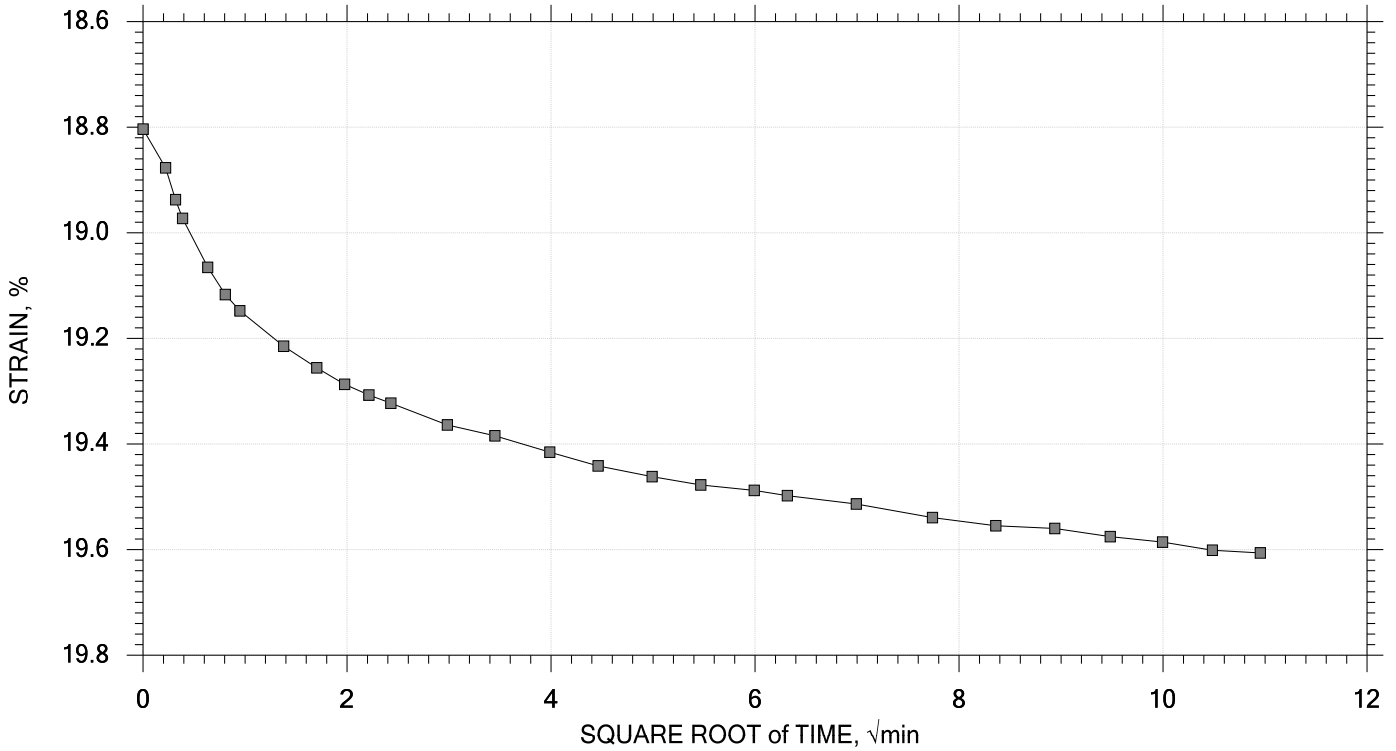
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 15 of 19

Stress: 32 tsf





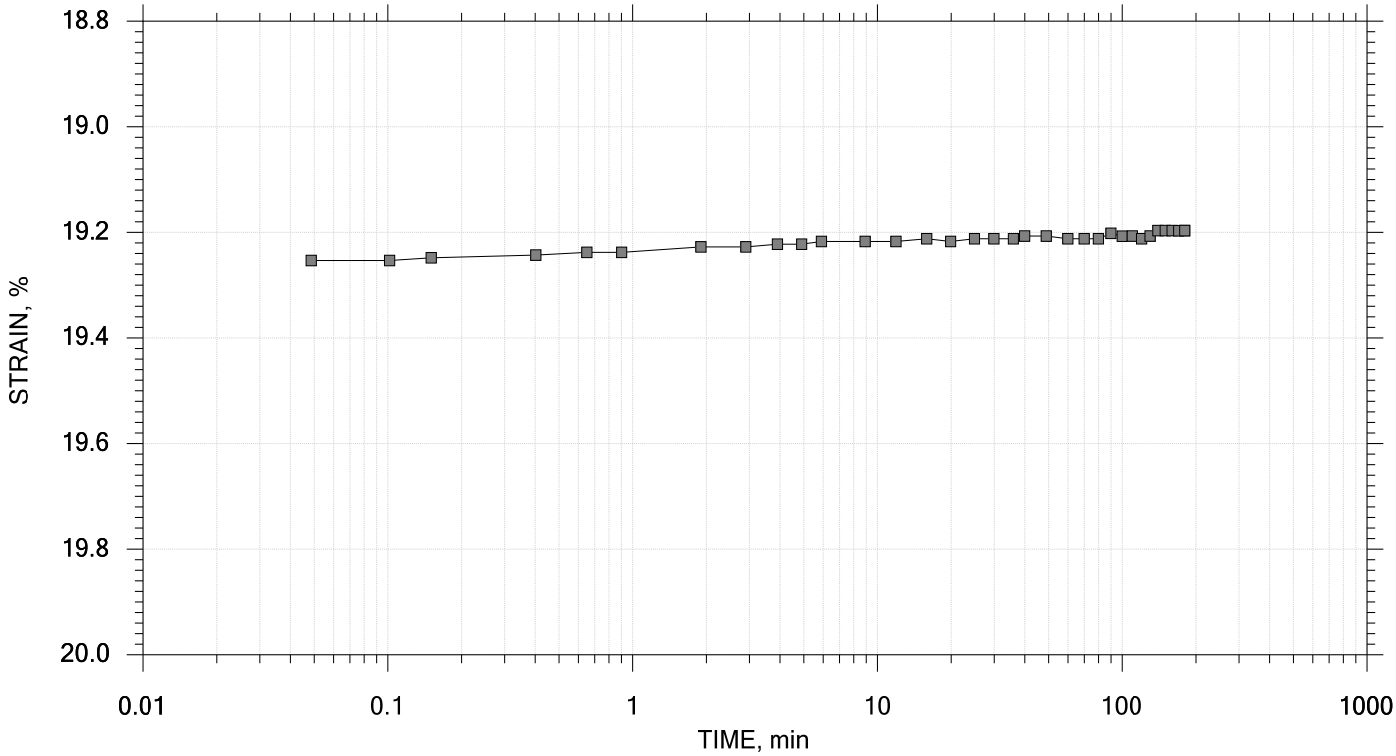
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

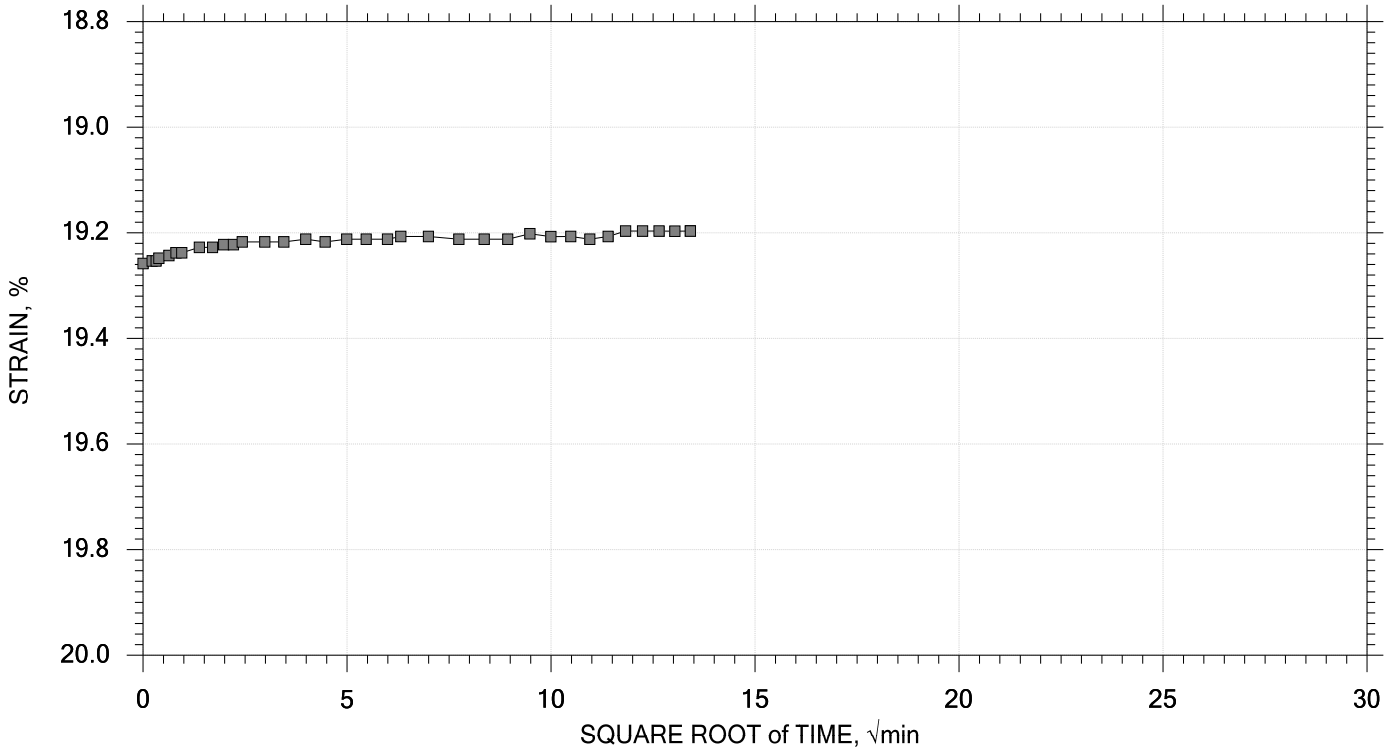
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 16 of 19

Stress: 8 tsf





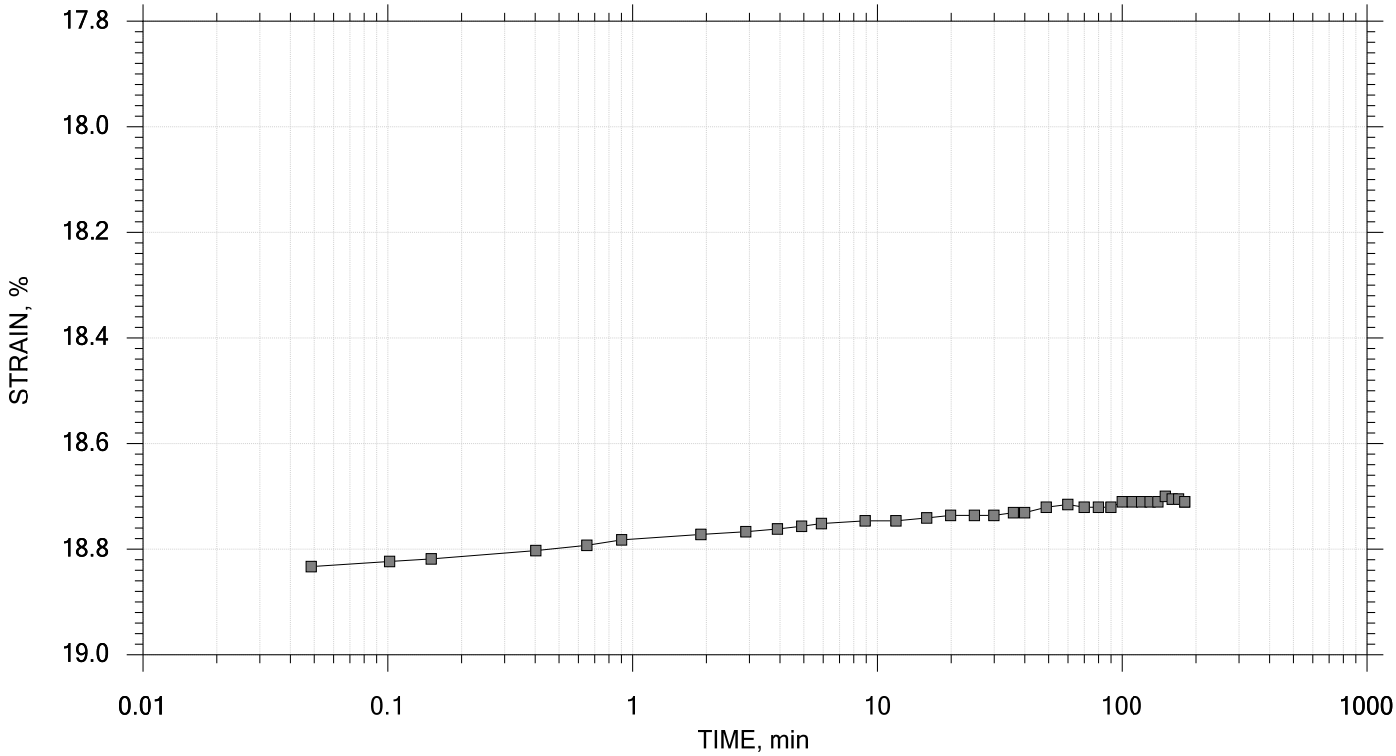
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

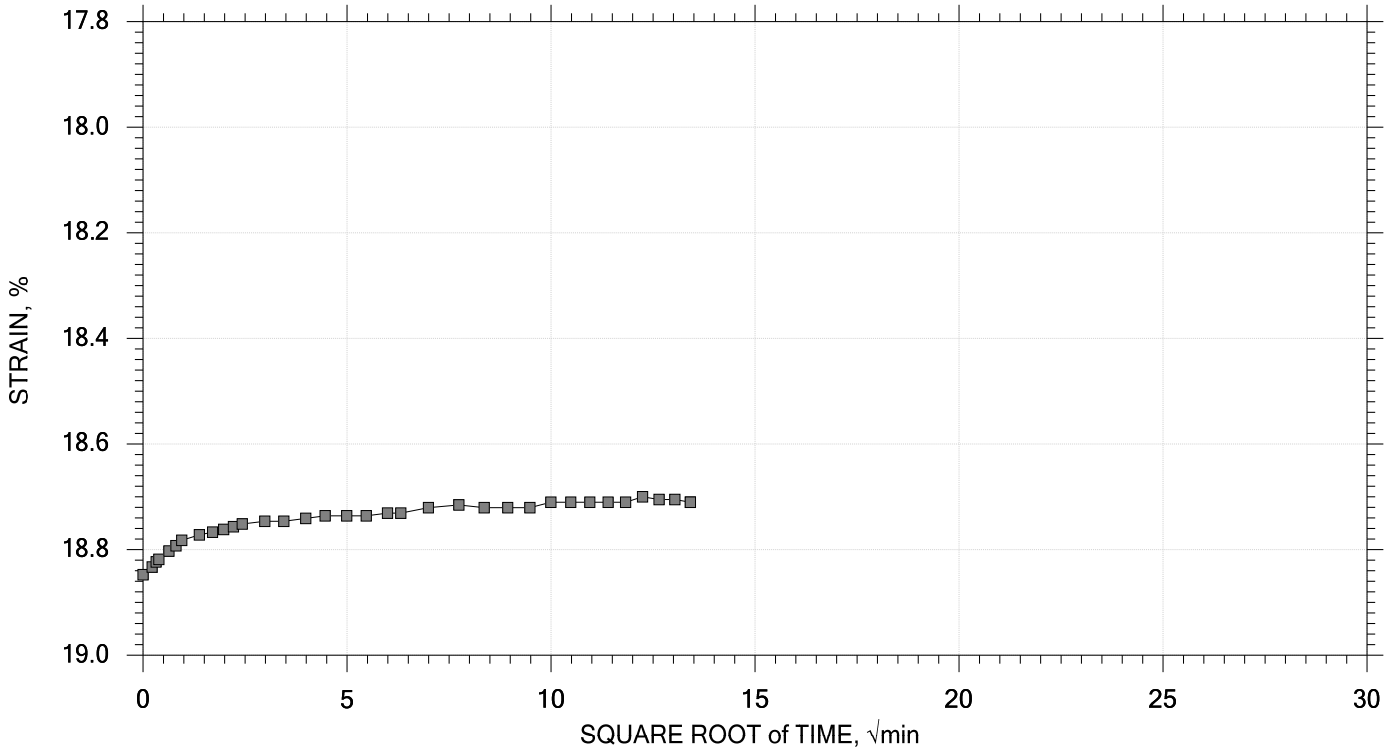
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 17 of 19

Stress: 2 tsf





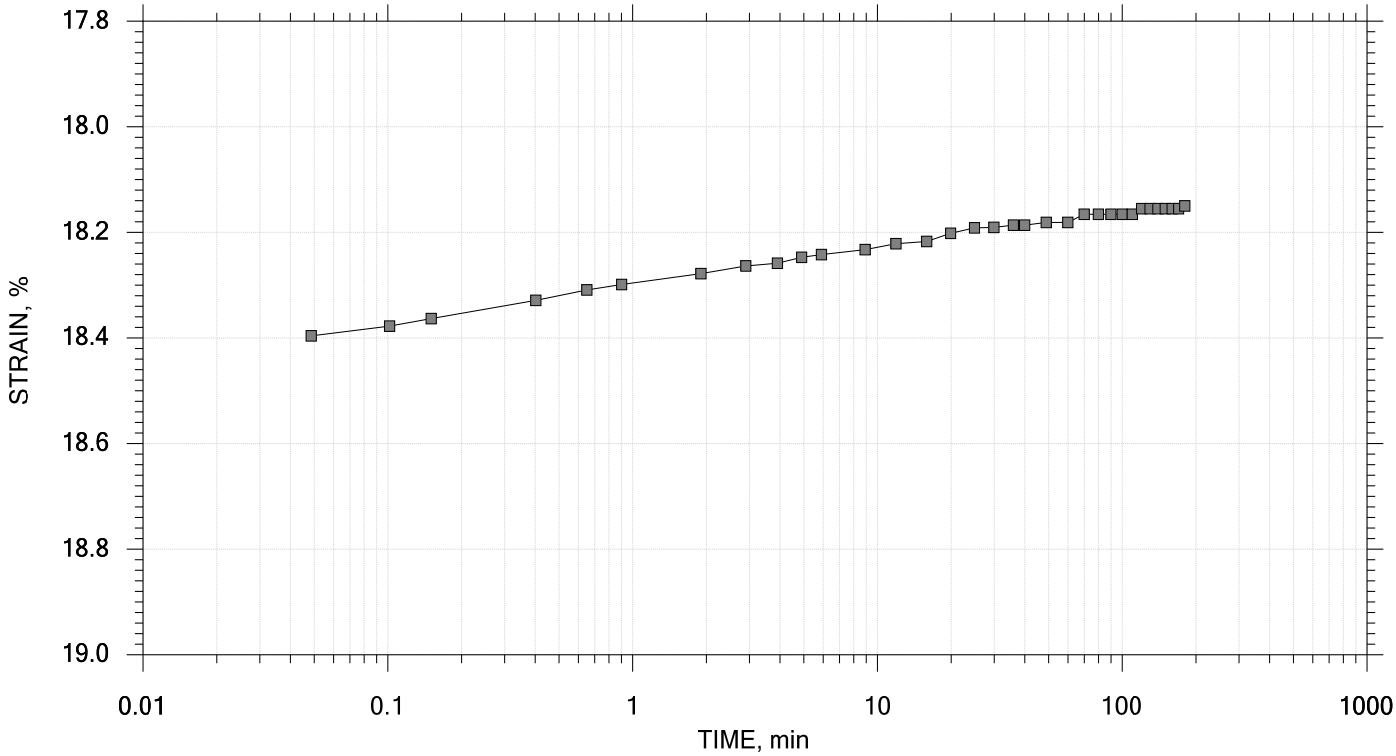
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

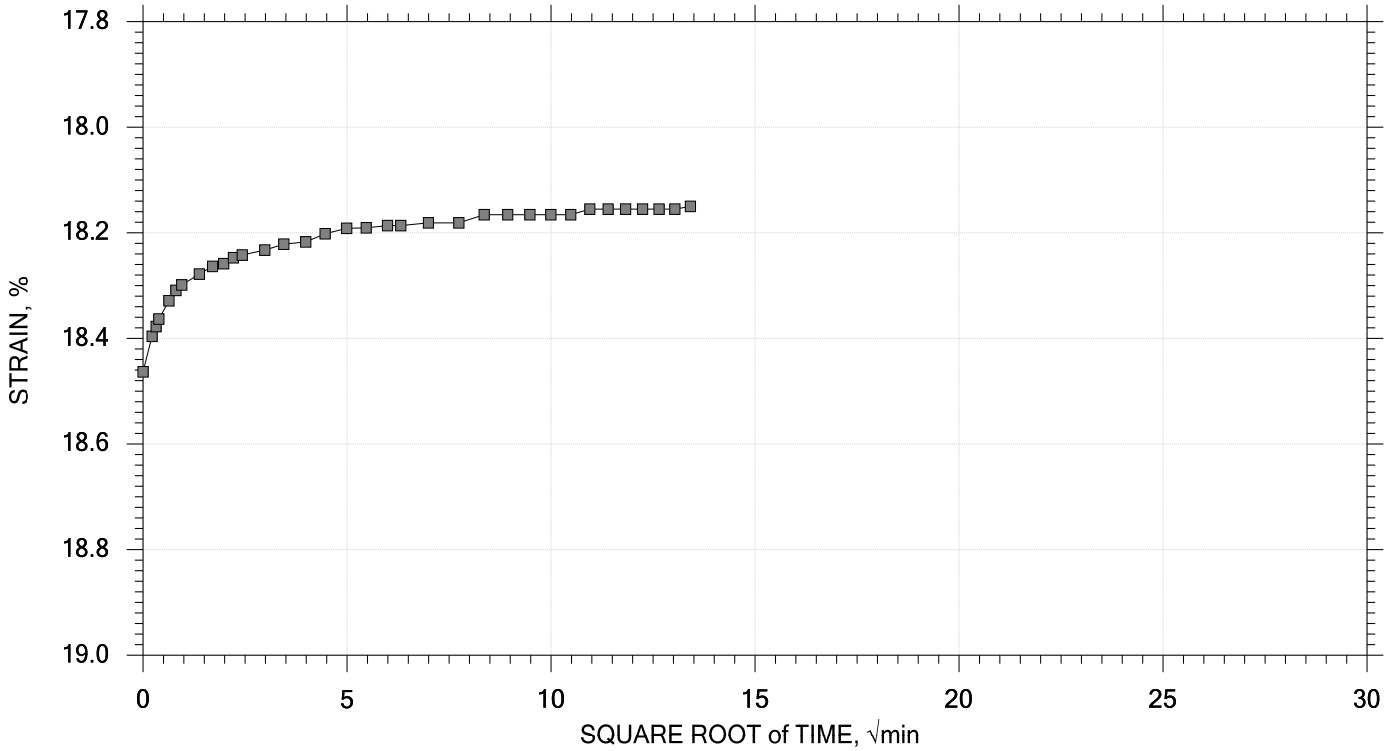
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 18 of 19

Stress: 0.5 tsf





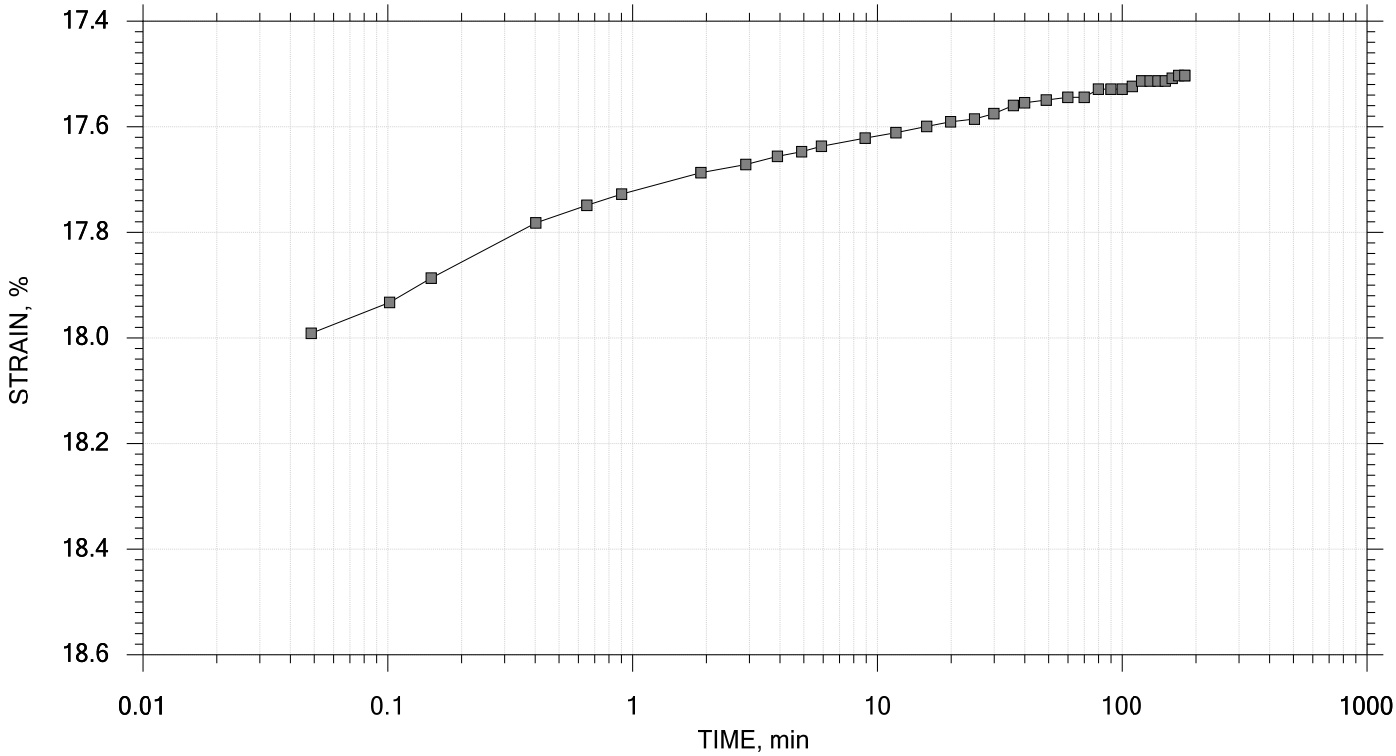
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

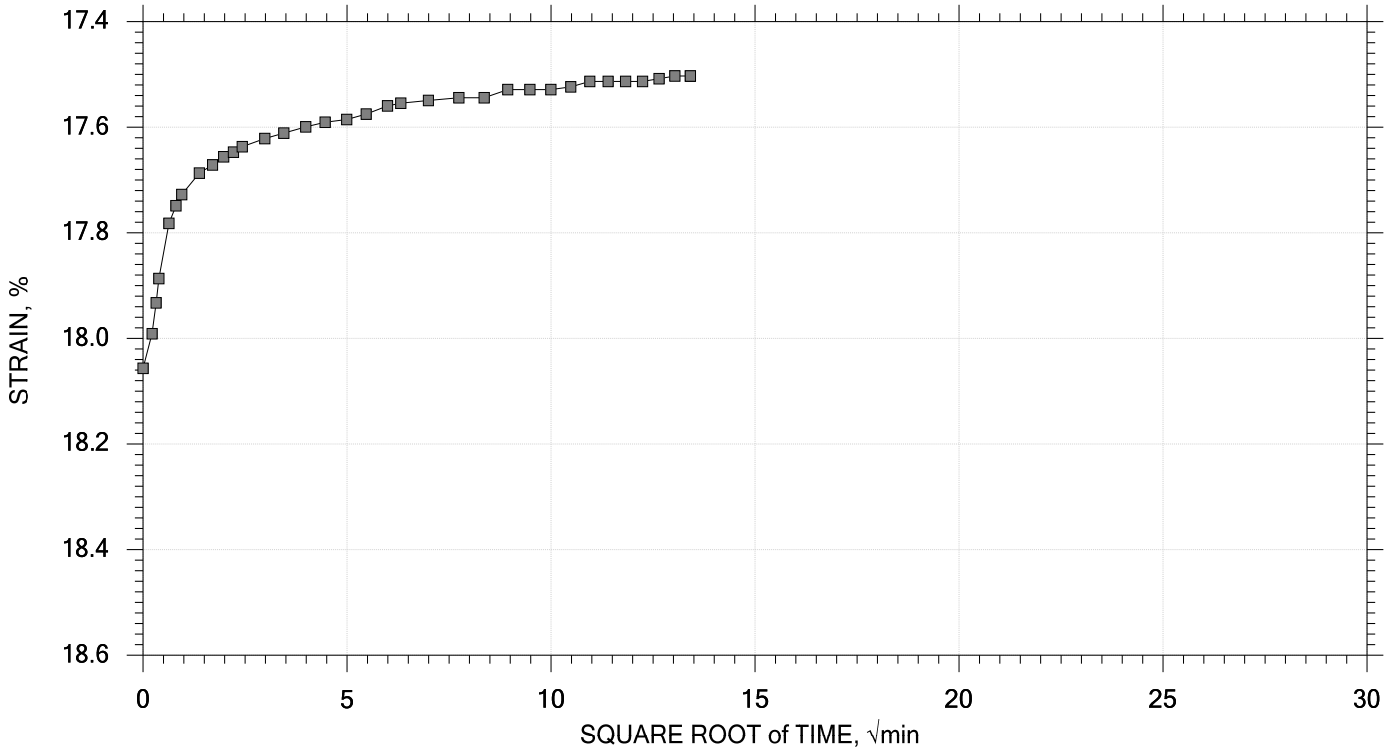
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 19 of 19

Stress: 0.125 tsf

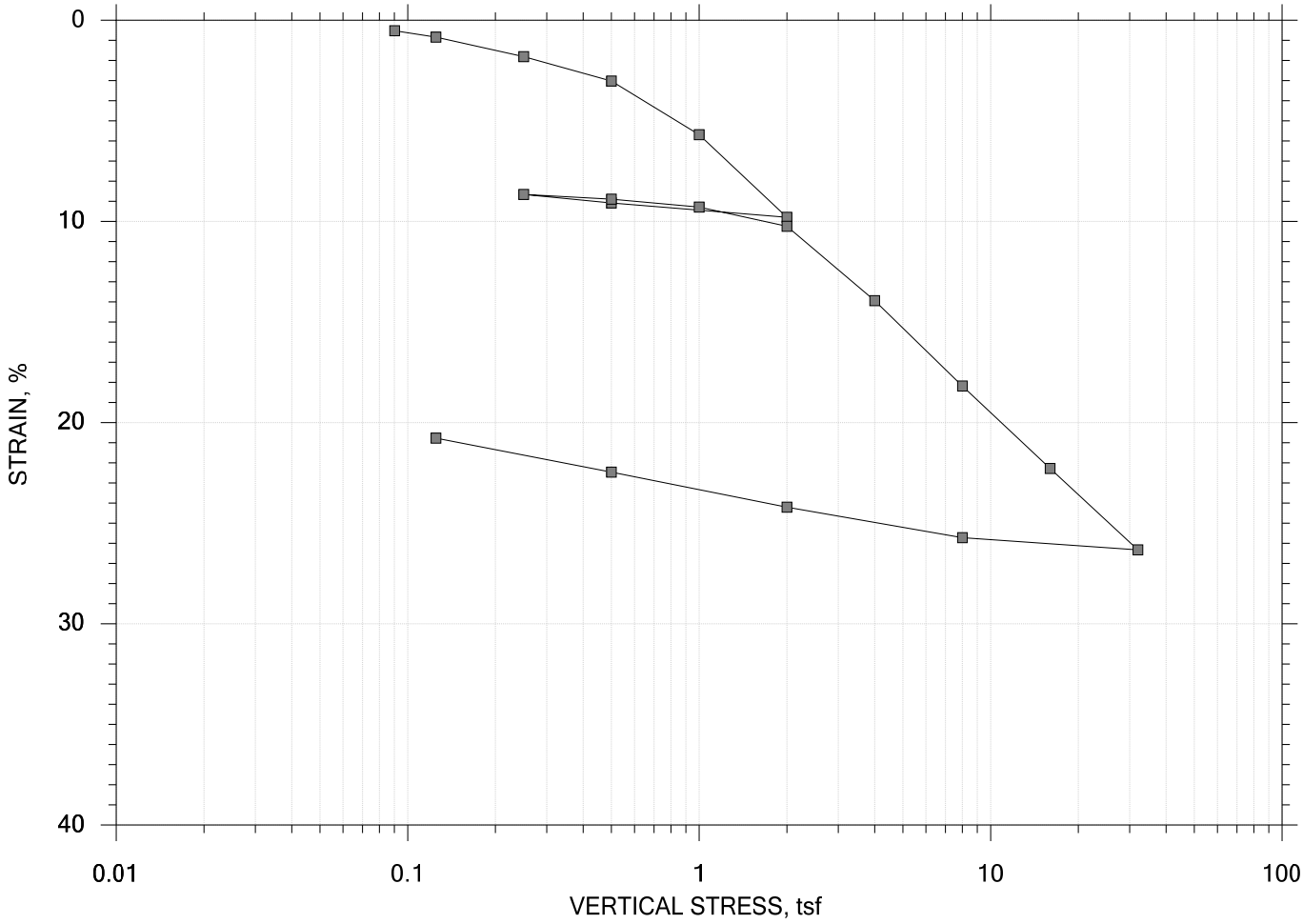


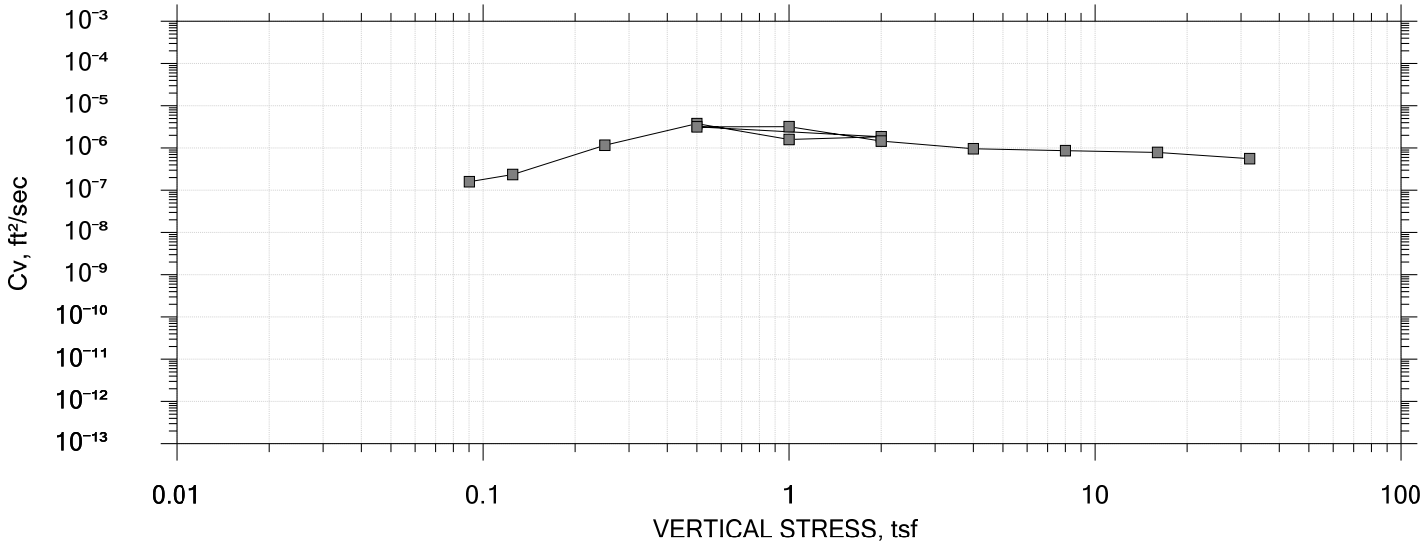


GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307367
	Boring No.: GS-B02	Tested By: jm	Checked By: mcm
	Sample No.: 1 (Tube)	Test Date: 12/15/17	Test No.: IP-2
	Depth: 5-7 ft	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray silty sand (ASH), Moisture content determined at 60°C for ash.		
	Remarks: System 2054, Swell Pressure = 0.0656 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT

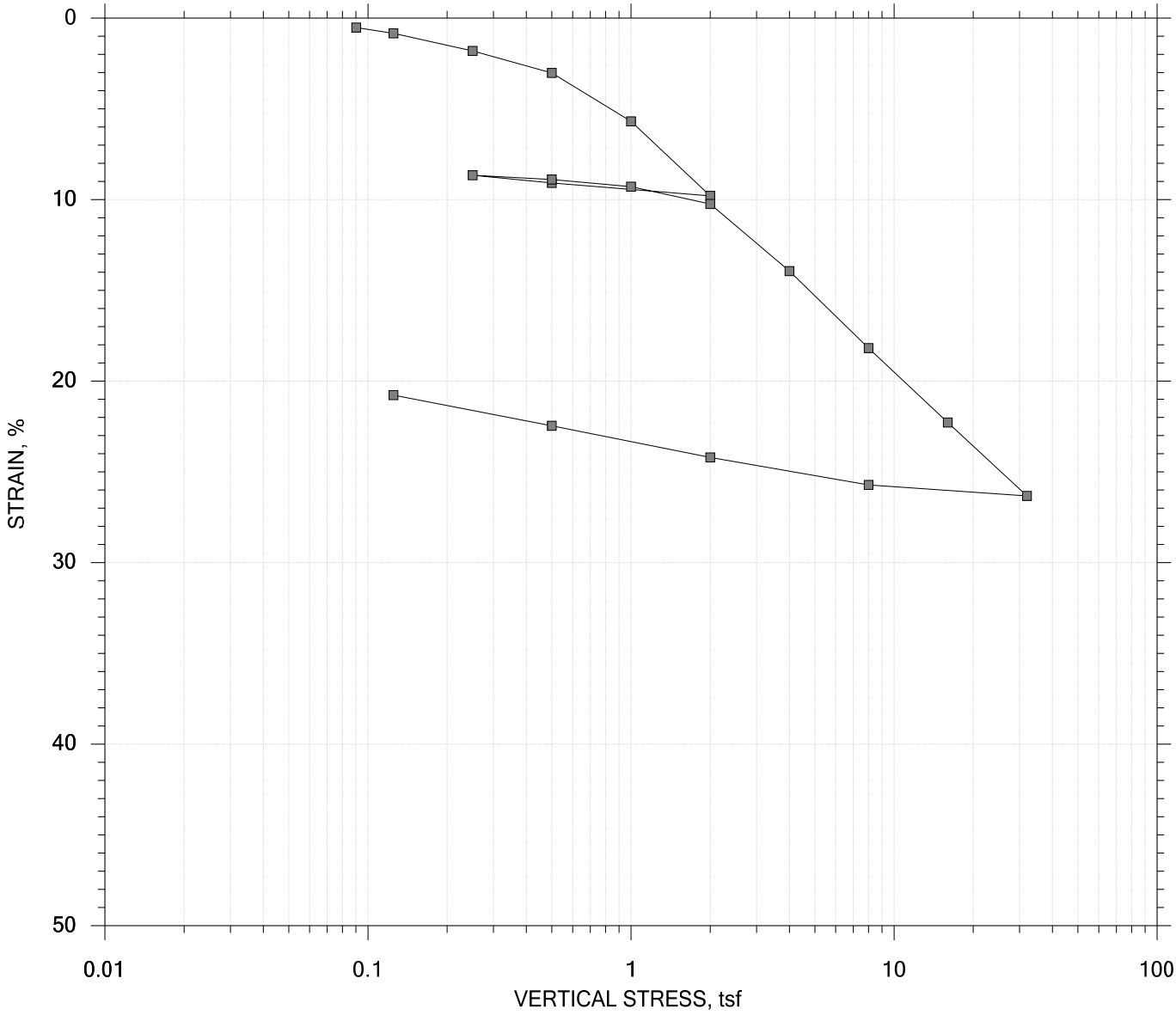




GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT



				Before Test	After Test
Current Vertical Effective Stress: ---			Water Content, %	32.32	20.71
Preconsolidation Stress: ---			Dry Unit Weight, pcf	88.295	107.87
Compression Ratio: ---			Saturation, %	96.36	100.00
Diameter: 2.5 in		Height: 1 in	Void Ratio	0.90	0.56
LL: 44	PL: 19	PI: 25	GS: 2.69		

GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: Dynegy Hennepin West Ash Pond | Location: Hennepin, IL | Project No.: GTX-307445
Boring No.: GS-B03 | Tested By: jm | Checked By: mcm
Sample No.: 8 (Tube) | Test Date: 12/15/17 | Depth: 24-26 ft
Test No.: IP-3 | Sample Type: intact | Elevation: ---

Soil Description: Moist, dark grayish brown clay
Remarks: System 5077, Swell Pressure = 0.0902 tsf

Estimated Specific Gravity: 2.69 | Liquid Limit: 44 | Specimen Diameter: 2.50 in
Initial Void Ratio: 0.903 | Plastic Limit: 19 | Initial Height: 1.00 in
Final Void Ratio: 0.557 | Plasticity Index: 25 | Final Height: 0.82 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	cb1	RING	ash7	ash7
Wt. Container + Wet Soil, gm	137.18	158.73	145.52	145.52
Wt. Container + Dry Soil, gm	106.02	121.96	121.96	121.96
Wt. Container, gm	8.1400	8.1900	8.1900	8.1900
Wt. Dry Soil, gm	97.880	113.77	113.77	113.77
Water Content, %	31.83	32.32	20.71	20.71
Void Ratio	---	0.903	0.557	---
Degree of Saturation, %	---	96.36	100.00	---
Dry Unit Weight, pcf	---	88.295	107.87	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: Dynegy Hennepin West Ash Pond | Location: Hennepin, IL | Project No.: GTX-307445
Boring No.: GS-B03 | Tested By: jm | Checked By: mcm
Sample No.: 8 (Tube) | Test Date: 12/15/17 | Depth: 24-26 ft
Test No.: IP-3 | Sample Type: intact | Elevation: ---

Soil Description: Moist, dark grayish brown clay
Remarks: System 5077, Swell Pressure = 0.0902 tsf

Displacement at End of Increment

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt T90 min	Cv ft²/sec	Mv 1/tsf	k cm/sec
1	0.0902	0.005204	0.893	0.520	182.996	1.33e-007	5.77e-002	7.32e-009
2	0.125	0.008358	0.887	0.836	80.926	2.99e-007	9.06e-002	2.58e-008
3	0.250	0.01808	0.868	1.81	29.738	8.03e-007	7.78e-002	5.94e-008
4	0.500	0.03015	0.845	3.02	6.705	3.48e-006	4.83e-002	1.60e-007
5	1.00	0.05683	0.794	5.68	13.973	1.61e-006	5.34e-002	8.16e-008
6	2.00	0.09793	0.716	9.79	10.953	1.91e-006	4.11e-002	7.46e-008
7	0.500	0.09080	0.730	9.08	6.285	3.20e-006	4.76e-003	1.45e-008
8	0.250	0.08658	0.738	8.66	27.181	7.50e-007	1.69e-002	1.20e-008
9	0.500	0.08889	0.733	8.89	6.695	3.05e-006	9.27e-003	2.69e-008
10	1.00	0.09282	0.726	9.28	6.958	2.91e-006	7.86e-003	2.18e-008
11	2.00	0.1024	0.708	10.2	13.499	1.48e-006	9.54e-003	1.34e-008
12	4.00	0.1394	0.637	13.9	17.361	1.09e-006	1.85e-002	1.92e-008
13	8.00	0.1818	0.557	18.2	20.980	8.24e-007	1.06e-002	8.31e-009
14	16.0	0.2228	0.479	22.3	20.473	7.63e-007	5.13e-003	3.72e-009
15	32.0	0.2633	0.402	26.3	25.098	5.60e-007	2.53e-003	1.35e-009
16	8.00	0.2572	0.413	25.7	10.002	1.34e-006	2.53e-004	3.23e-010
17	2.00	0.2420	0.442	24.2	20.883	6.62e-007	2.53e-003	1.59e-009
18	0.500	0.2246	0.475	22.5	90.976	1.59e-007	1.16e-002	1.75e-009
19	0.125	0.2077	0.507	20.8	183.902	8.20e-008	4.50e-002	3.51e-009

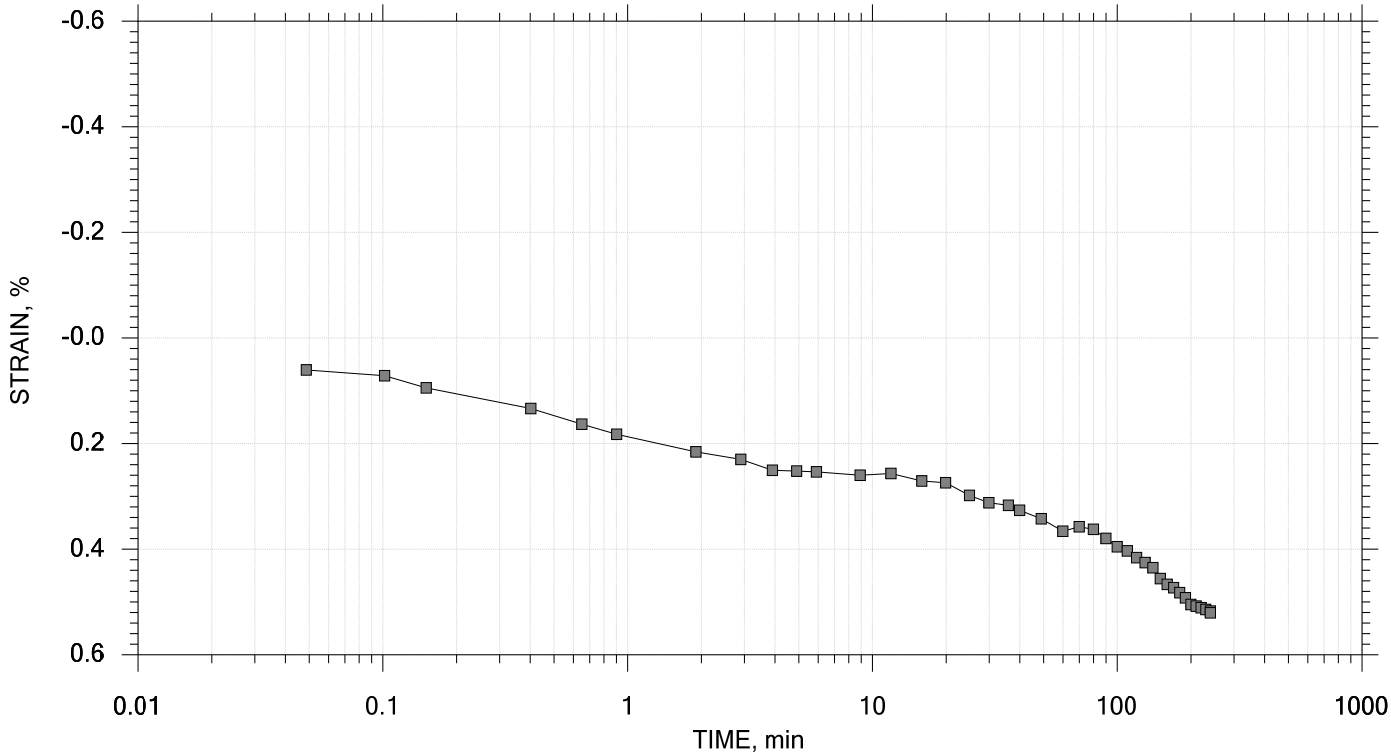
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/sec	Mv 1/tsf	k cm/sec	Ca %
1	0.0902	0.005204	0.893	0.520	0.000	0.00e+000	5.77e-002	0.00e+000	0.00e+000
2	0.125	0.008358	0.887	0.836	0.000	0.00e+000	9.06e-002	0.00e+000	0.00e+000
3	0.250	0.01808	0.868	1.81	0.000	0.00e+000	7.78e-002	0.00e+000	0.00e+000
4	0.500	0.03015	0.845	3.02	0.000	0.00e+000	4.83e-002	0.00e+000	0.00e+000
5	1.00	0.05683	0.794	5.68	0.000	0.00e+000	5.34e-002	0.00e+000	0.00e+000
6	2.00	0.09793	0.716	9.79	2.695	1.80e-006	4.11e-002	7.04e-008	0.00e+000
7	0.500	0.09080	0.730	9.08	1.675	2.79e-006	4.76e-003	1.26e-008	0.00e+000
8	0.250	0.08658	0.738	8.66	0.000	0.00e+000	1.69e-002	0.00e+000	0.00e+000
9	0.500	0.08889	0.733	8.89	0.000	0.00e+000	9.27e-003	0.00e+000	0.00e+000
10	1.00	0.09282	0.726	9.28	1.358	3.47e-006	7.86e-003	2.60e-008	0.00e+000
11	2.00	0.1024	0.708	10.2	0.000	0.00e+000	9.54e-003	0.00e+000	0.00e+000
12	4.00	0.1394	0.637	13.9	5.103	8.63e-007	1.85e-002	1.52e-008	0.00e+000
13	8.00	0.1818	0.557	18.2	4.375	9.18e-007	1.06e-002	9.26e-009	0.00e+000
14	16.0	0.2228	0.479	22.3	4.453	8.15e-007	5.13e-003	3.97e-009	0.00e+000
15	32.0	0.2633	0.402	26.3	5.797	5.63e-007	2.53e-003	1.36e-009	0.00e+000
16	8.00	0.2572	0.413	25.7	2.323	1.34e-006	2.53e-004	3.23e-010	0.00e+000
17	2.00	0.2420	0.442	24.2	7.555	4.25e-007	2.53e-003	1.02e-009	0.00e+000
18	0.500	0.2246	0.475	22.5	0.000	0.00e+000	1.16e-002	0.00e+000	0.00e+000
19	0.125	0.2077	0.507	20.8	0.000	0.00e+000	4.50e-002	0.00e+000	0.00e+000

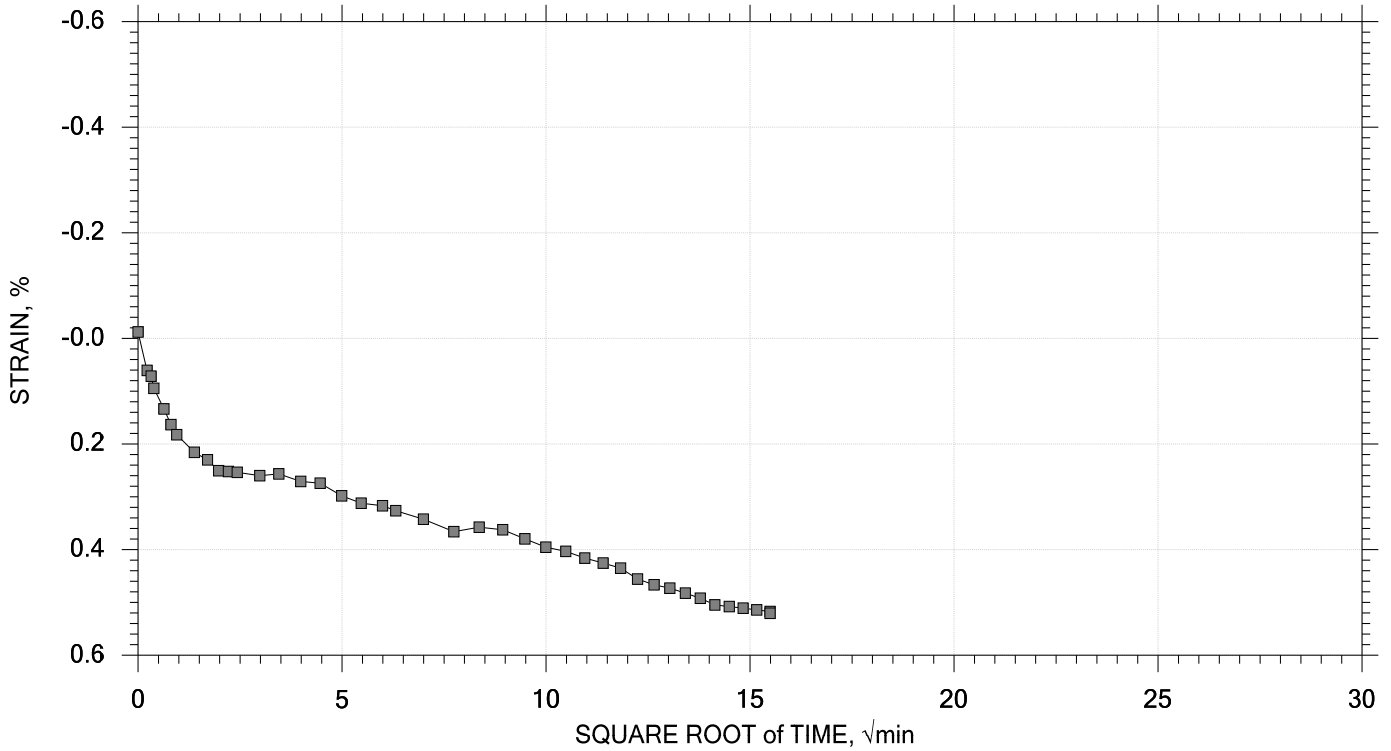
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Volume Step 1 of 19

Stress: 0.090185 tsf





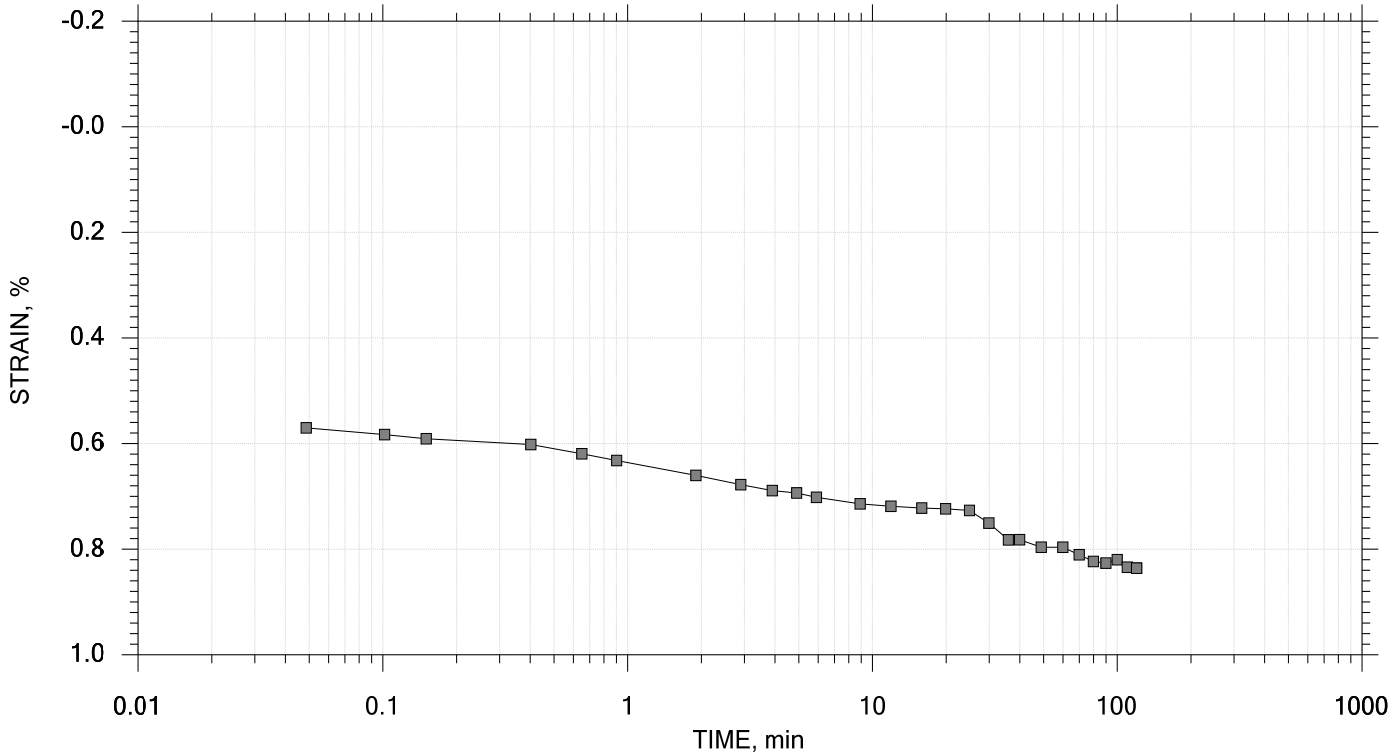
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

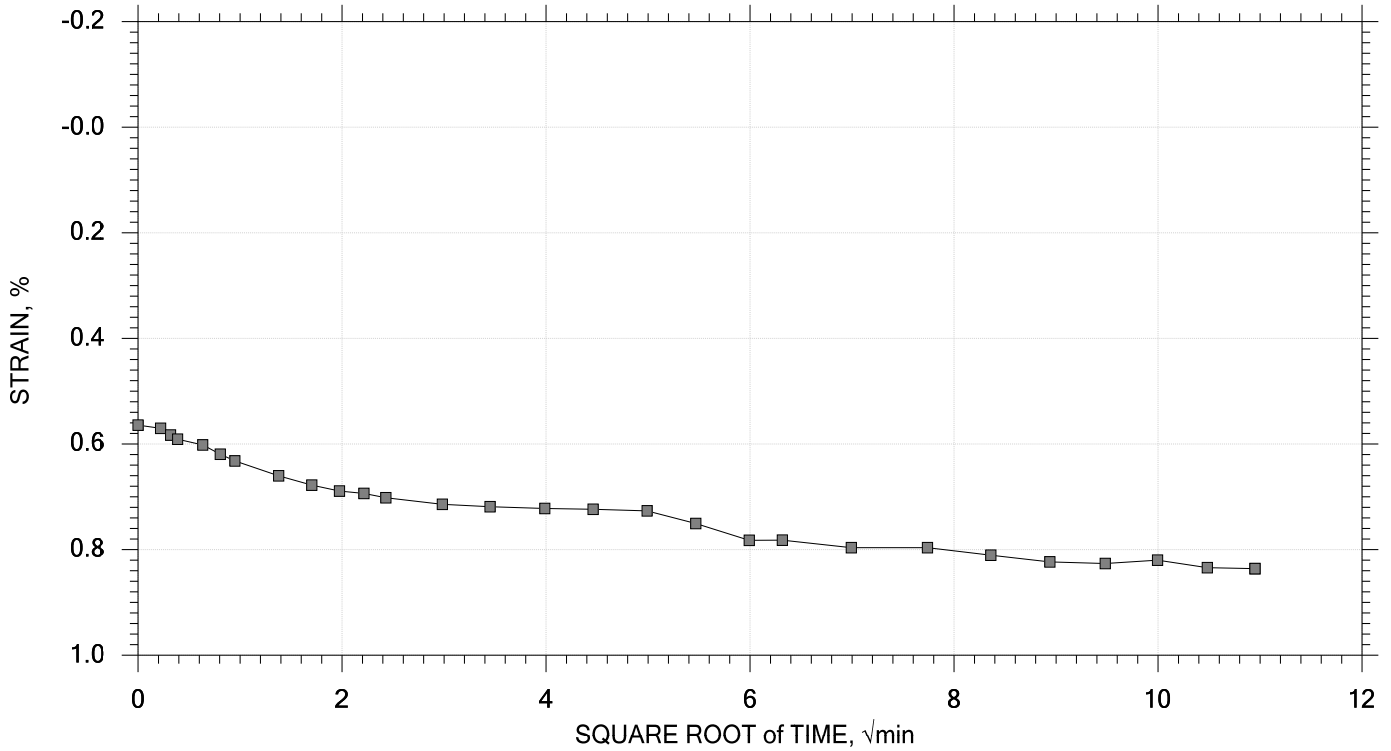
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 2 of 19

Stress: 0.125 tsf





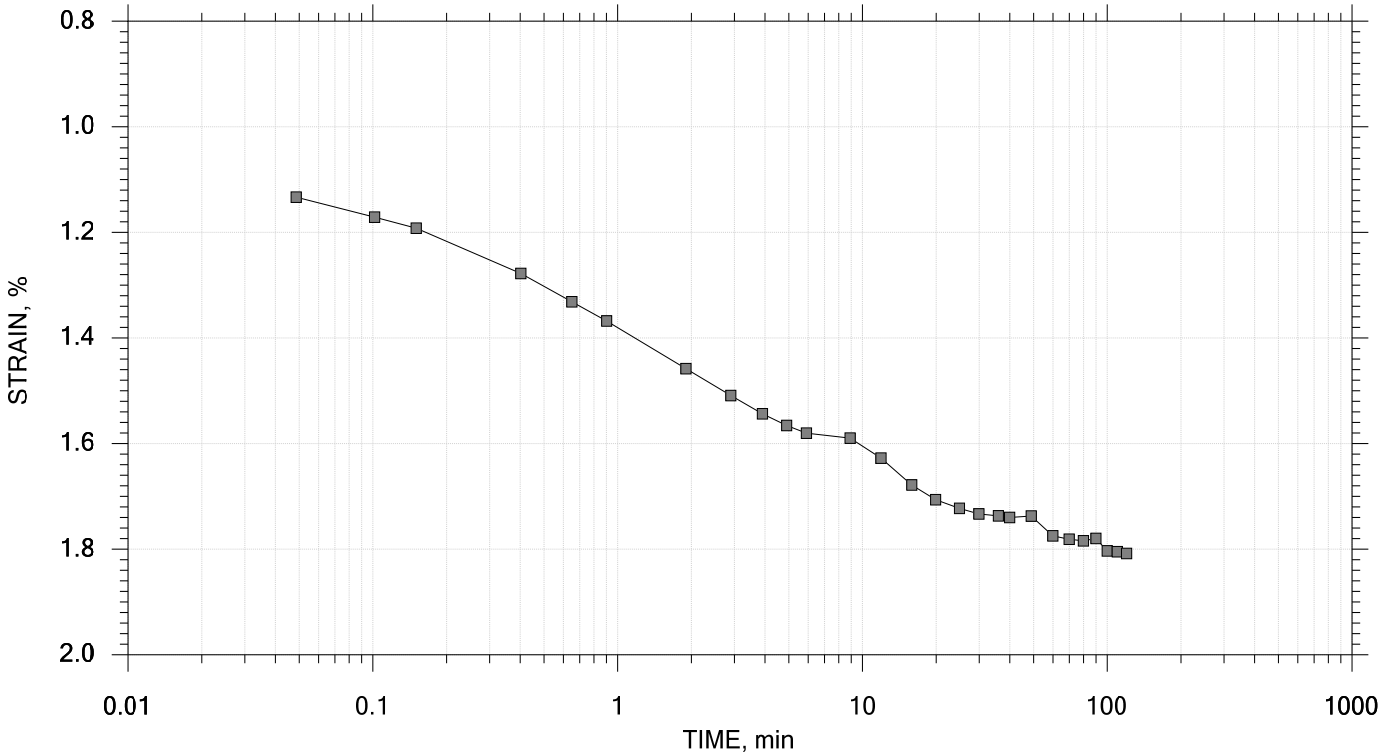
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

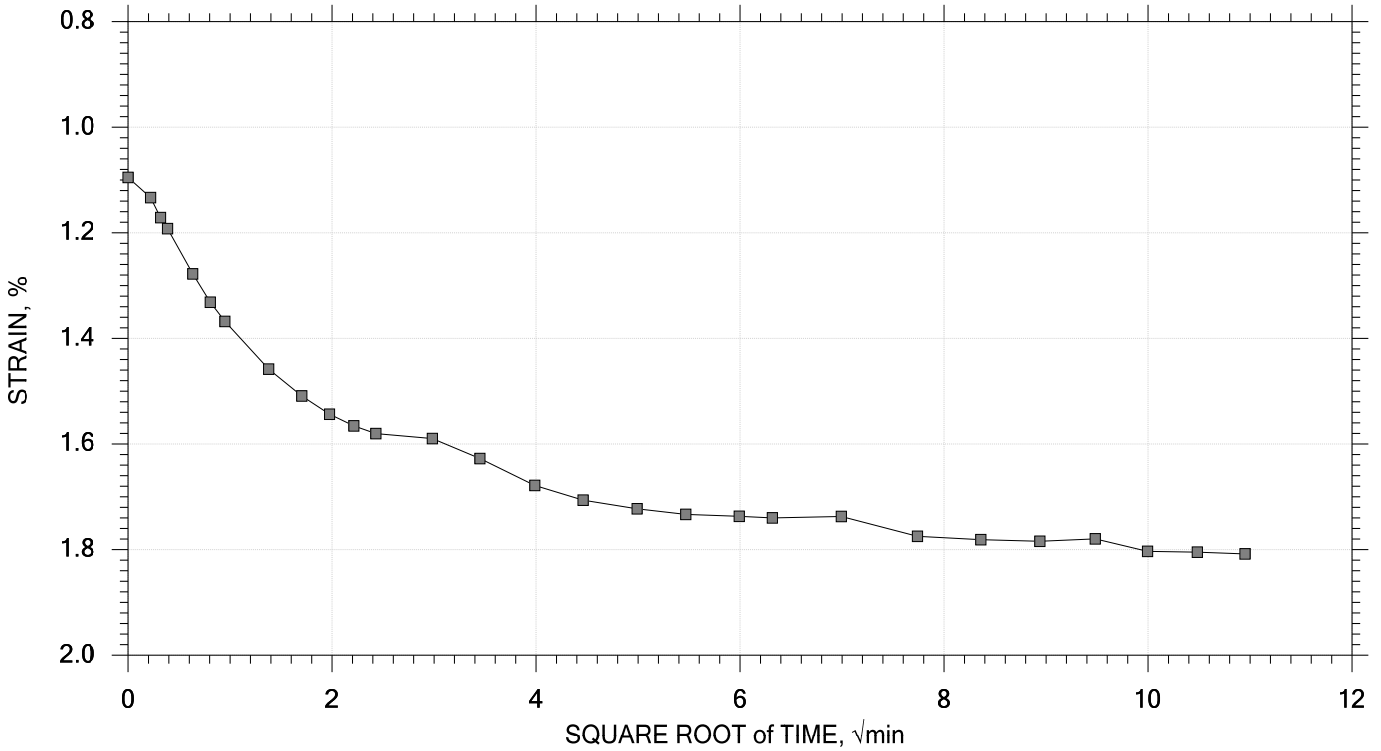
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 3 of 19

Stress: 0.25 tsf





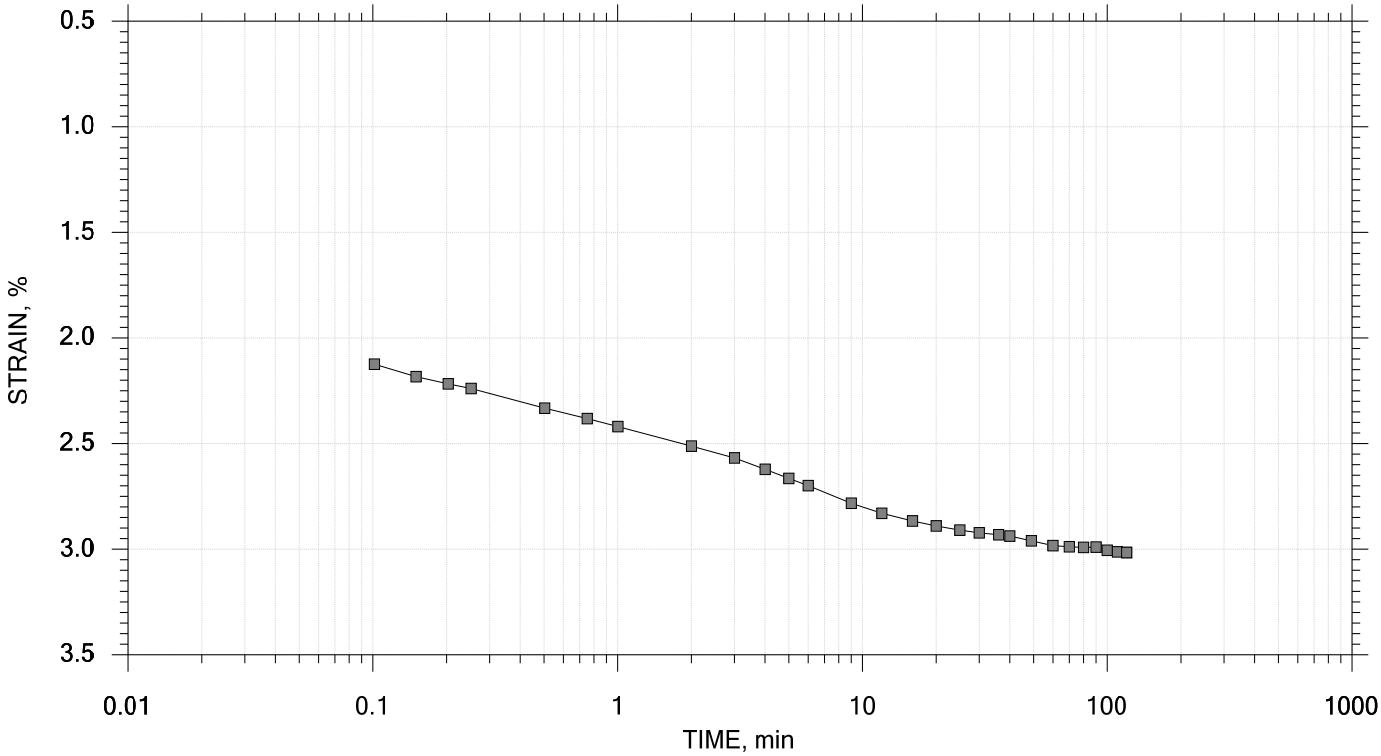
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

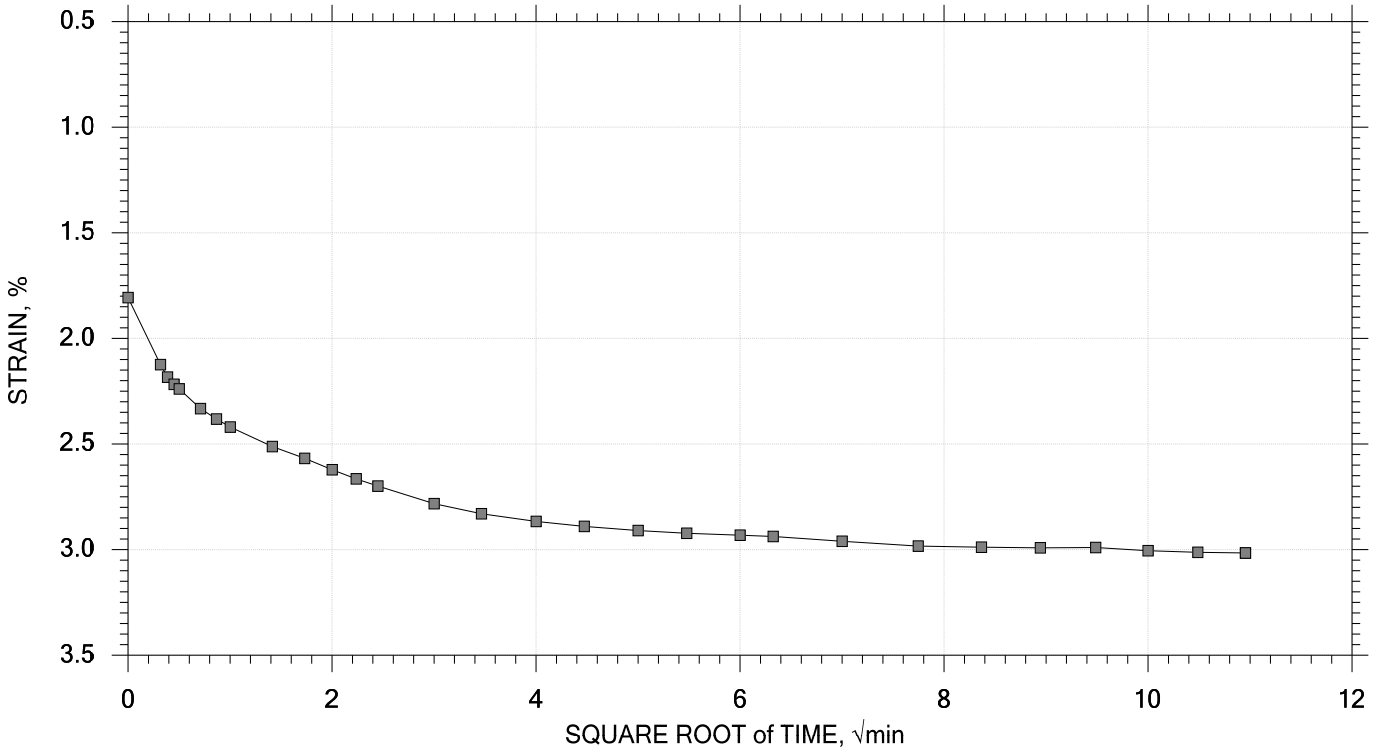
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 4 of 19

Stress: 0.5 tsf





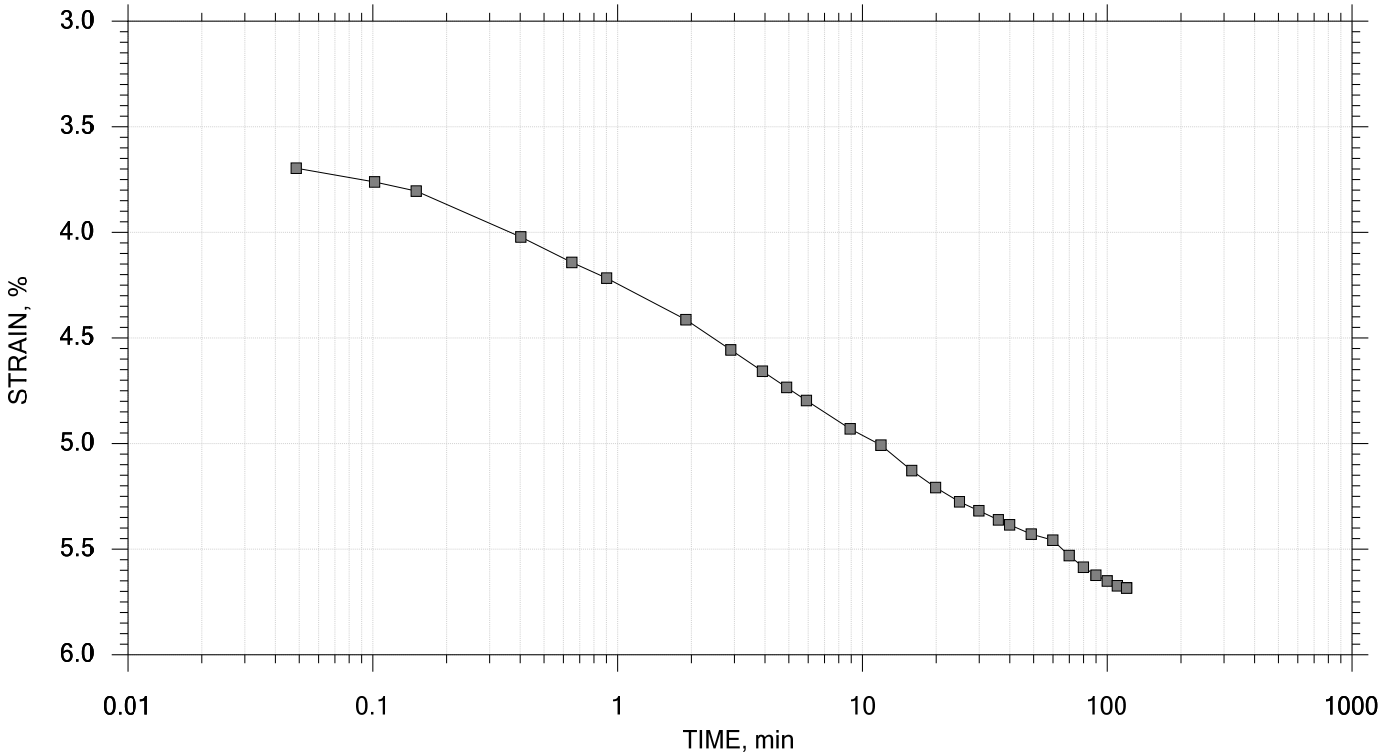
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

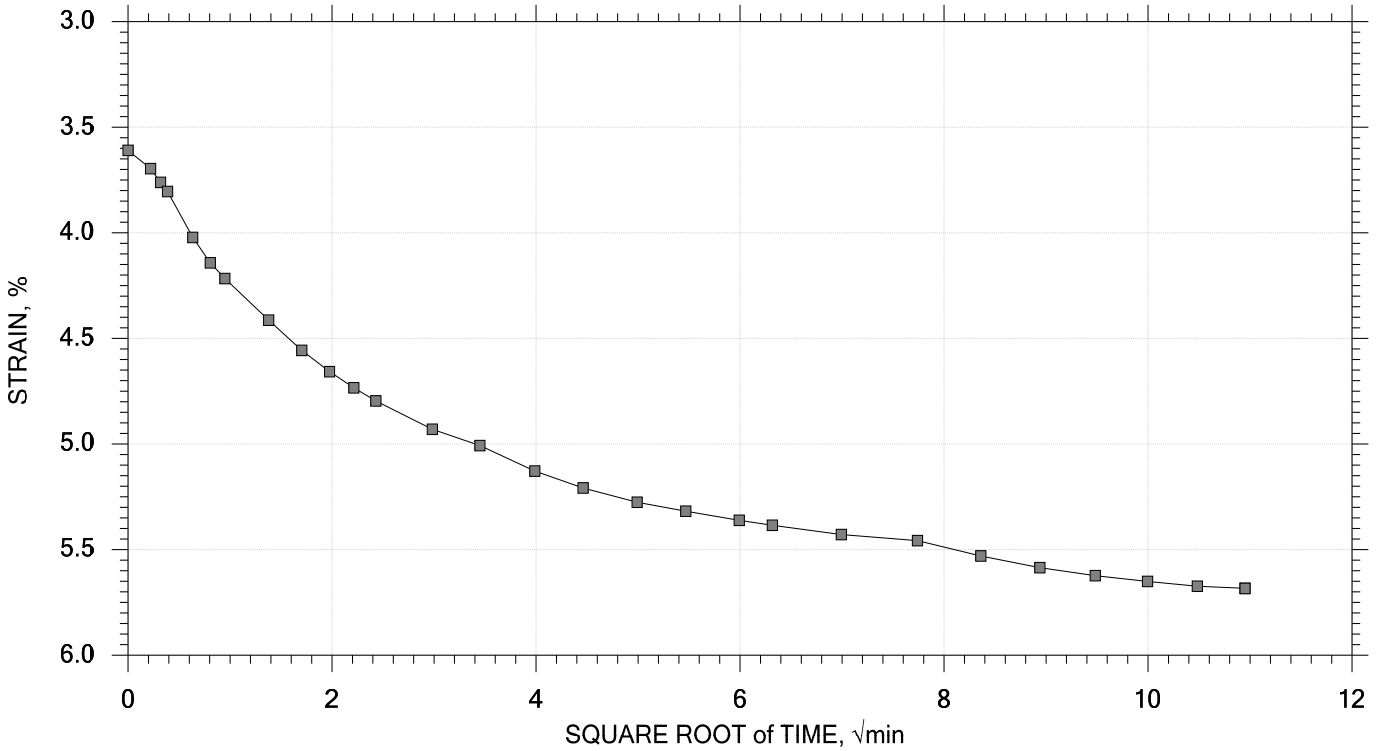
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 5 of 19

Stress: 1 tsf





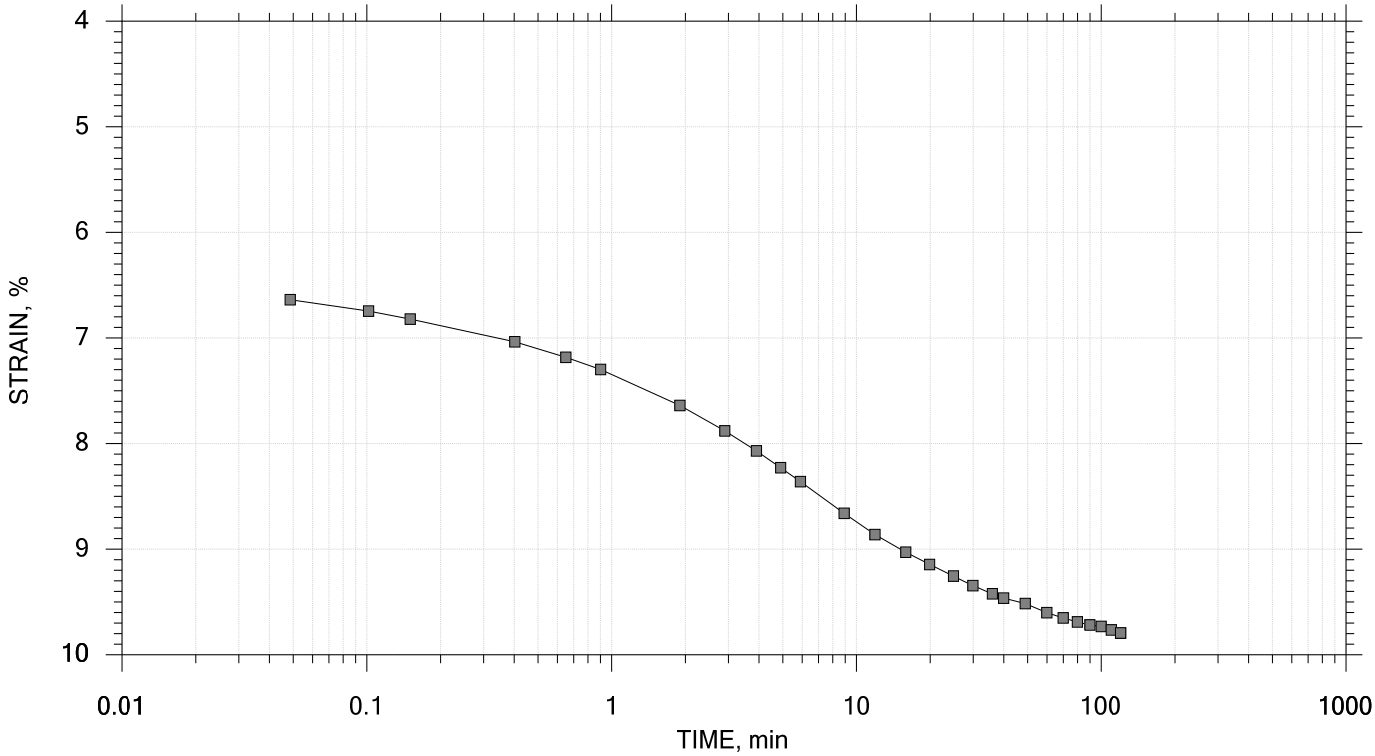
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

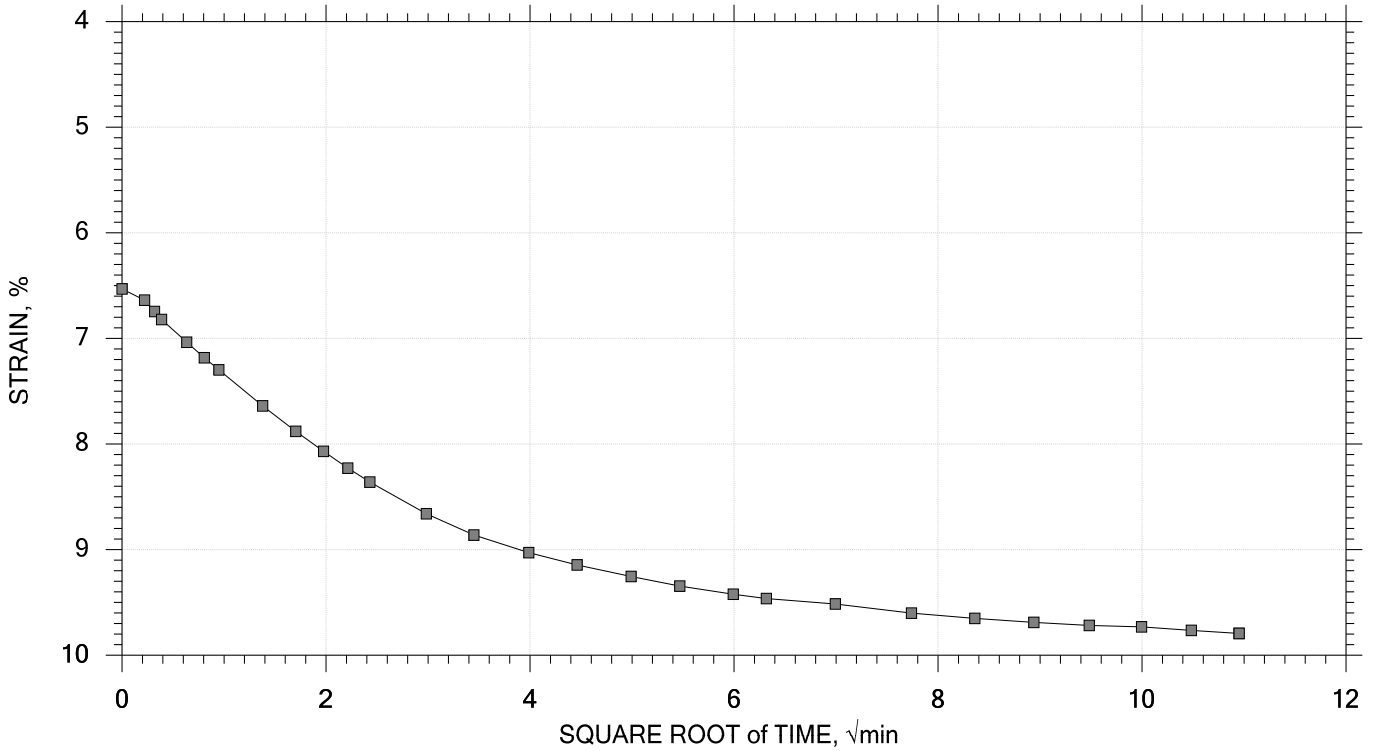
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 6 of 19

Stress: 2 tsf





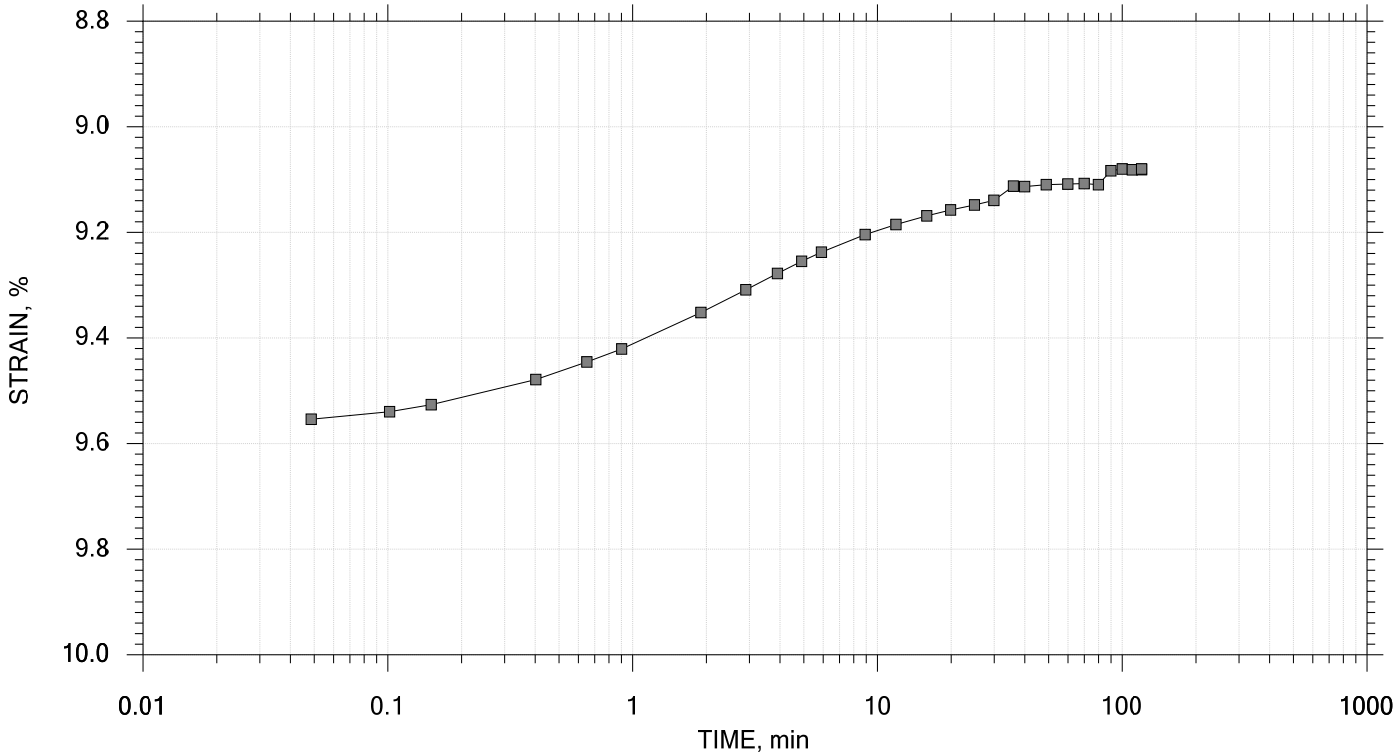
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

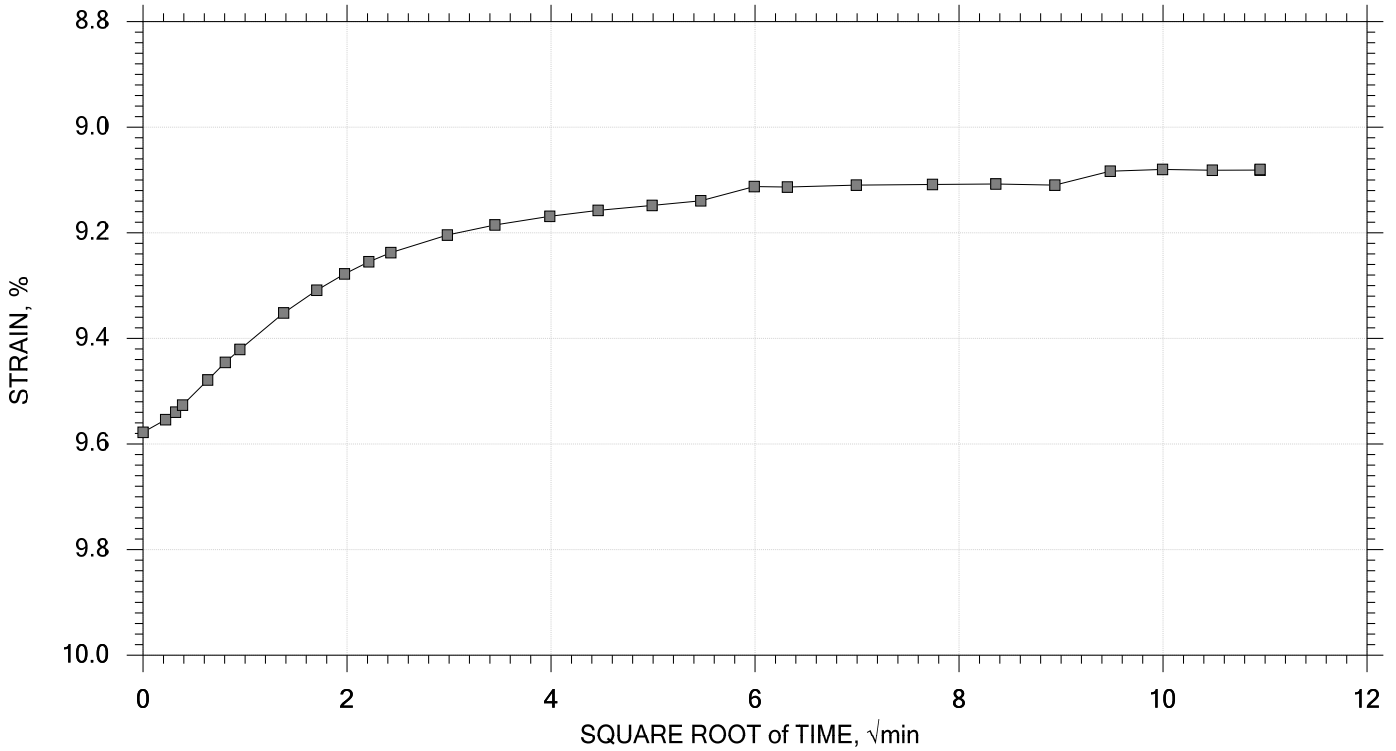
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 7 of 19

Stress: 0.5 tsf





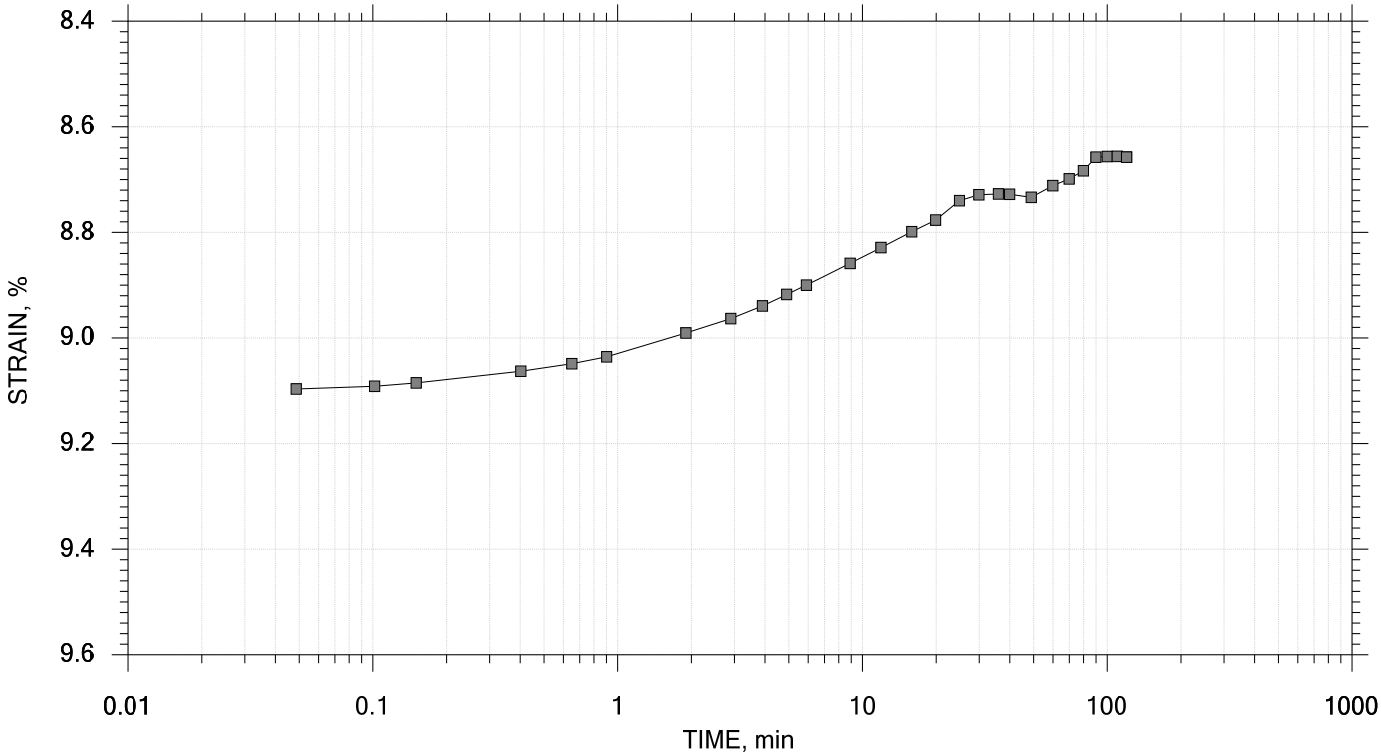
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

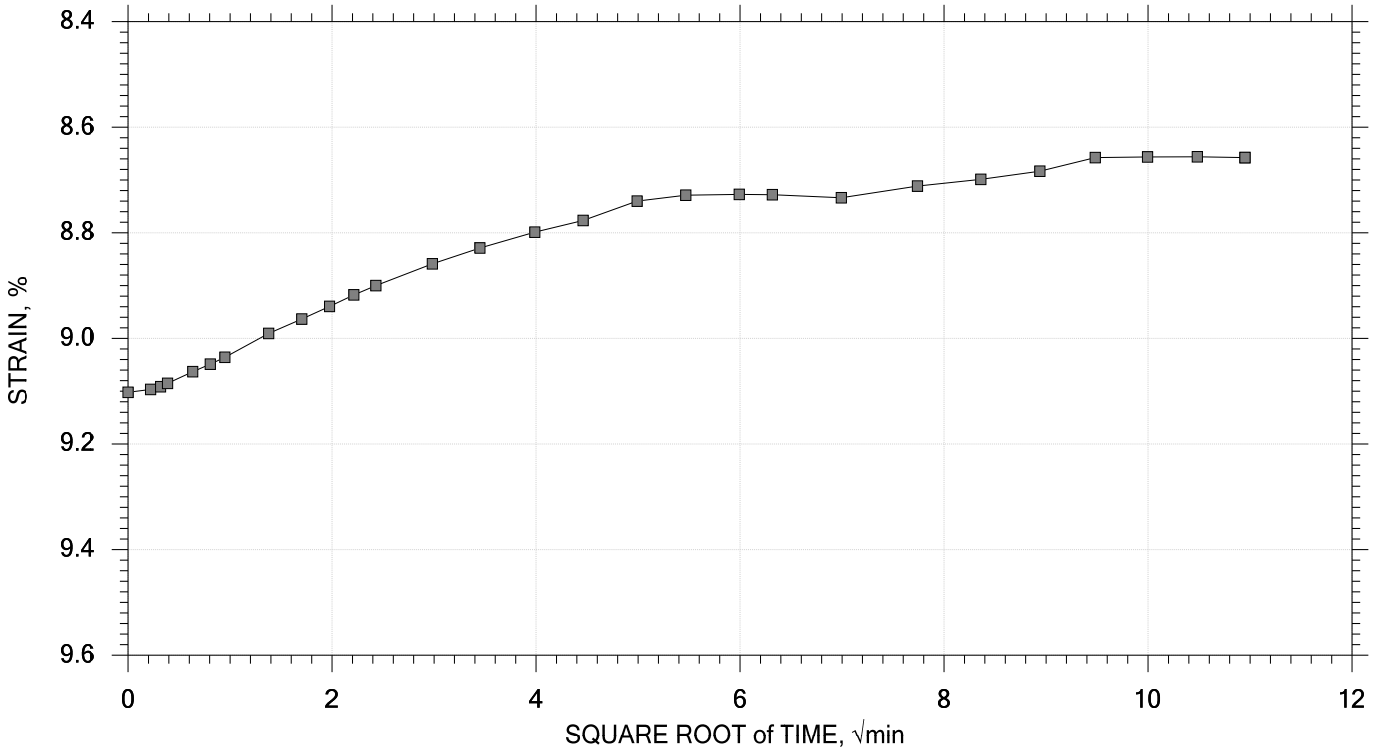
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 8 of 19

Stress: 0.25 tsf





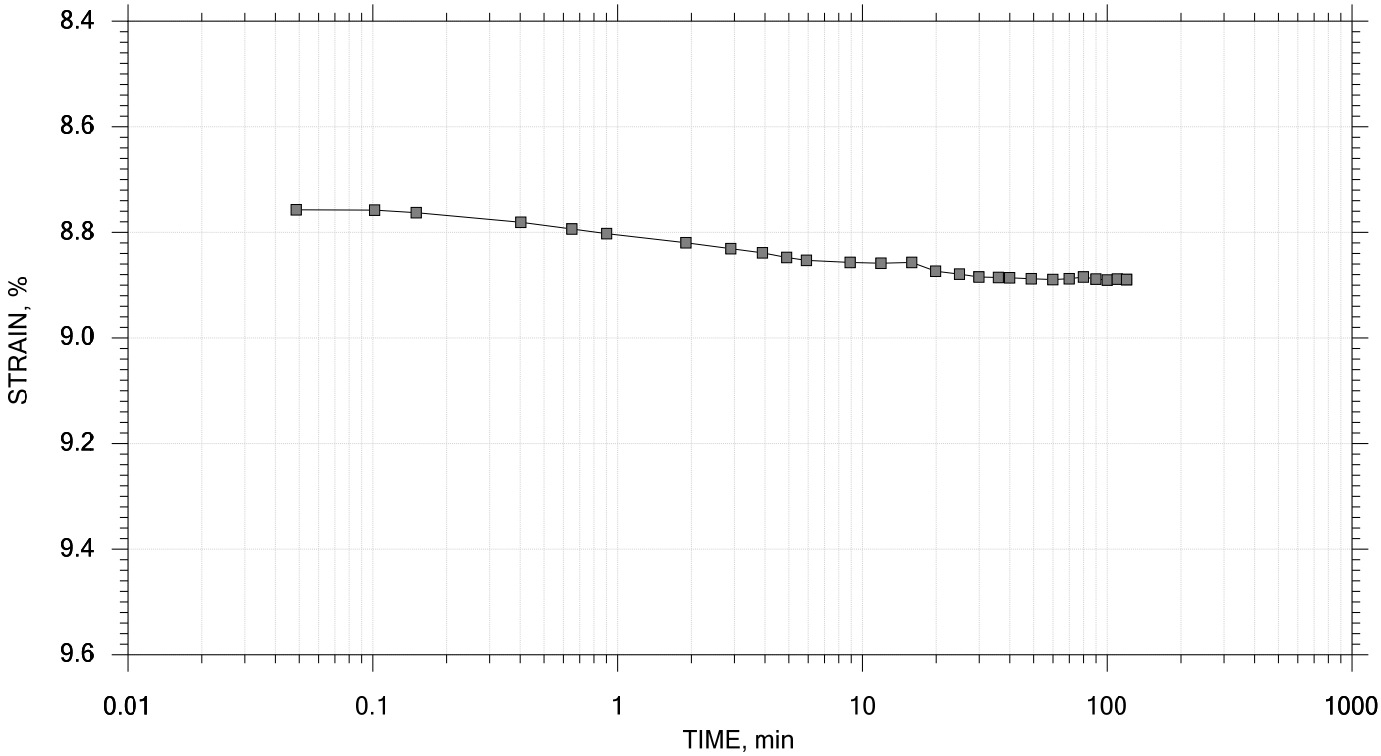
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

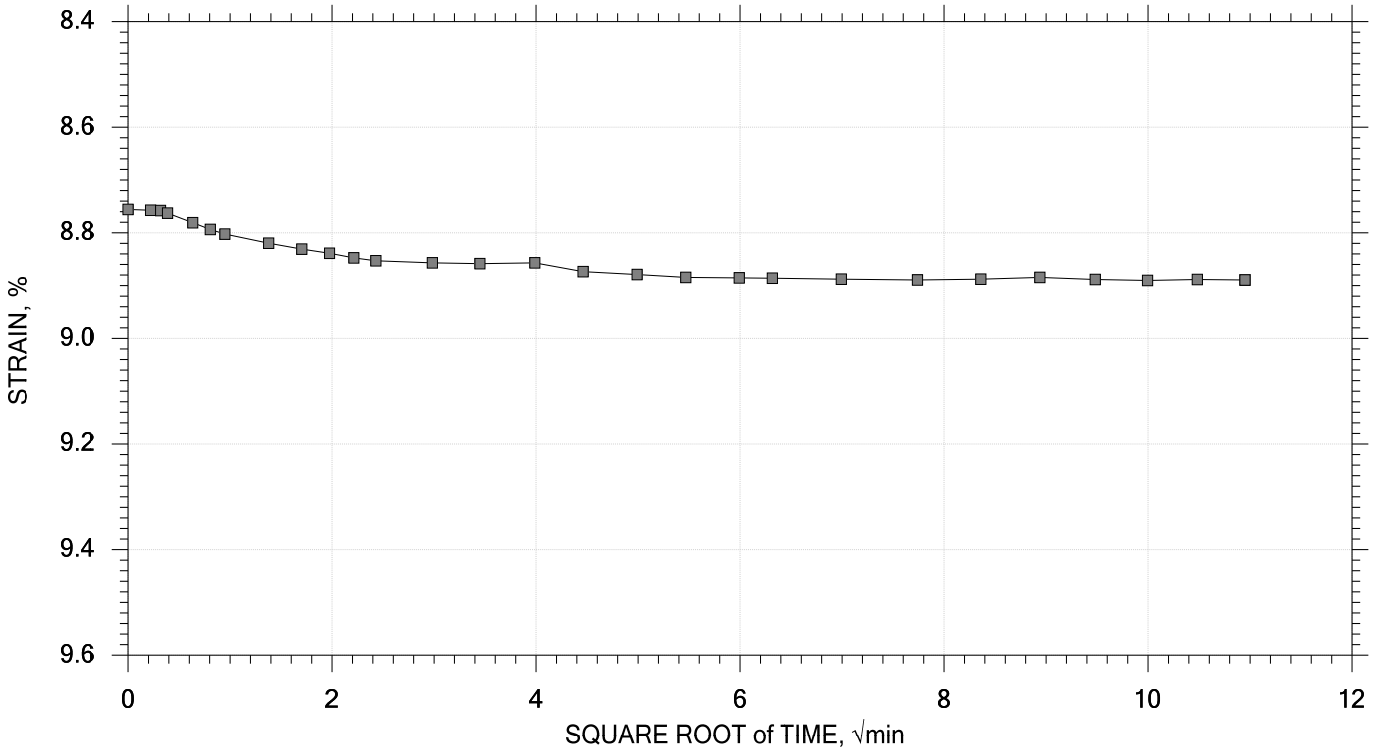
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 9 of 19

Stress: 0.5 tsf





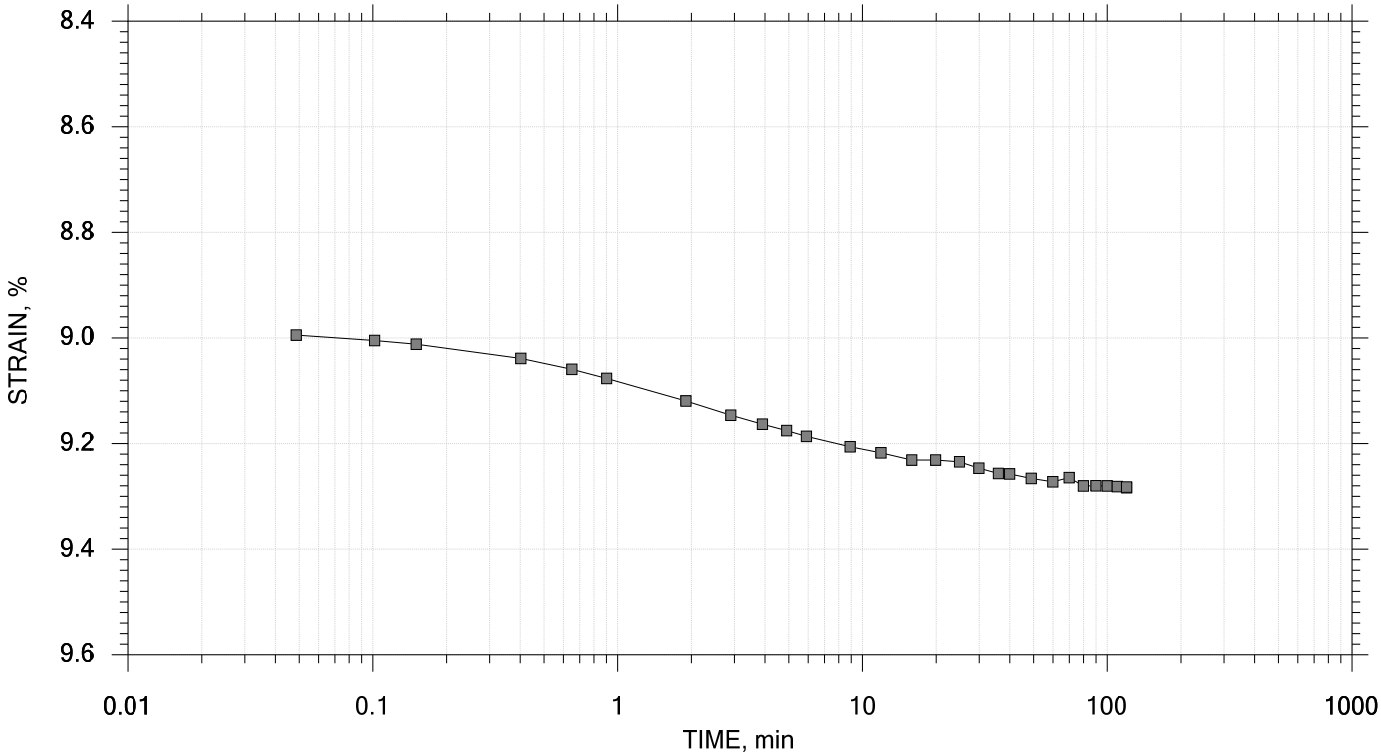
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

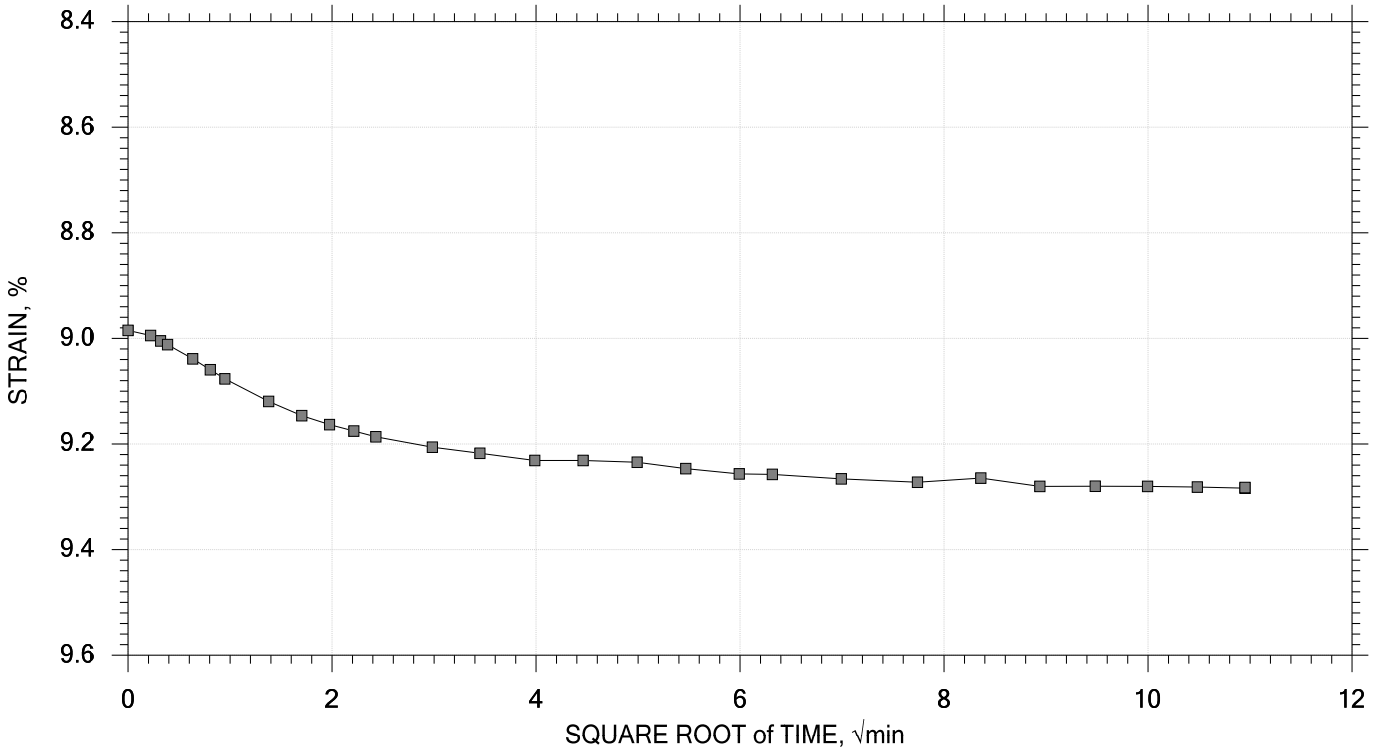
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 10 of 19

Stress: 1 tsf





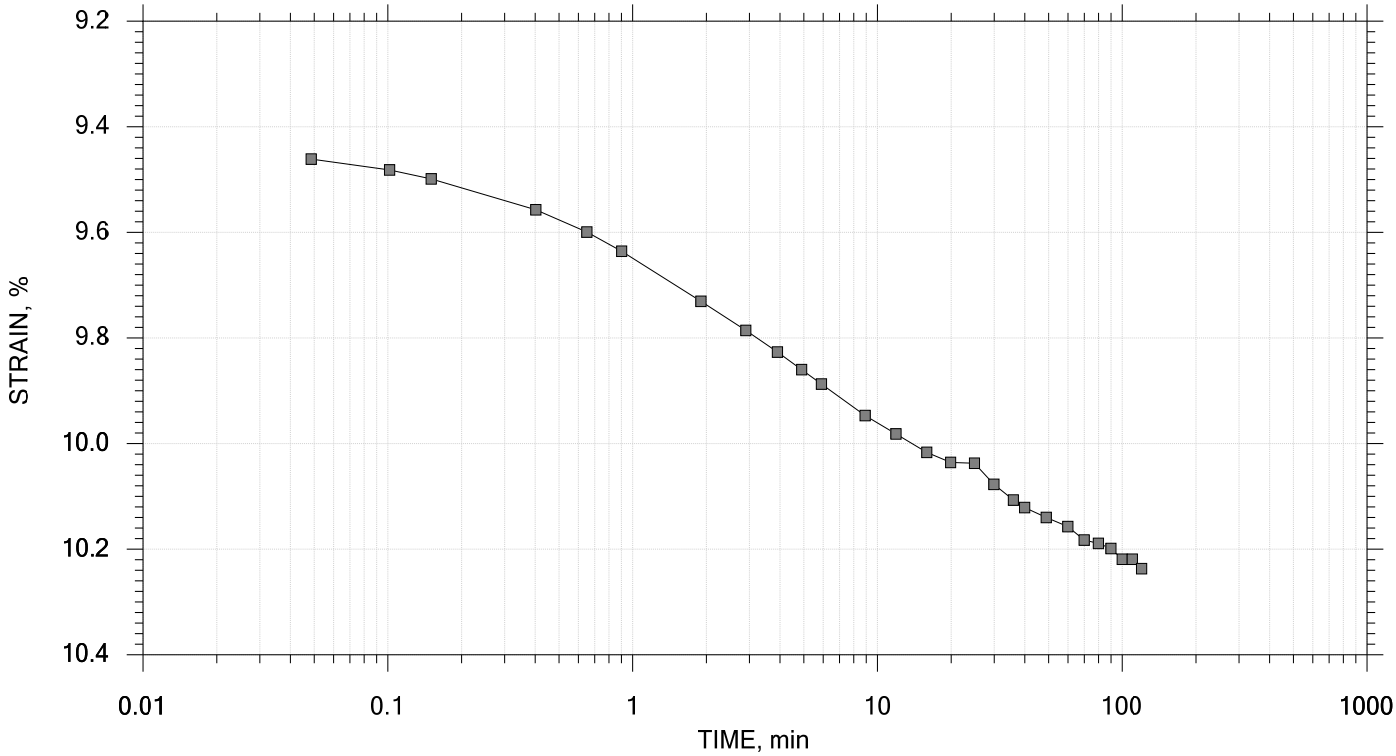
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

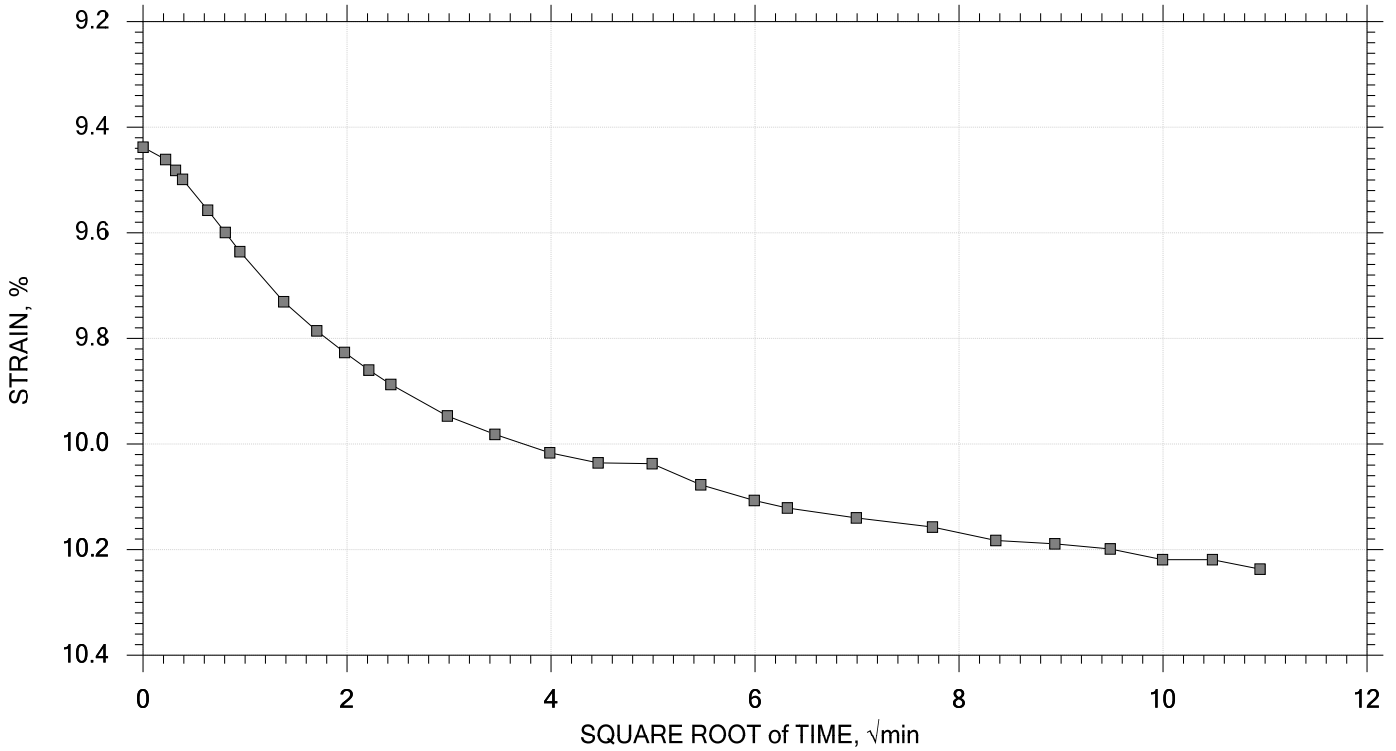
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 11 of 19

Stress: 2 tsf





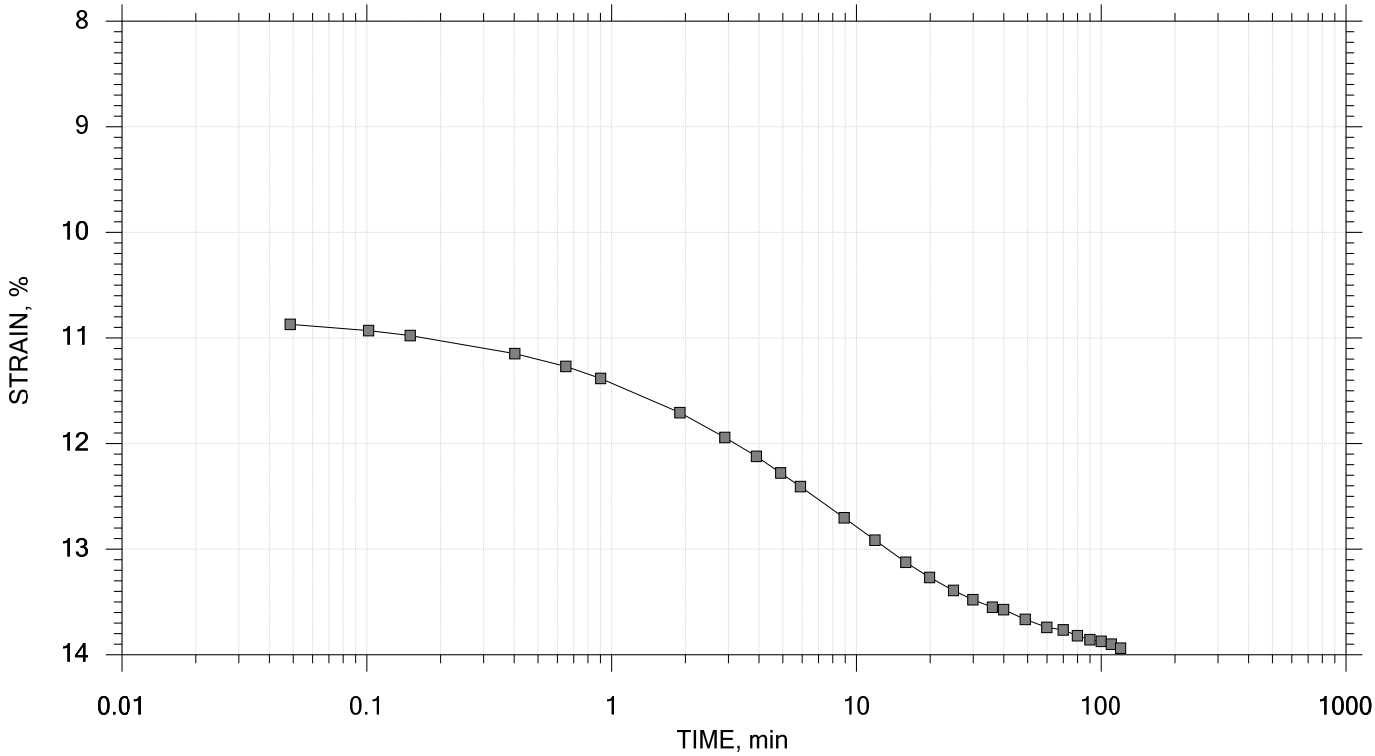
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

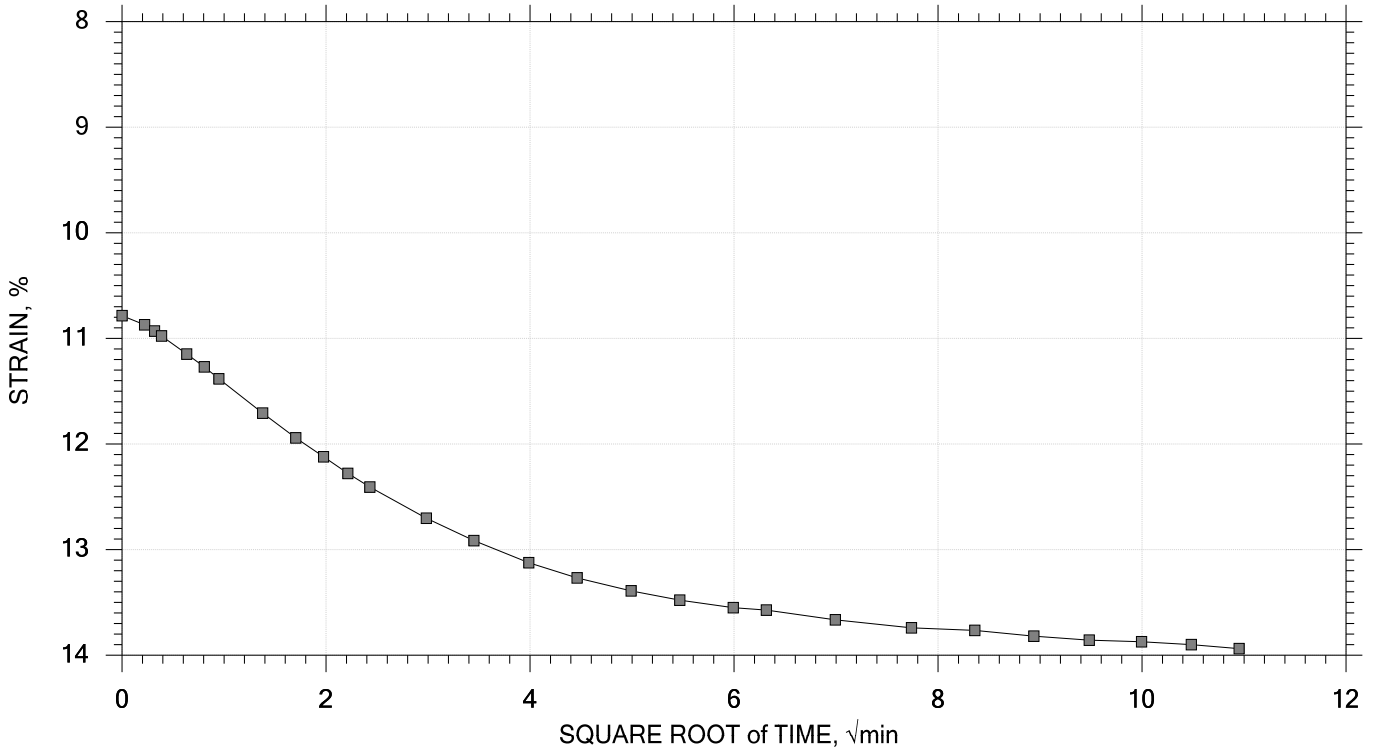
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 12 of 19

Stress: 4 tsf





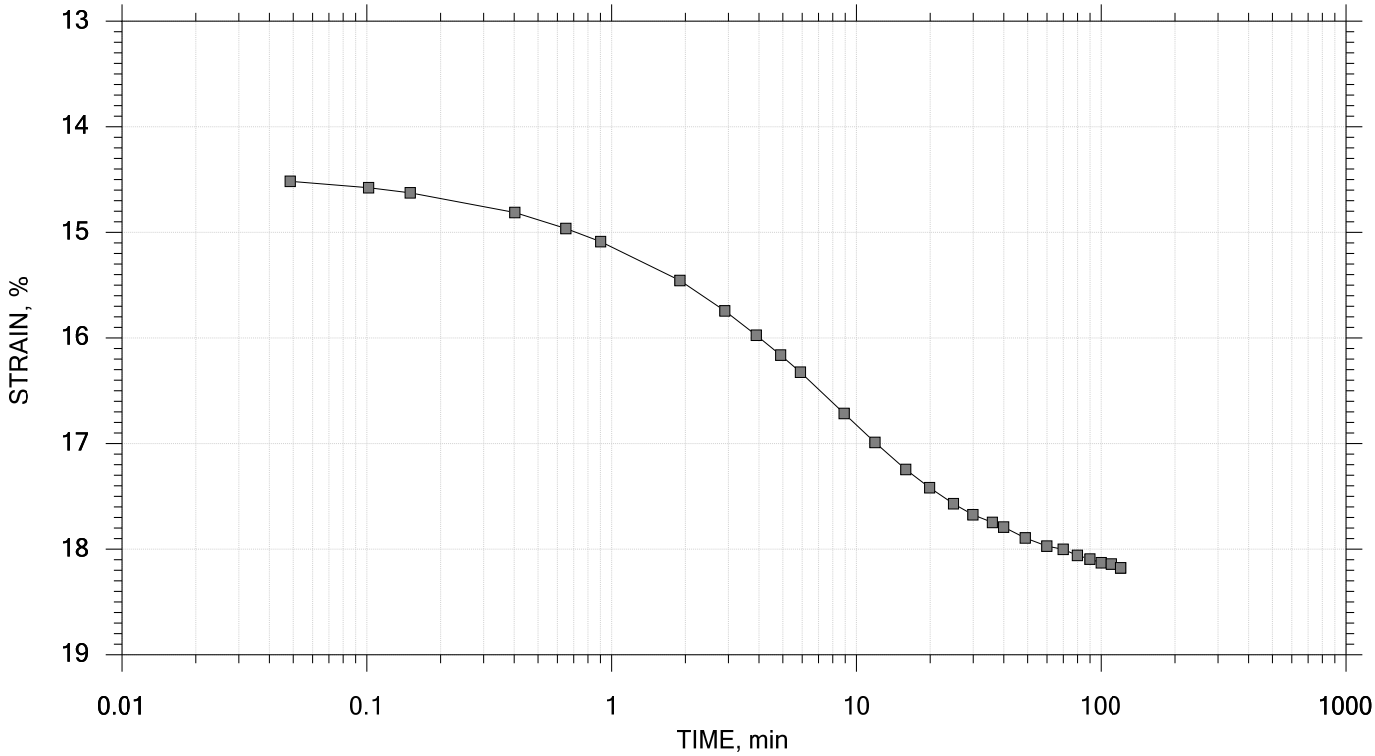
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

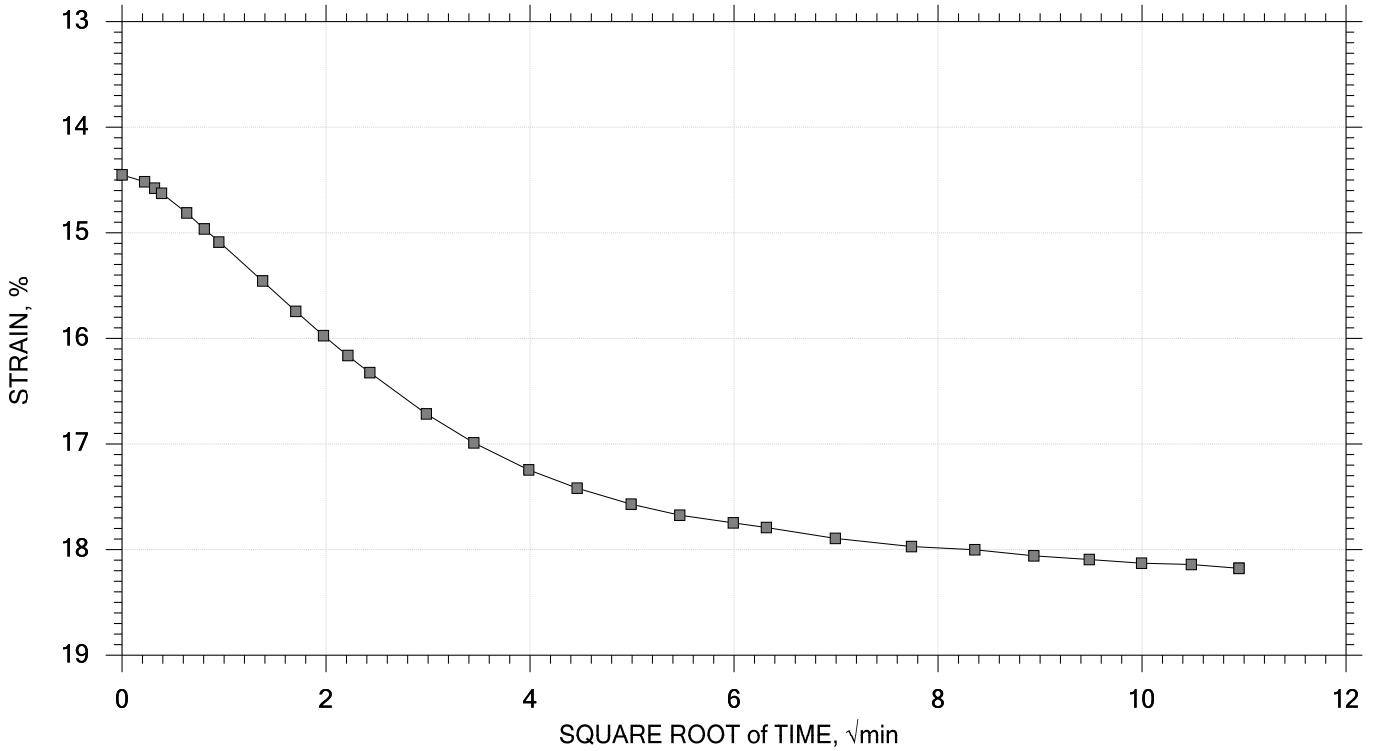
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 13 of 19

Stress: 8 tsf





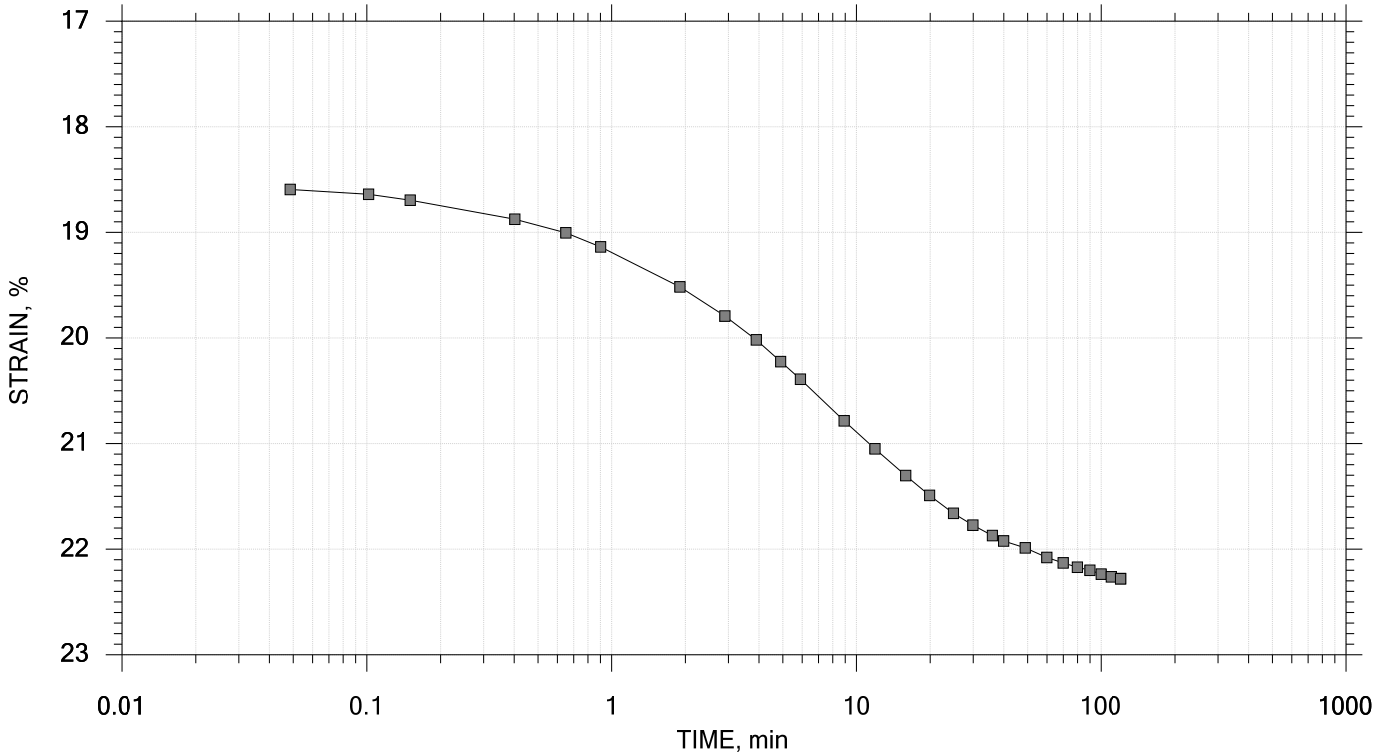
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

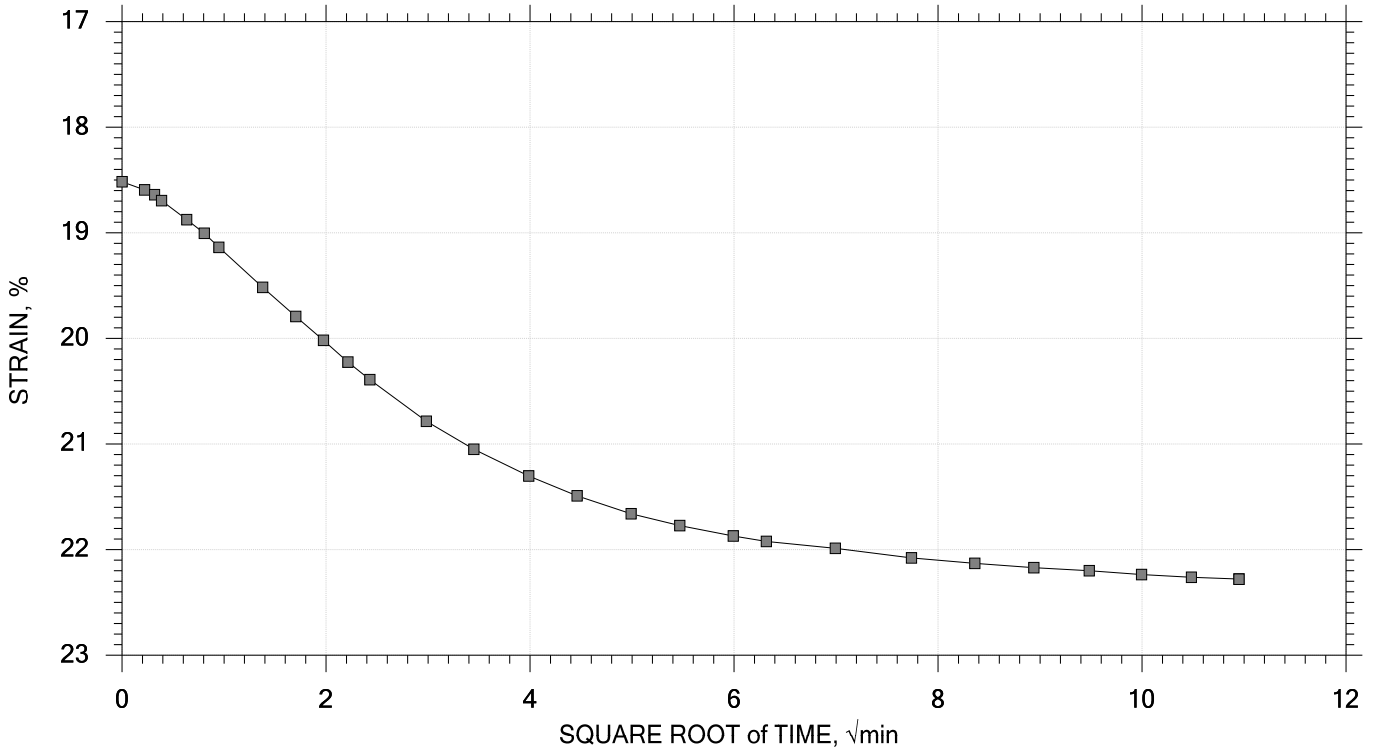
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 14 of 19

Stress: 16 tsf





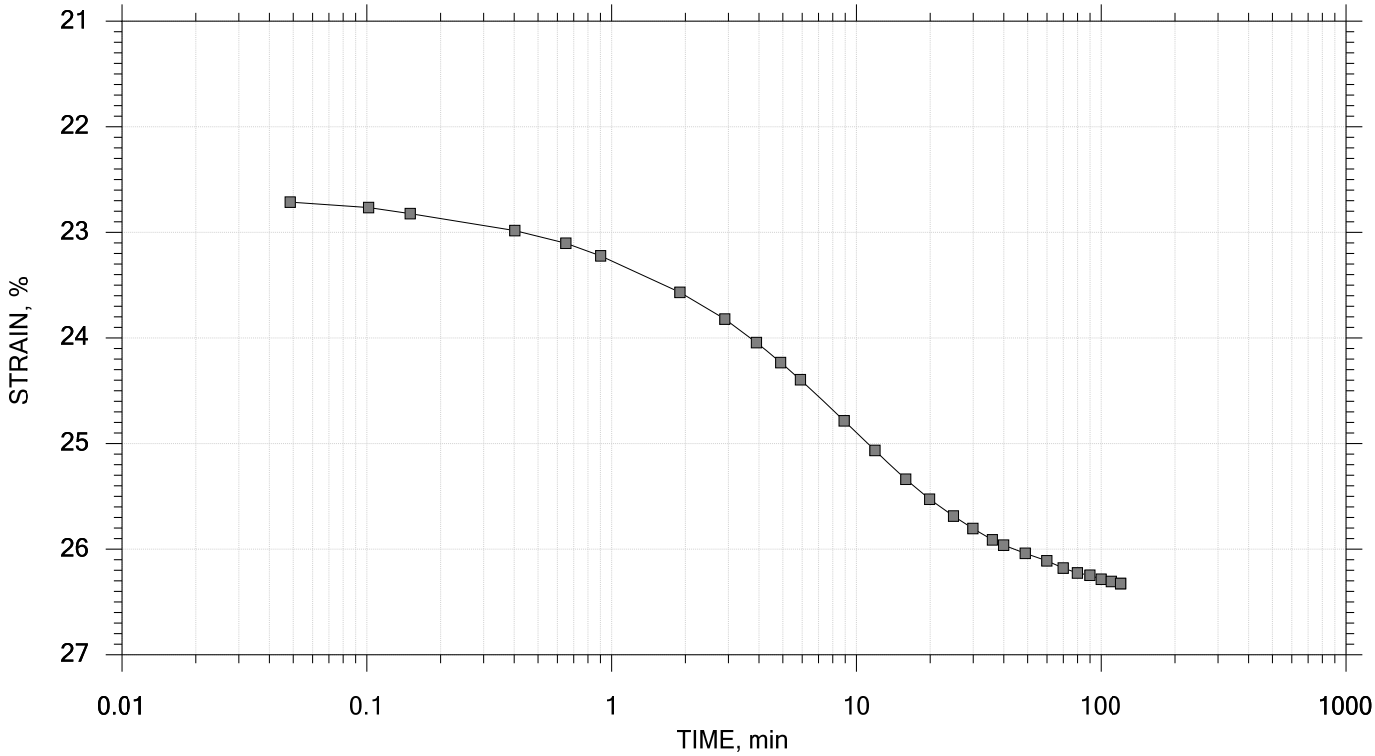
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

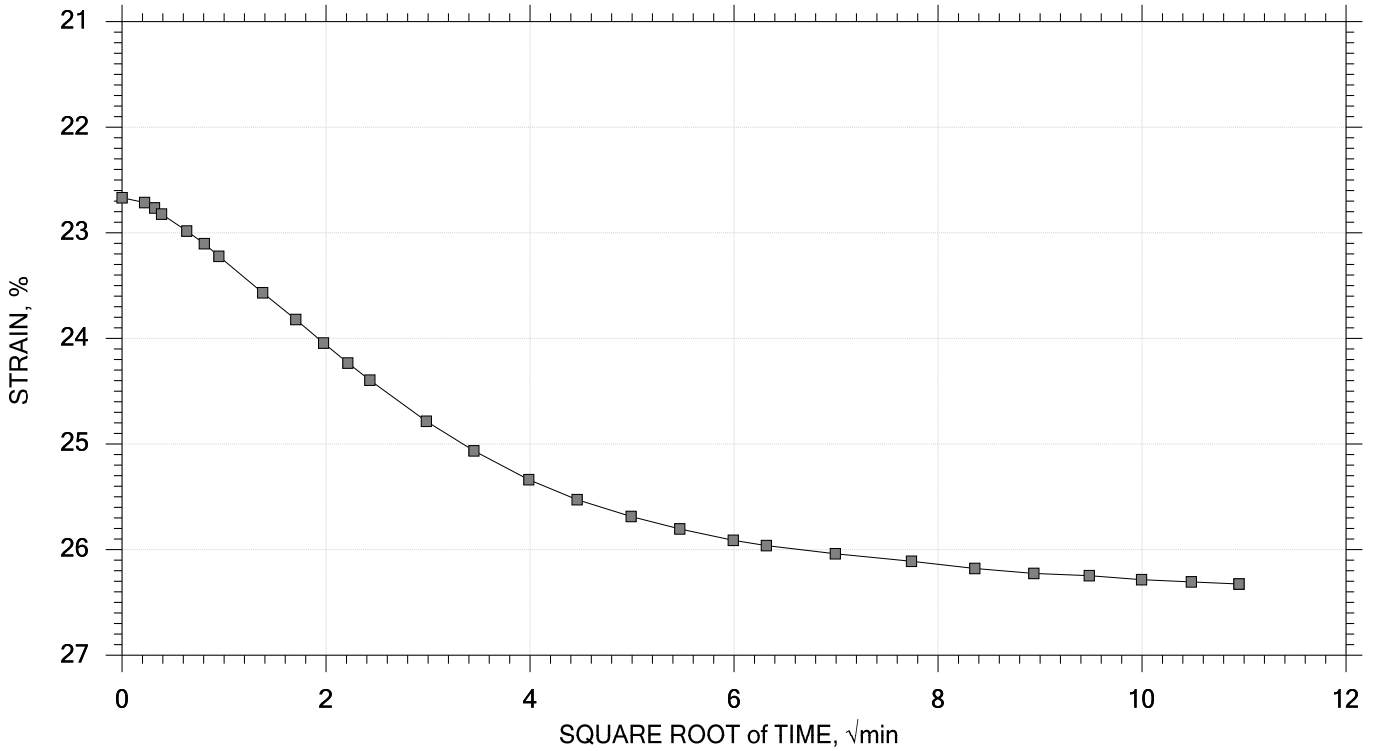
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 15 of 19

Stress: 32 tsf





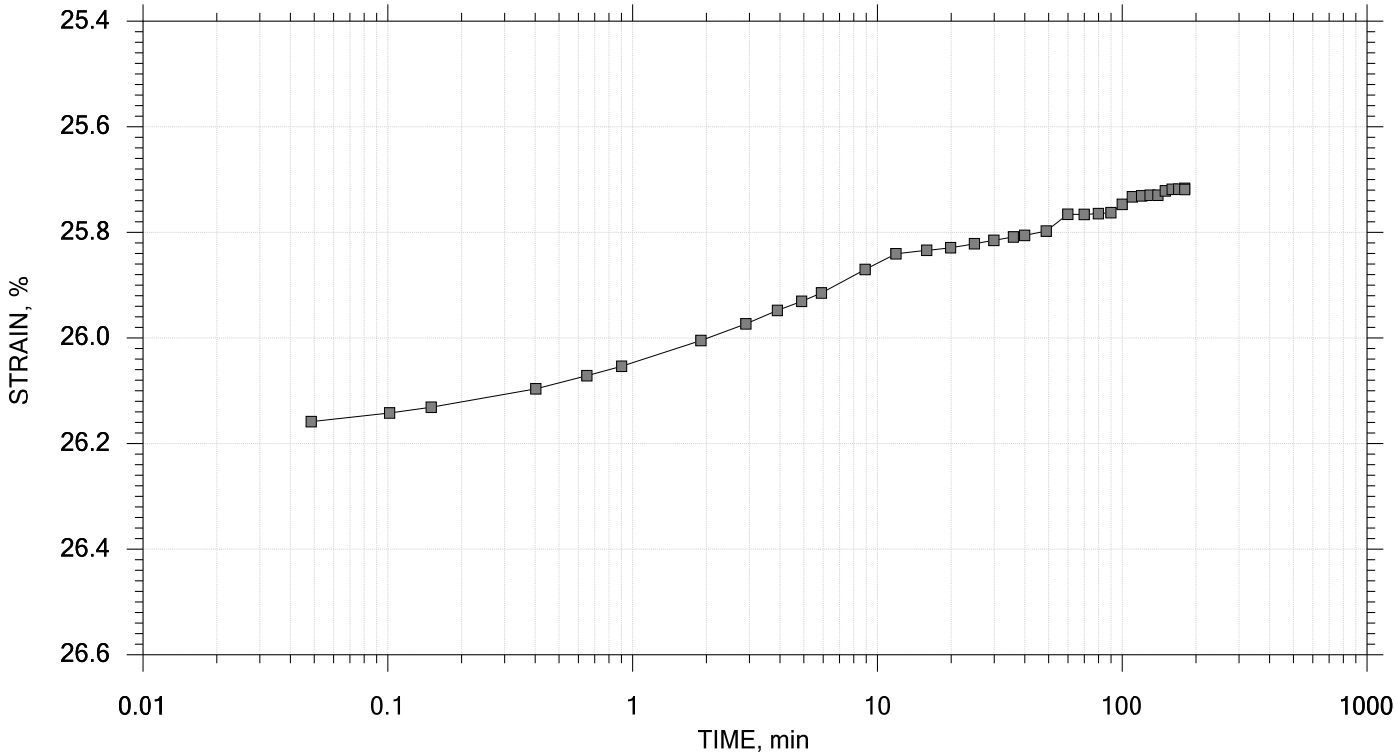
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

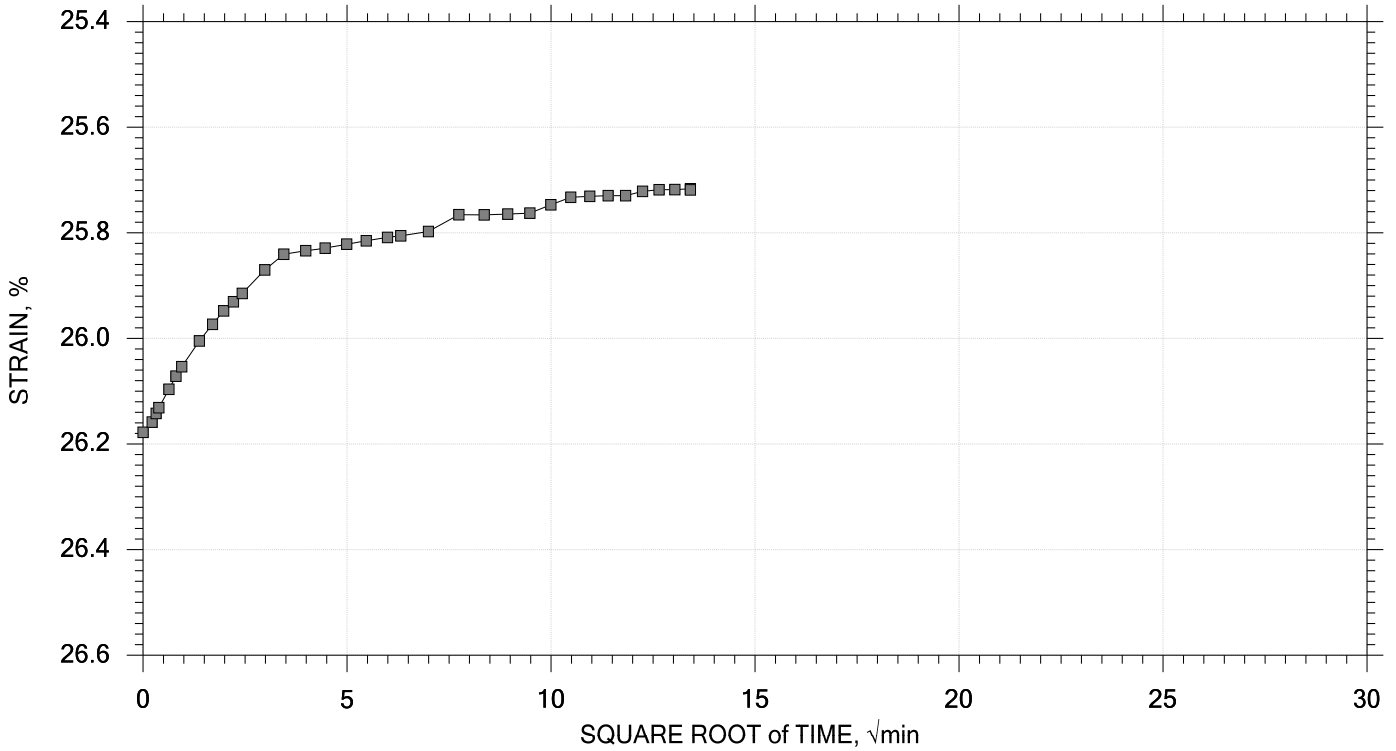
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 16 of 19

Stress: 8 tsf





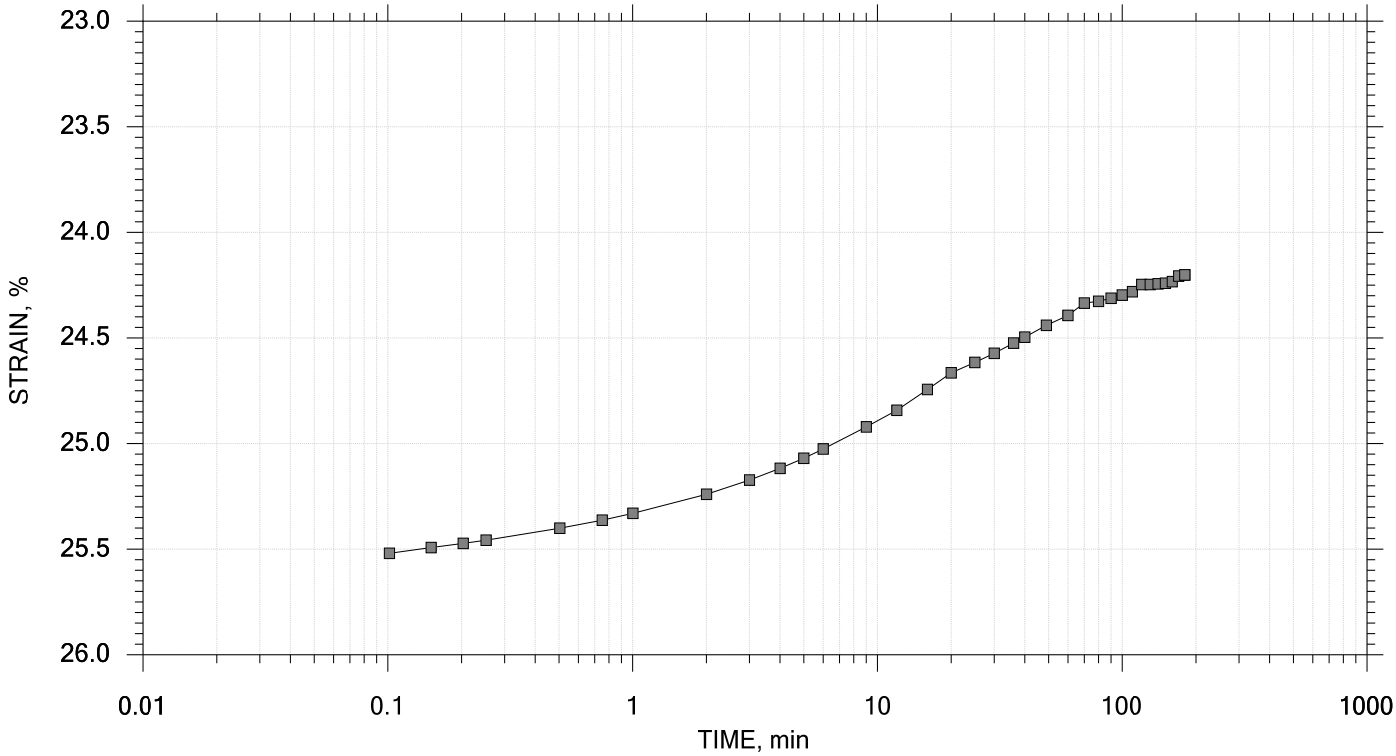
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

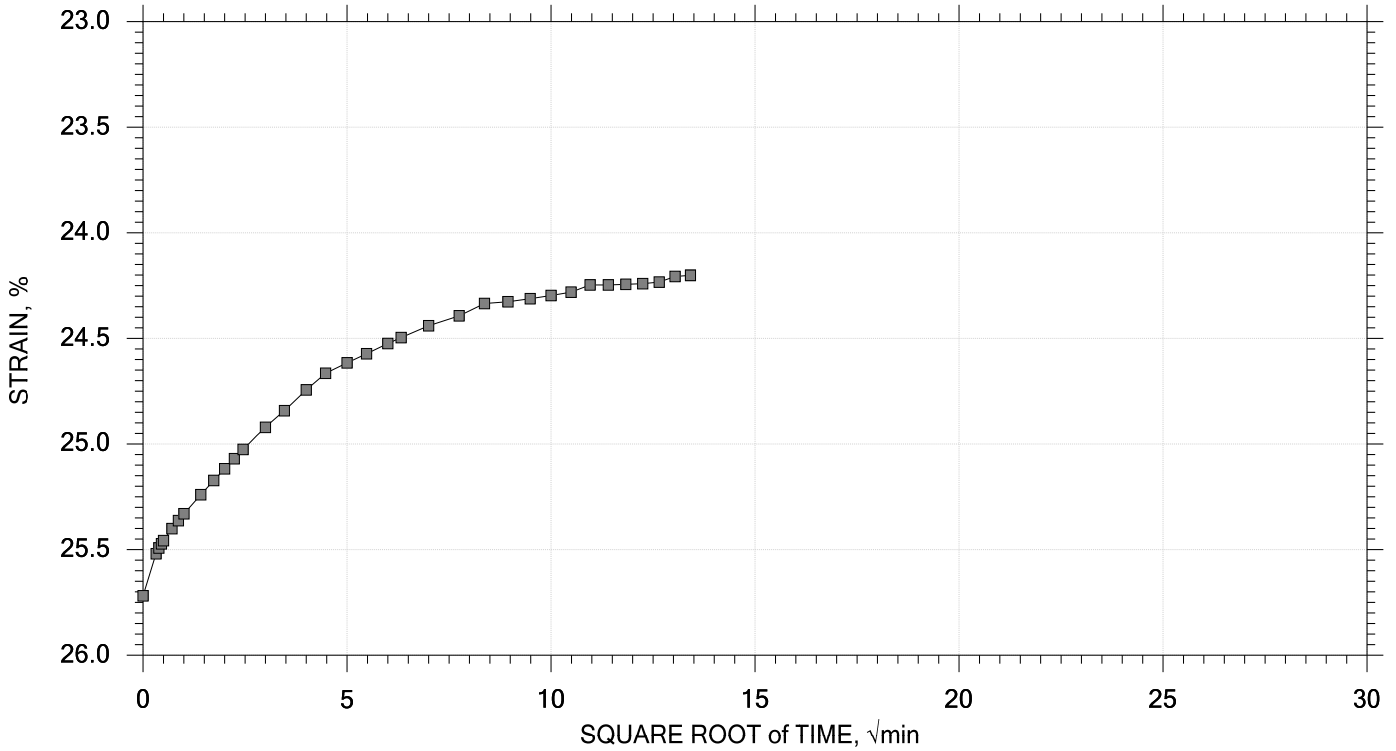
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 17 of 19

Stress: 2 tsf





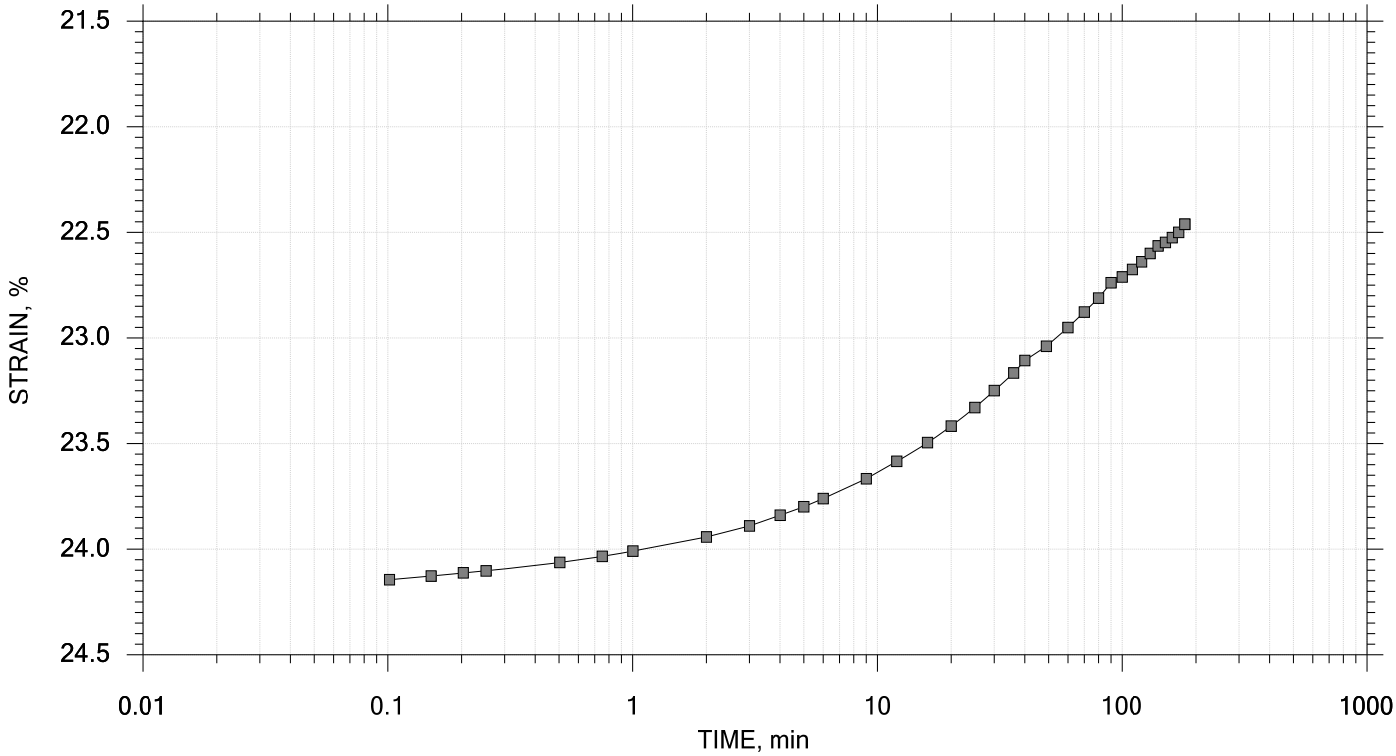
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

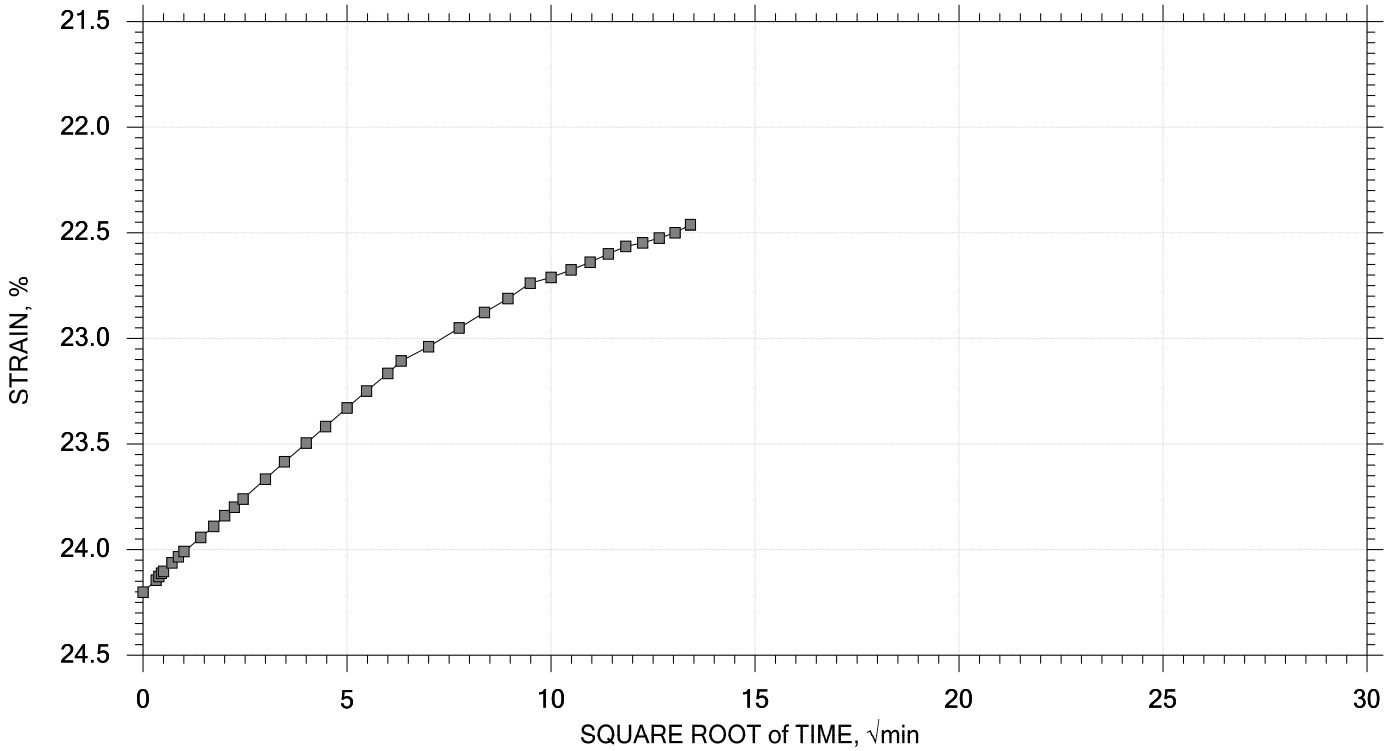
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 18 of 19

Stress: 0.5 tsf





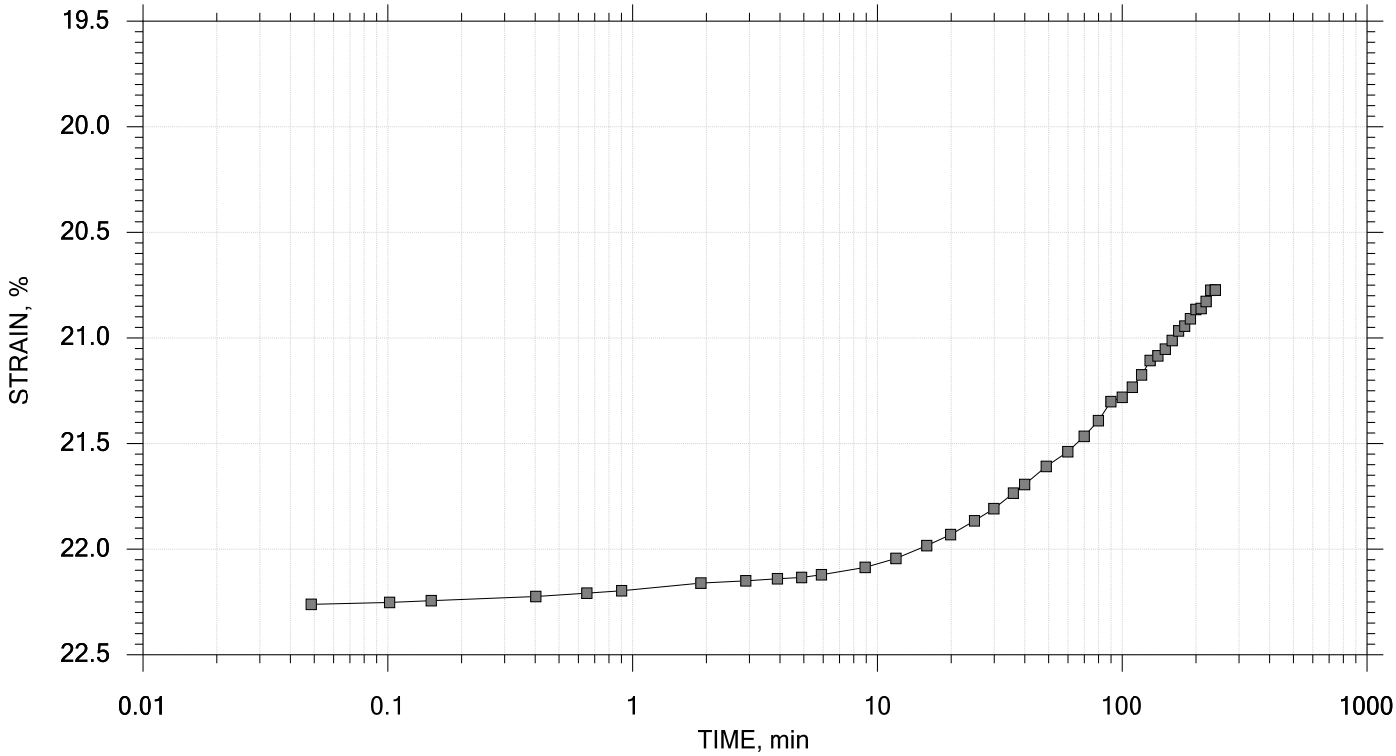
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

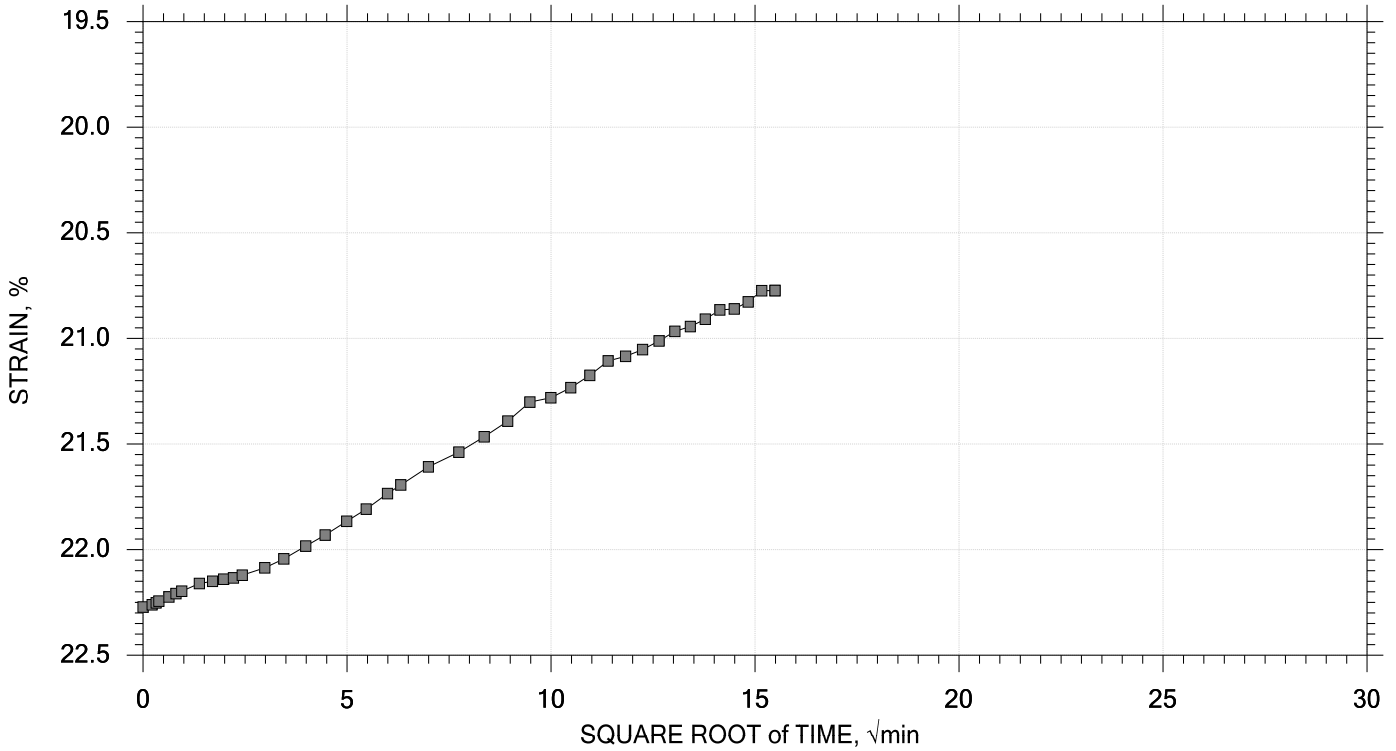
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 19 of 19

Stress: 0.125 tsf

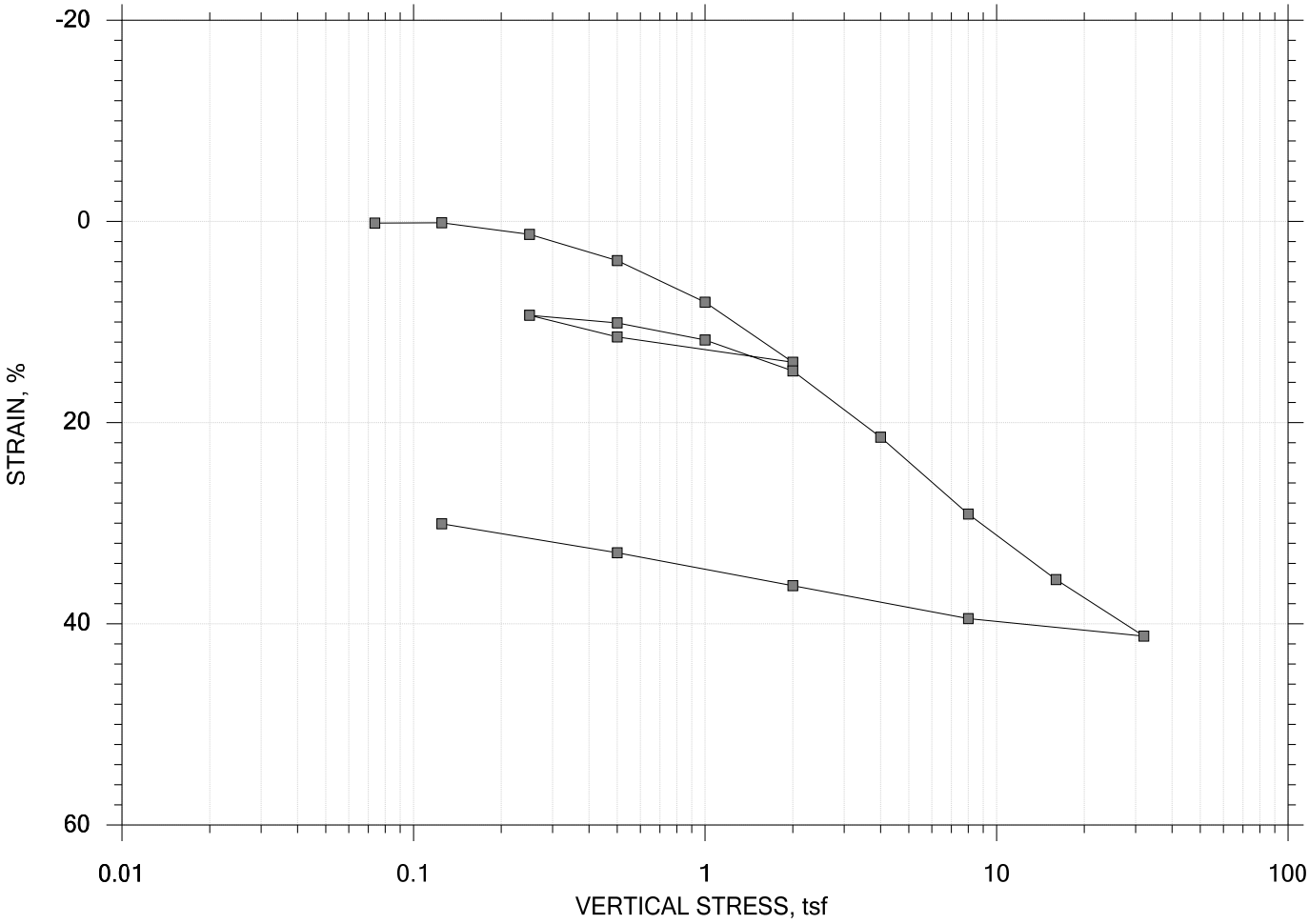


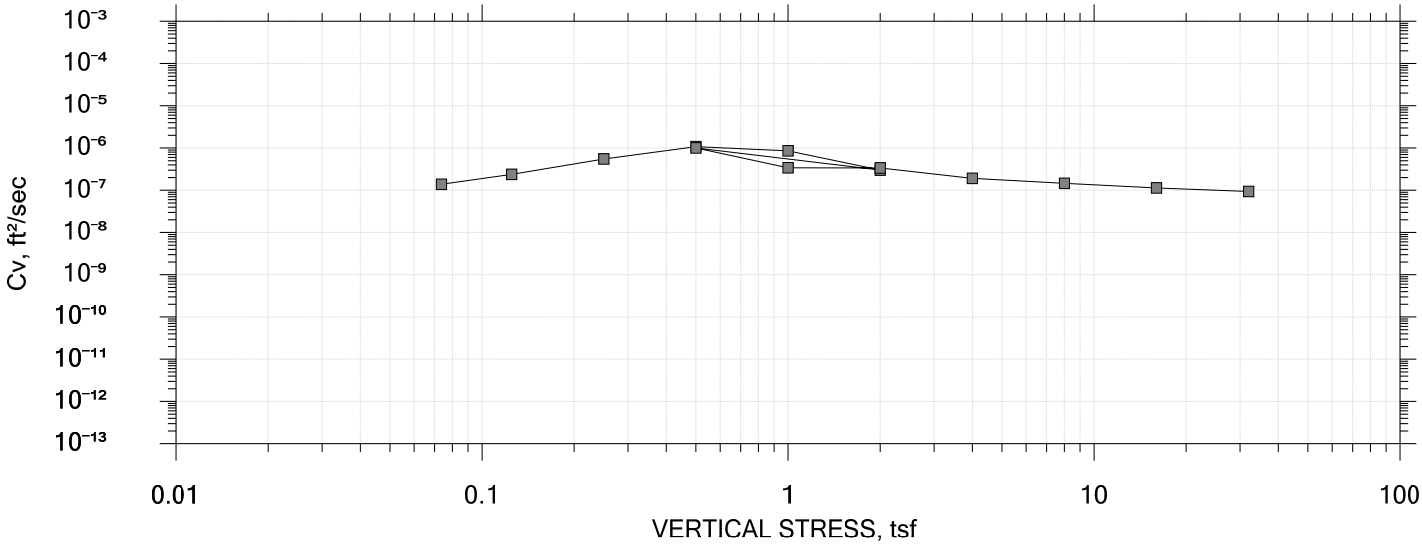


GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B03	Tested By: jm	Checked By: mcm
	Sample No.: 8 (Tube)	Test Date: 12/15/17	Test No.: IP-3
	Depth: 24-26 ft	Sample Type: intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: System 5077, Swell Pressure = 0.0902 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT

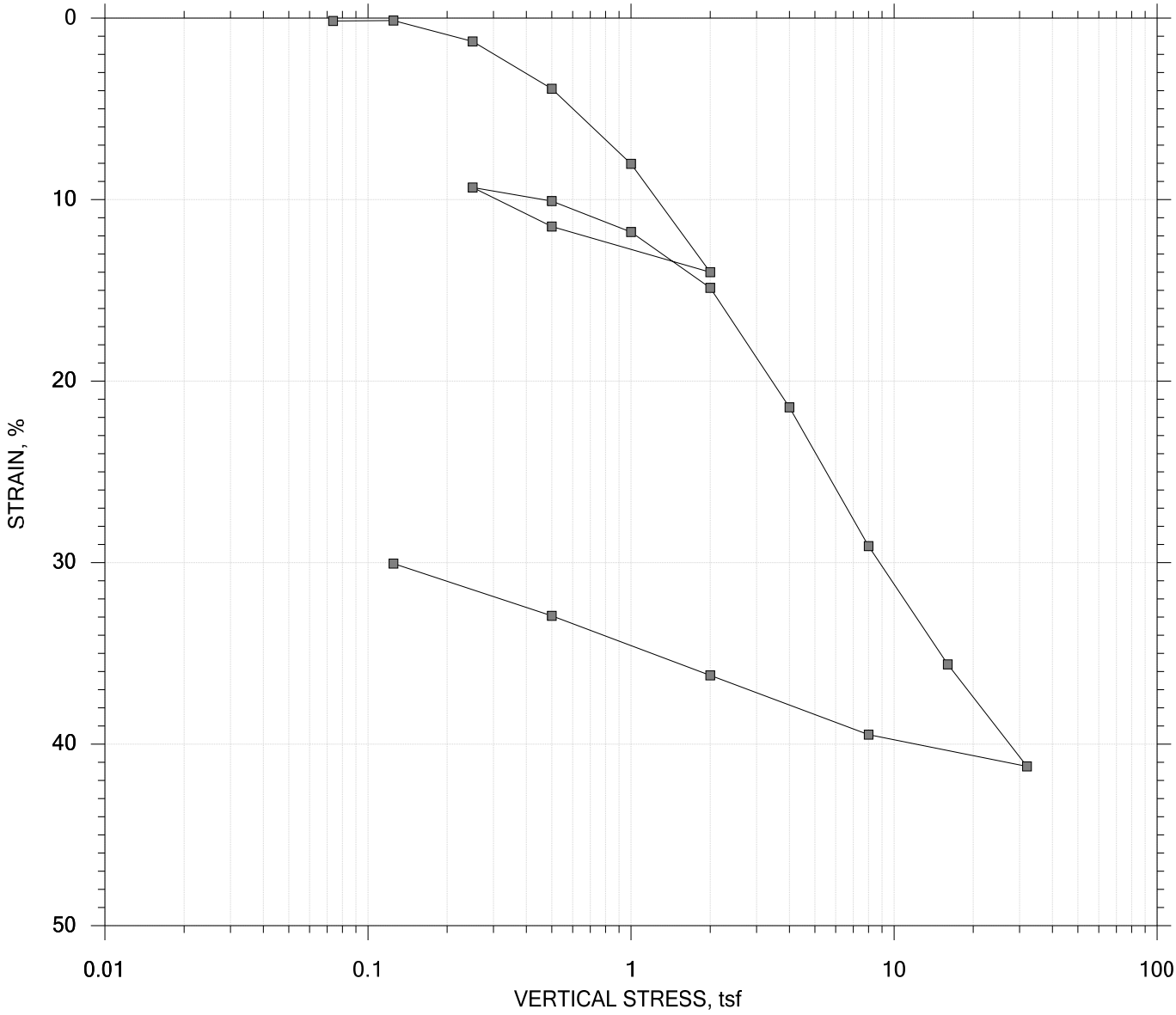




GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT



					Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	62.87	38.78
Preconsolidation Stress: ---				Dry Unit Weight, pcf	59.262	80.793
Compression Ratio: ---				Saturation, %	94.05	100.00
Diameter: 2.5 in		Height: 1 in		Void Ratio	1.74	1.01
LL: 84	PL: 30	PI: 54	GS: 2.60			

GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: Dynegy Hennepin West Ash Pond | Location: Hennepin, IL | Project No.: GTX-307445
Boring No.: GS-B04 | Tested By: jm | Checked By: mcm
Sample No.: 9 | Test Date: 12/18/17 | Depth: 33.5-35.5 f
Test No.: IP-3 | Sample Type: intact | Elevation: ---

Soil Description: Moist, very dark gray clay
Remarks: System 5077, Swell Pressure = 0.0737 tsf

Estimated Specific Gravity: 2.60 | Liquid Limit: 84 | Specimen Diameter: 2.50 in
Initial Void Ratio: 1.74 | Plastic Limit: 30 | Initial Height: 1.00 in
Final Void Ratio: 1.01 | Plasticity Index: 54 | Final Height: 0.73 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	pr9	RING	b24	b24
Wt. Container + Wet Soil, gm	125.80	185.61	167.21	167.21
Wt. Container + Dry Soil, gm	82.400	137.60	137.60	137.60
Wt. Container, gm	8.2100	61.240	61.240	61.240
Wt. Dry Soil, gm	74.190	76.360	76.360	76.360
Water Content, %	58.50	62.87	38.78	38.78
Void Ratio	---	1.74	1.01	---
Degree of Saturation, %	---	94.05	100.00	---
Dry Unit Weight, pcf	---	59.262	80.793	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: Dynegy Hennepin West Ash Pond | Location: Hennepin, IL | Project No.: GTX-307445
Boring No.: GS-B04 | Tested By: jm | Checked By: mcm
Sample No.: 9 | Test Date: 12/18/17 | Depth: 33.5-35.5 f
Test No.: IP-3 | Sample Type: intact | Elevation: ---

Soil Description: Moist, very dark gray clay
Remarks: System 5077, Swell Pressure = 0.0737 tsf

Displacement at End of Increment

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt T90 min	Cv ft²/sec	Mv 1/tsf	k cm/sec
1	0.0737	0.001569	1.73	0.157	205.651	1.19e-007	2.13e-002	2.41e-009
2	0.125	0.001364	1.73	0.136	36.943	6.62e-007	-3.99e-003	-2.51e-009
3	0.250	0.01283	1.70	1.28	43.700	5.54e-007	9.17e-002	4.83e-008
4	0.500	0.03891	1.63	3.89	21.292	1.09e-006	1.04e-001	1.09e-007
5	1.00	0.08025	1.52	8.03	25.514	8.51e-007	8.27e-002	6.69e-008
6	2.00	0.1399	1.35	14.0	54.714	3.55e-007	5.97e-002	2.02e-008
7	0.500	0.1148	1.42	11.5	46.049	4.06e-007	1.67e-002	6.46e-009
8	0.250	0.09333	1.48	9.33	174.826	1.13e-007	8.59e-002	9.21e-009
9	0.500	0.1008	1.46	10.1	19.128	1.05e-006	2.98e-002	2.97e-008
10	1.00	0.1178	1.41	11.8	54.290	3.59e-007	3.41e-002	1.16e-008
11	2.00	0.1486	1.33	14.9	57.935	3.18e-007	3.08e-002	9.32e-009
12	4.00	0.2144	1.15	21.4	78.021	2.11e-007	3.29e-002	6.59e-009
13	8.00	0.2909	0.941	29.1	89.182	1.54e-007	1.91e-002	2.80e-009
14	16.0	0.3560	0.762	35.6	97.753	1.15e-007	8.14e-003	8.90e-010
15	32.0	0.4123	0.608	41.2	98.618	9.44e-008	3.52e-003	3.16e-010
16	8.00	0.3948	0.656	39.5	56.715	1.54e-007	7.30e-004	1.07e-010
17	2.00	0.3621	0.746	36.2	219.793	4.31e-008	5.44e-003	2.23e-010
18	0.500	0.3293	0.836	32.9	180.878	5.81e-008	2.19e-002	1.21e-009
19	0.125	0.3005	0.914	30.0	0.000	0.00e+000	7.69e-002	0.00e+000

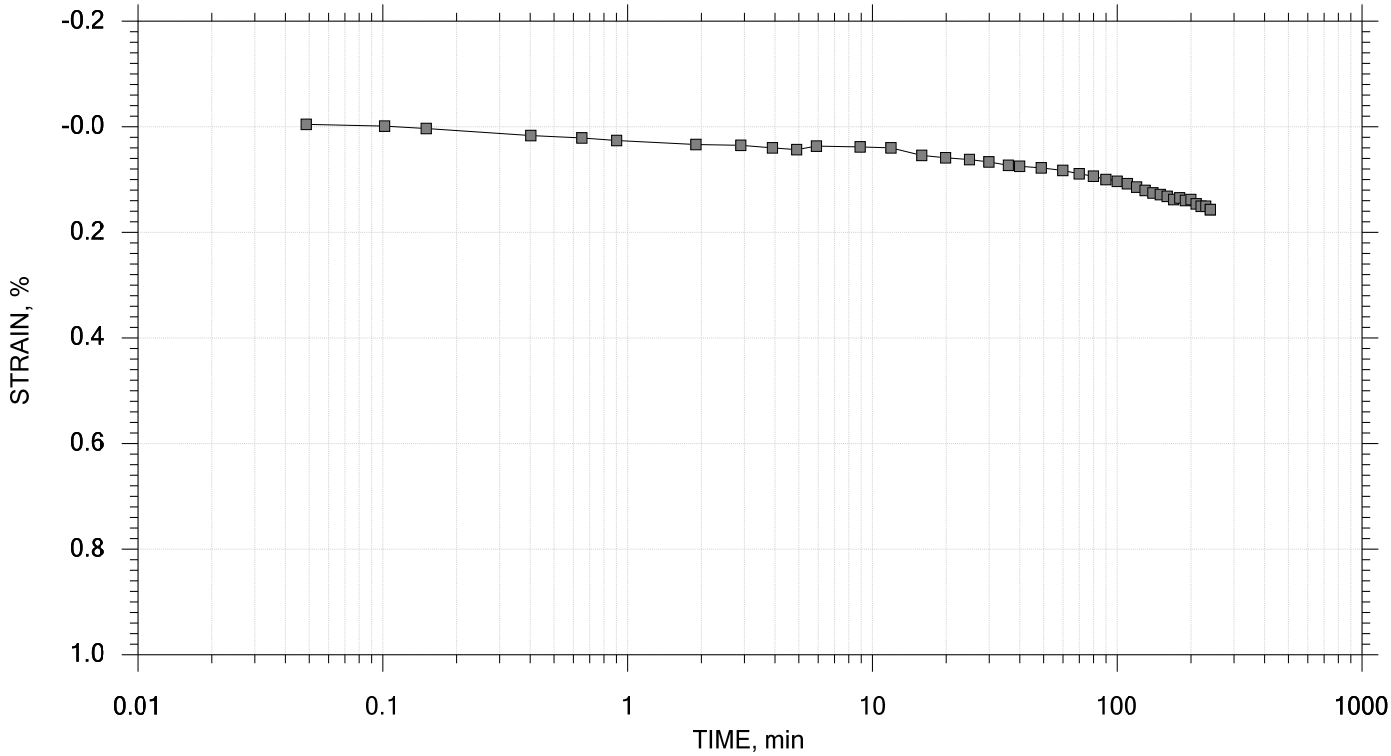
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/sec	Mv 1/tsf	k cm/sec	Ca %
1	0.0737	0.001569	1.73	0.157	0.000	0.00e+000	2.13e-002	0.00e+000	0.00e+000
2	0.125	0.001364	1.73	0.136	0.000	0.00e+000	-3.99e-003	-0.00e+000	0.00e+000
3	0.250	0.01283	1.70	1.28	11.298	4.97e-007	9.17e-002	4.34e-008	0.00e+000
4	0.500	0.03891	1.63	3.89	0.000	0.00e+000	1.04e-001	0.00e+000	0.00e+000
5	1.00	0.08025	1.52	8.03	0.000	0.00e+000	8.27e-002	0.00e+000	0.00e+000
6	2.00	0.1399	1.35	14.0	16.558	2.73e-007	5.97e-002	1.55e-008	0.00e+000
7	0.500	0.1148	1.42	11.5	0.000	0.00e+000	1.67e-002	0.00e+000	0.00e+000
8	0.250	0.09333	1.48	9.33	40.700	1.12e-007	8.59e-002	9.19e-009	0.00e+000
9	0.500	0.1008	1.46	10.1	0.000	0.00e+000	2.98e-002	0.00e+000	0.00e+000
10	1.00	0.1178	1.41	11.8	14.120	3.20e-007	3.41e-002	1.04e-008	0.00e+000
11	2.00	0.1486	1.33	14.9	12.000	3.57e-007	3.08e-002	1.05e-008	0.00e+000
12	4.00	0.2144	1.15	21.4	21.945	1.74e-007	3.29e-002	5.44e-009	0.00e+000
13	8.00	0.2909	0.941	29.1	22.819	1.40e-007	1.91e-002	2.54e-009	0.00e+000
14	16.0	0.3560	0.762	35.6	23.331	1.12e-007	8.14e-003	8.66e-010	0.00e+000
15	32.0	0.4123	0.608	41.2	23.372	9.25e-008	3.52e-003	3.09e-010	0.00e+000
16	8.00	0.3948	0.656	39.5	13.711	1.48e-007	7.30e-004	1.03e-010	0.00e+000
17	2.00	0.3621	0.746	36.2	0.000	0.00e+000	5.44e-003	0.00e+000	0.00e+000
18	0.500	0.3293	0.836	32.9	0.000	0.00e+000	2.19e-002	0.00e+000	0.00e+000
19	0.125	0.3005	0.914	30.0	0.000	0.00e+000	7.69e-002	0.00e+000	0.00e+000

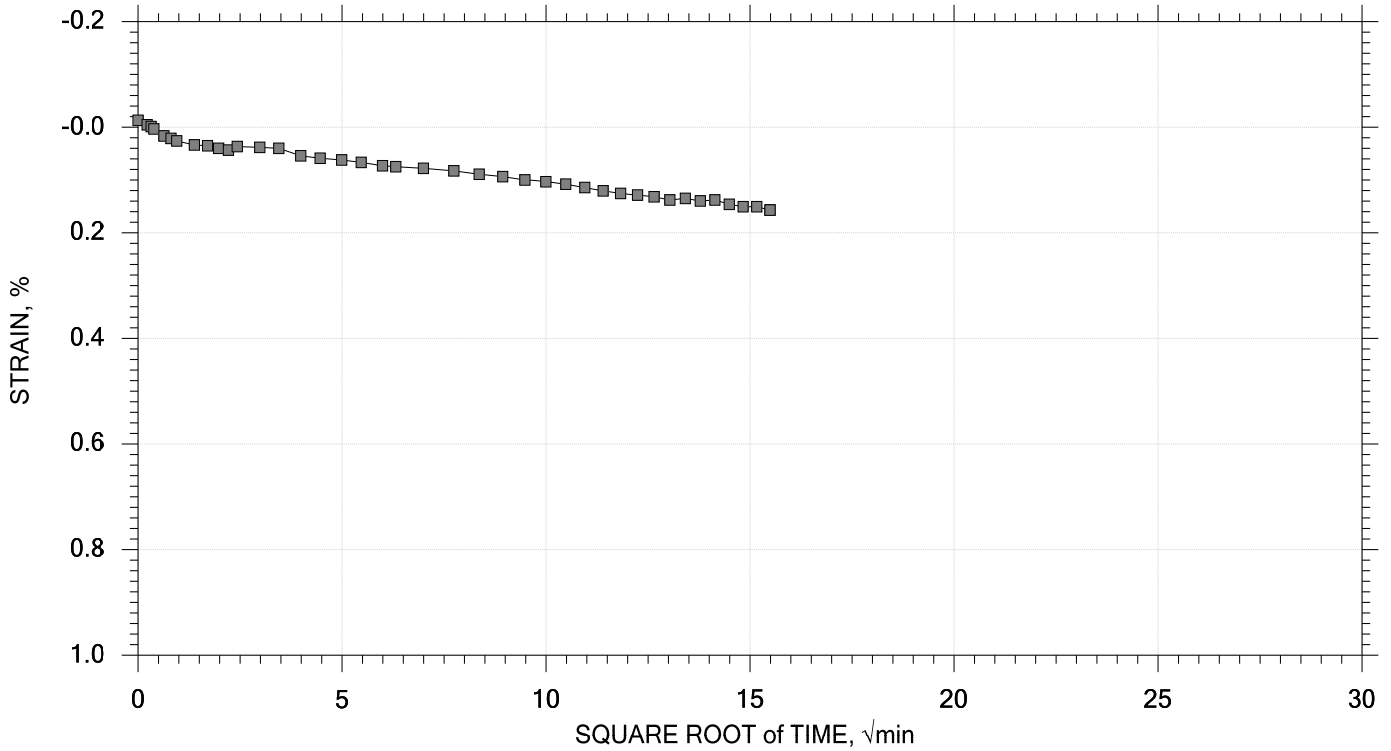
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Volume Step 1 of 19

Stress: 0.073692 tsf





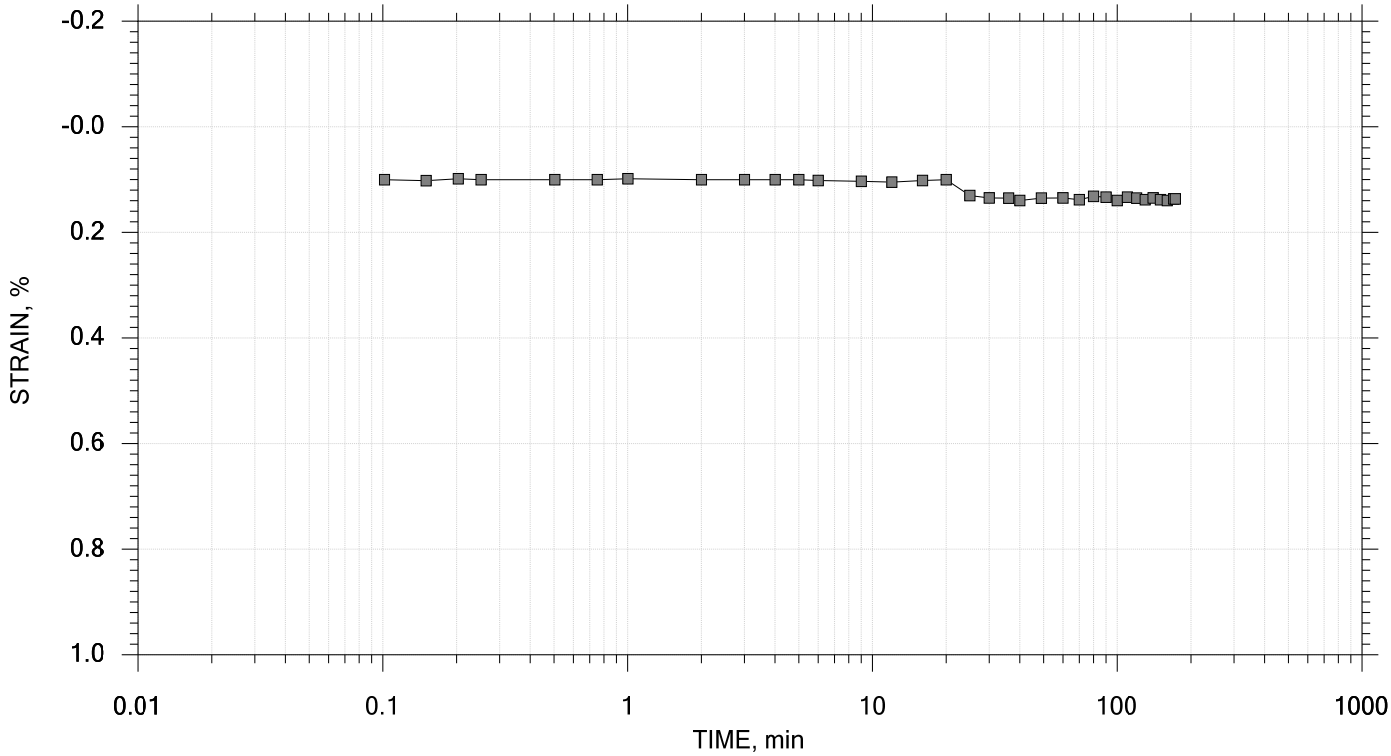
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

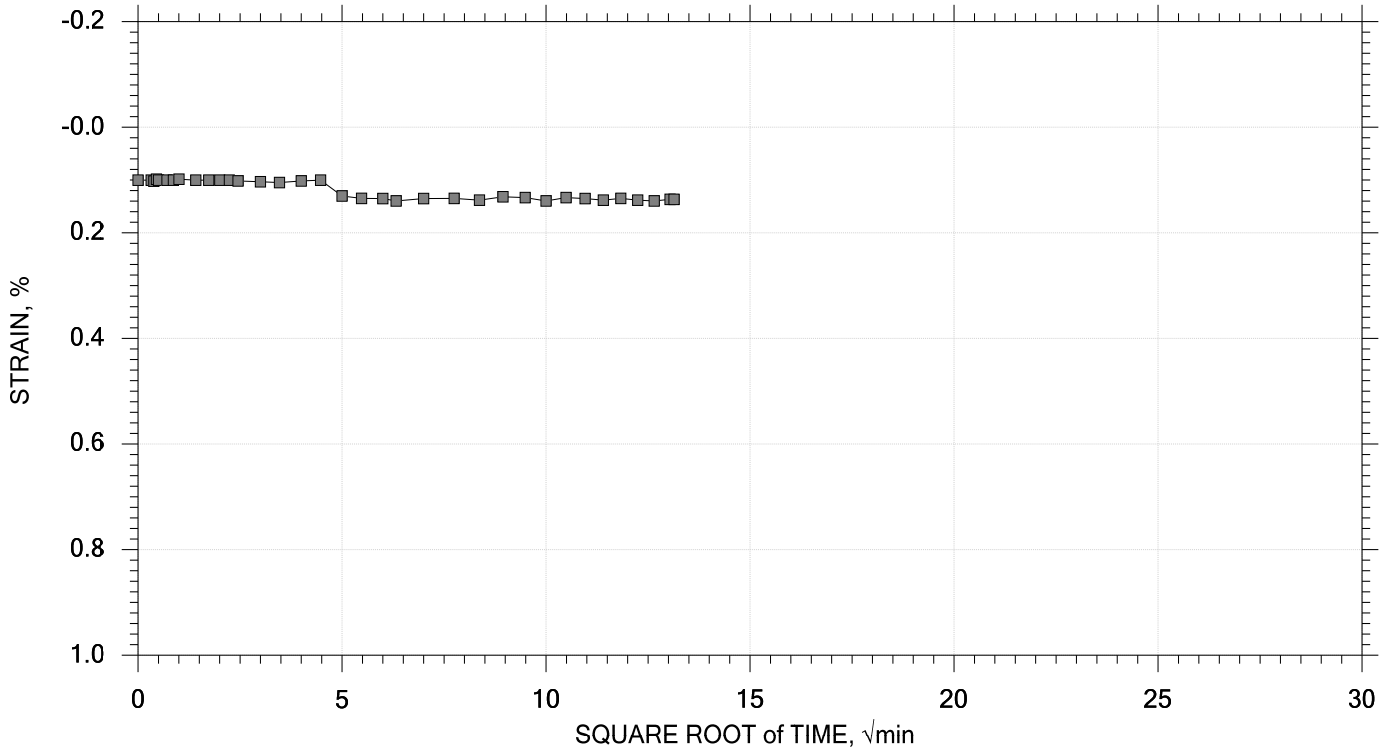
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 2 of 19

Stress: 0.125 tsf





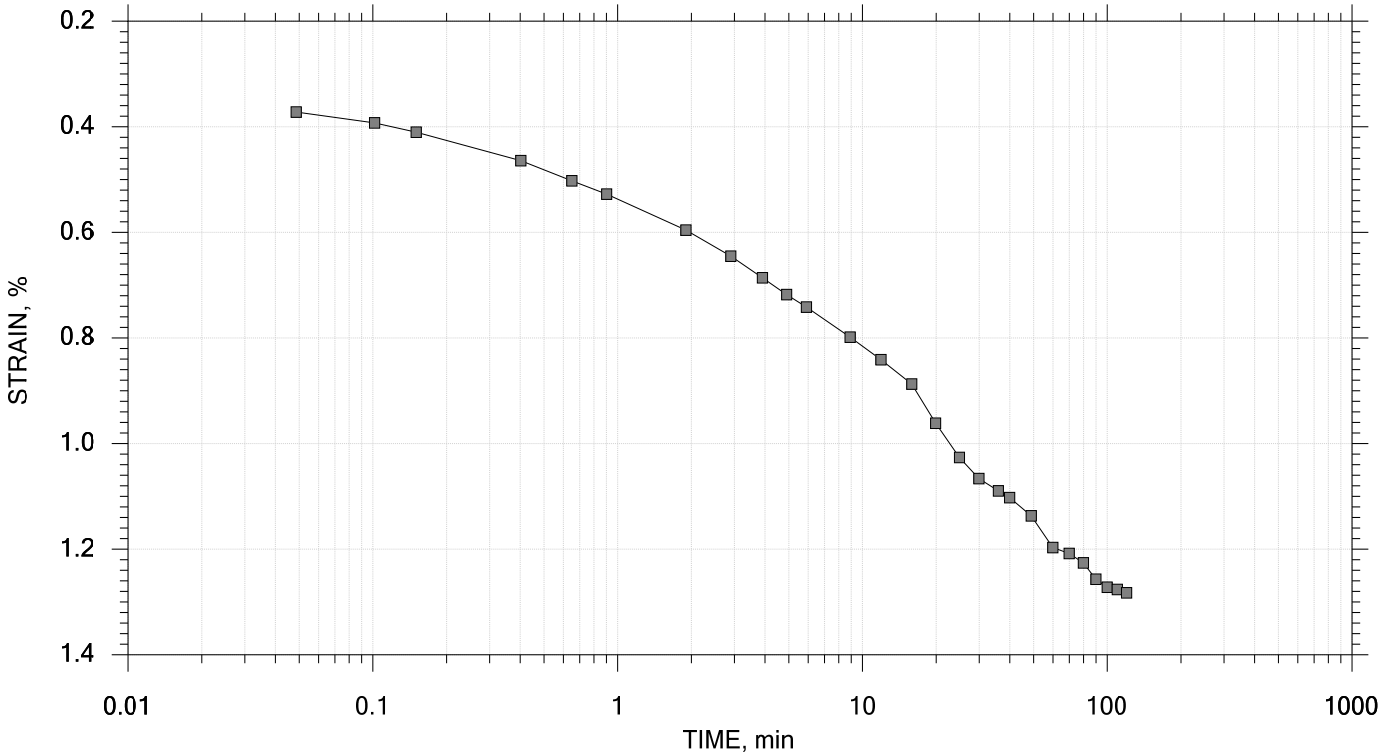
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

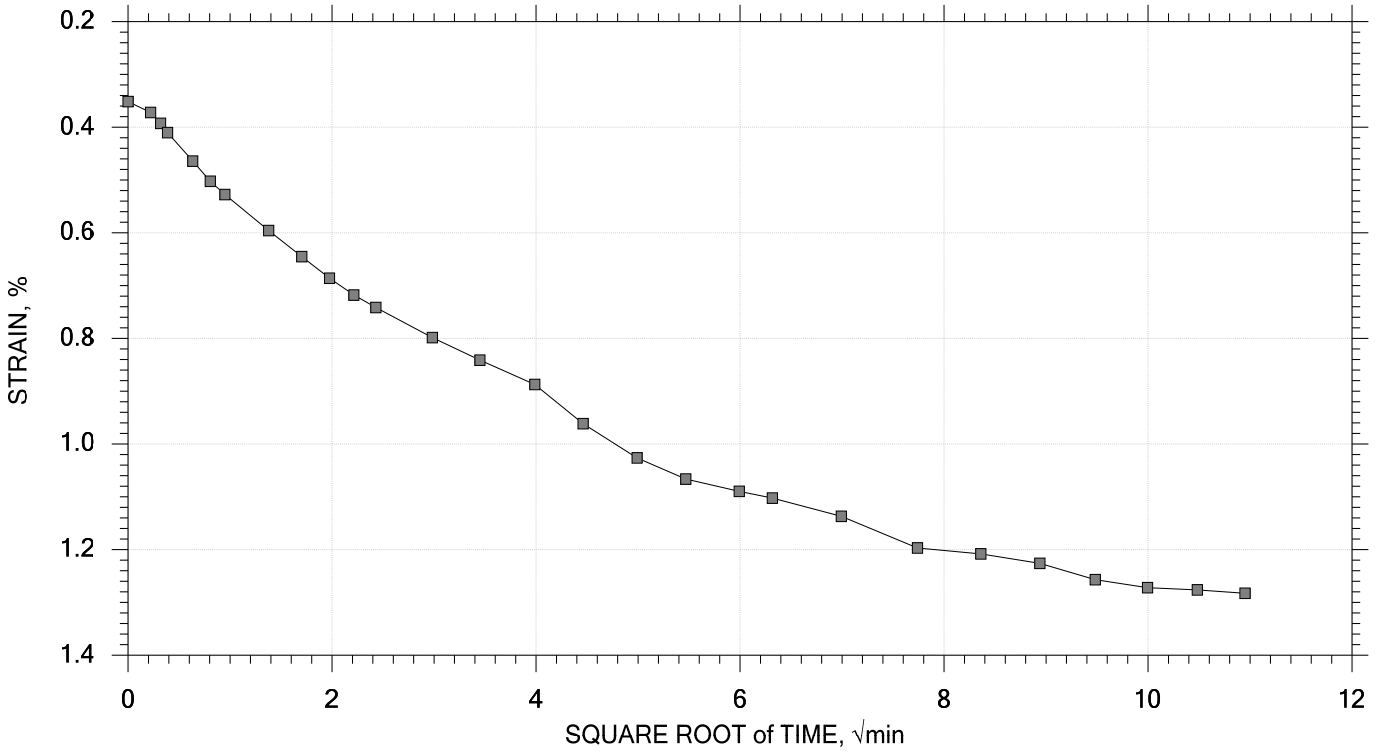
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 3 of 19

Stress: 0.25 tsf





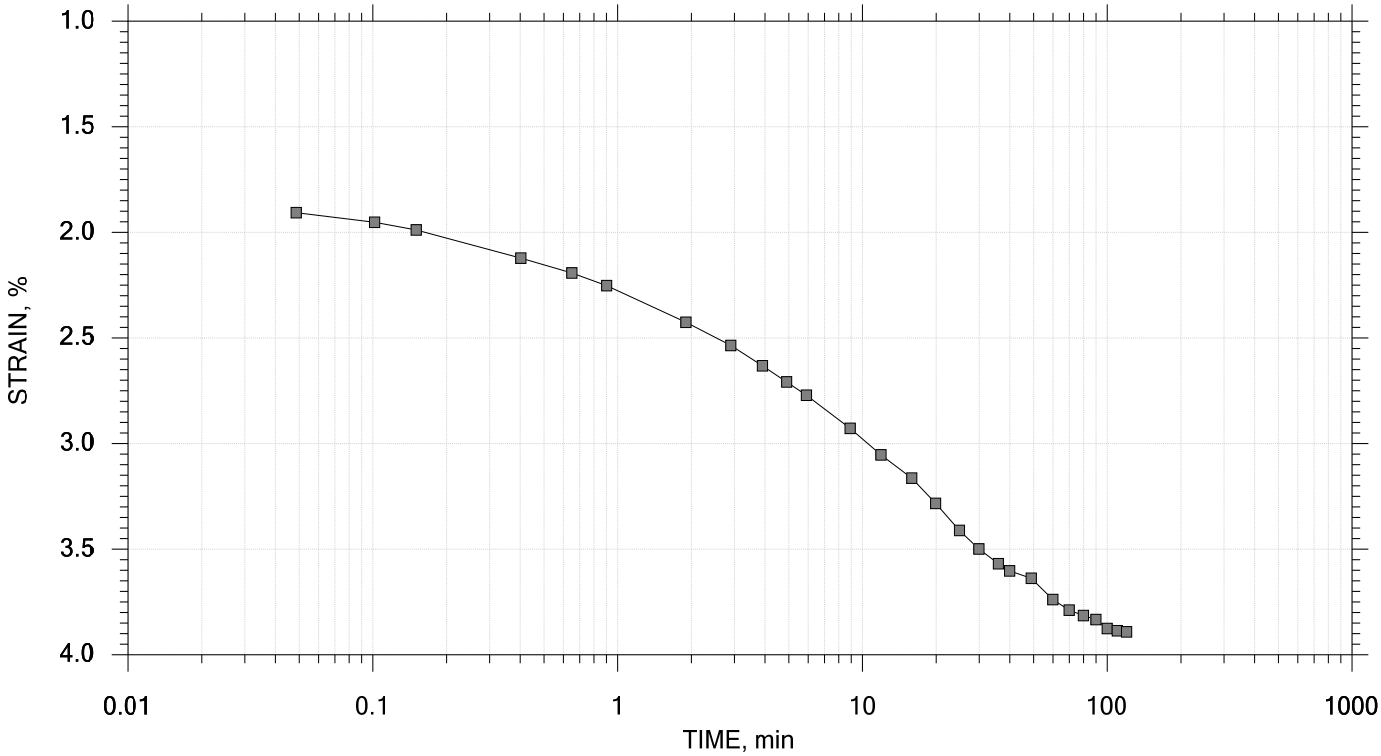
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

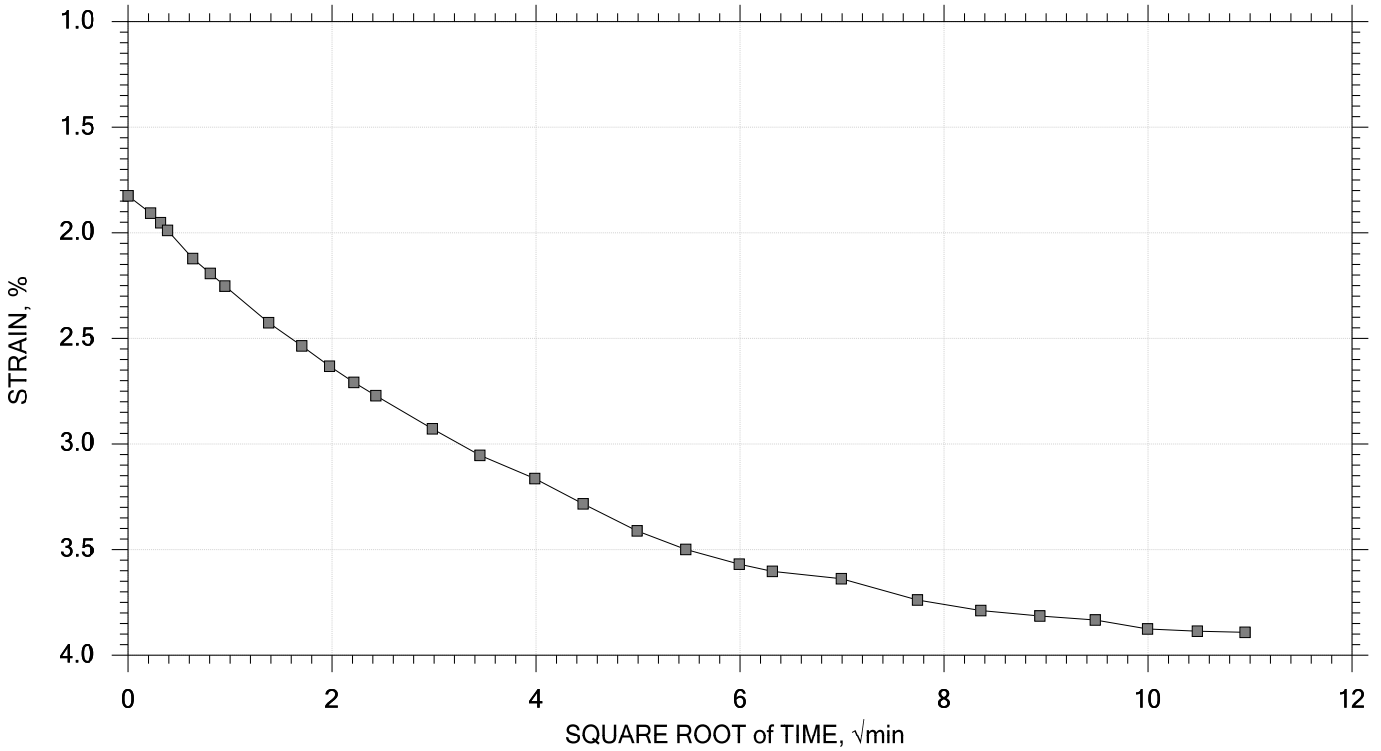
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 4 of 19

Stress: 0.5 tsf





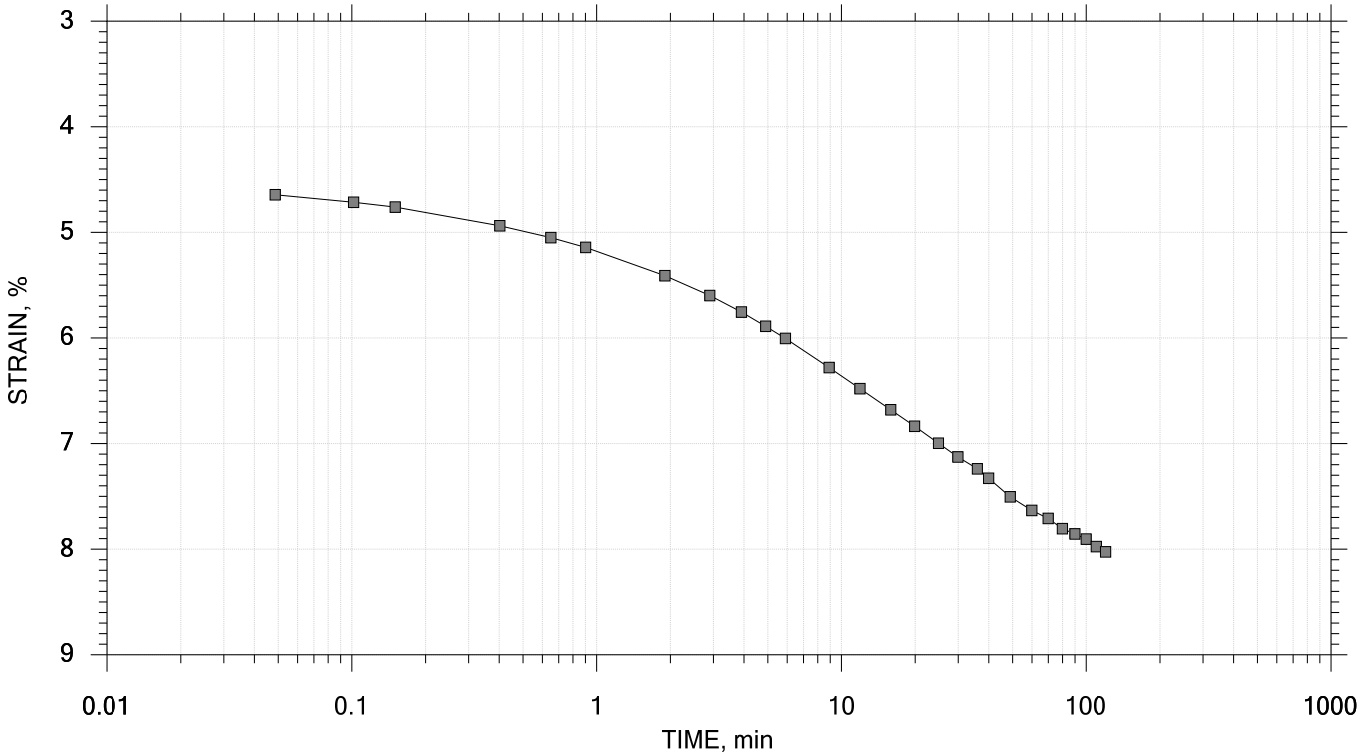
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

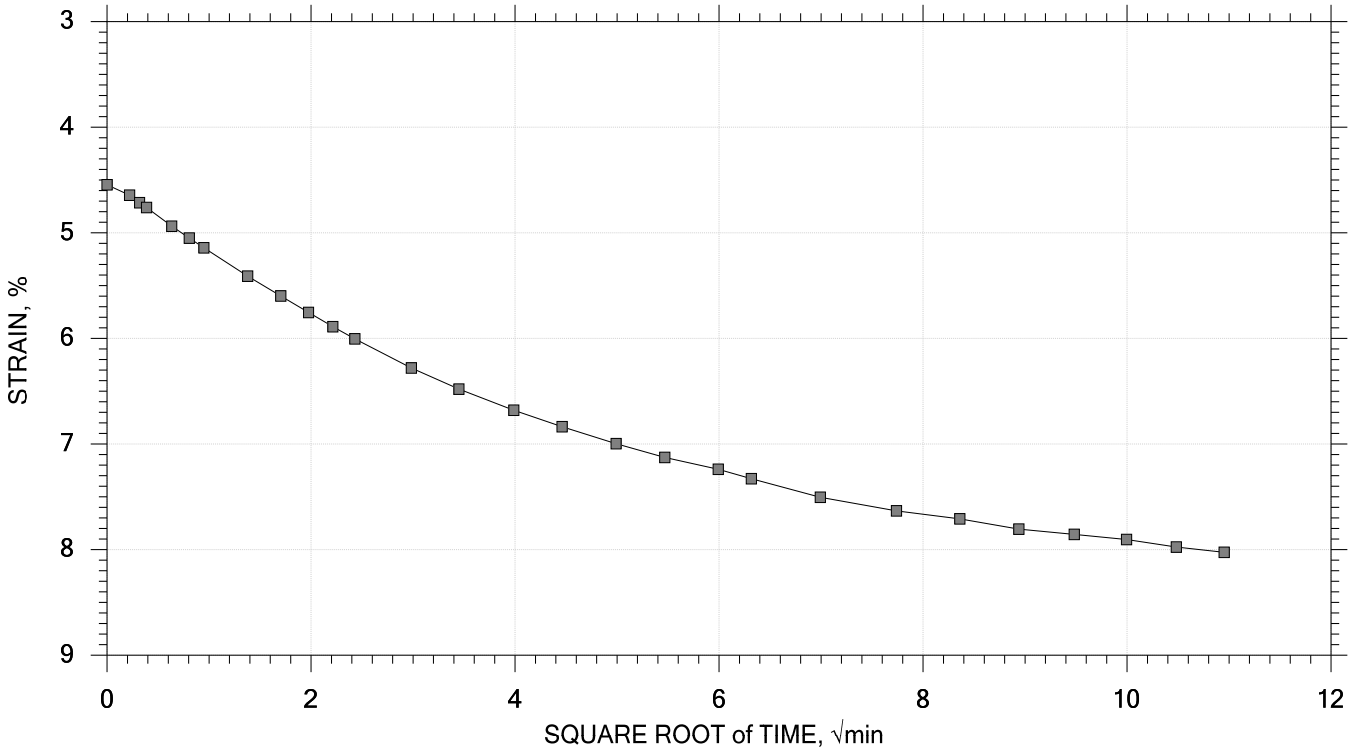
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 5 of 19

Stress: 1 tsf





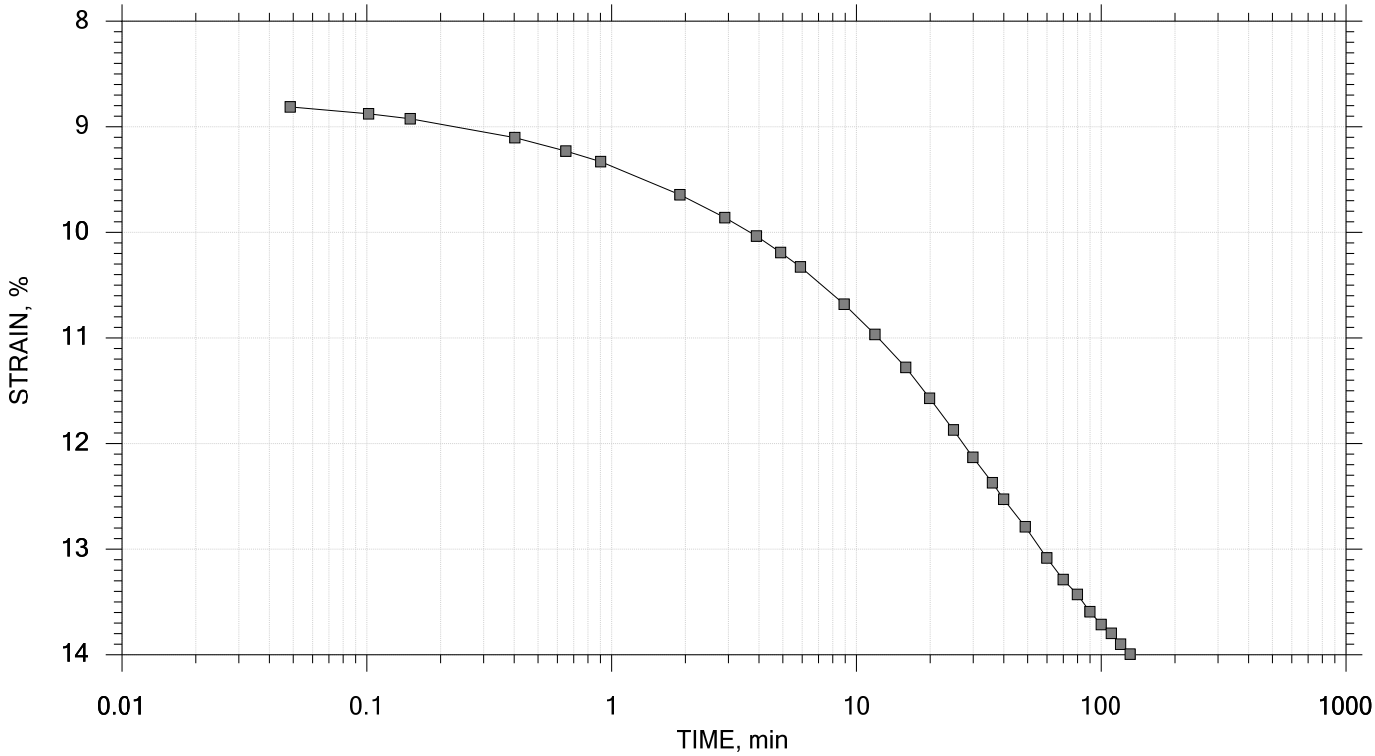
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

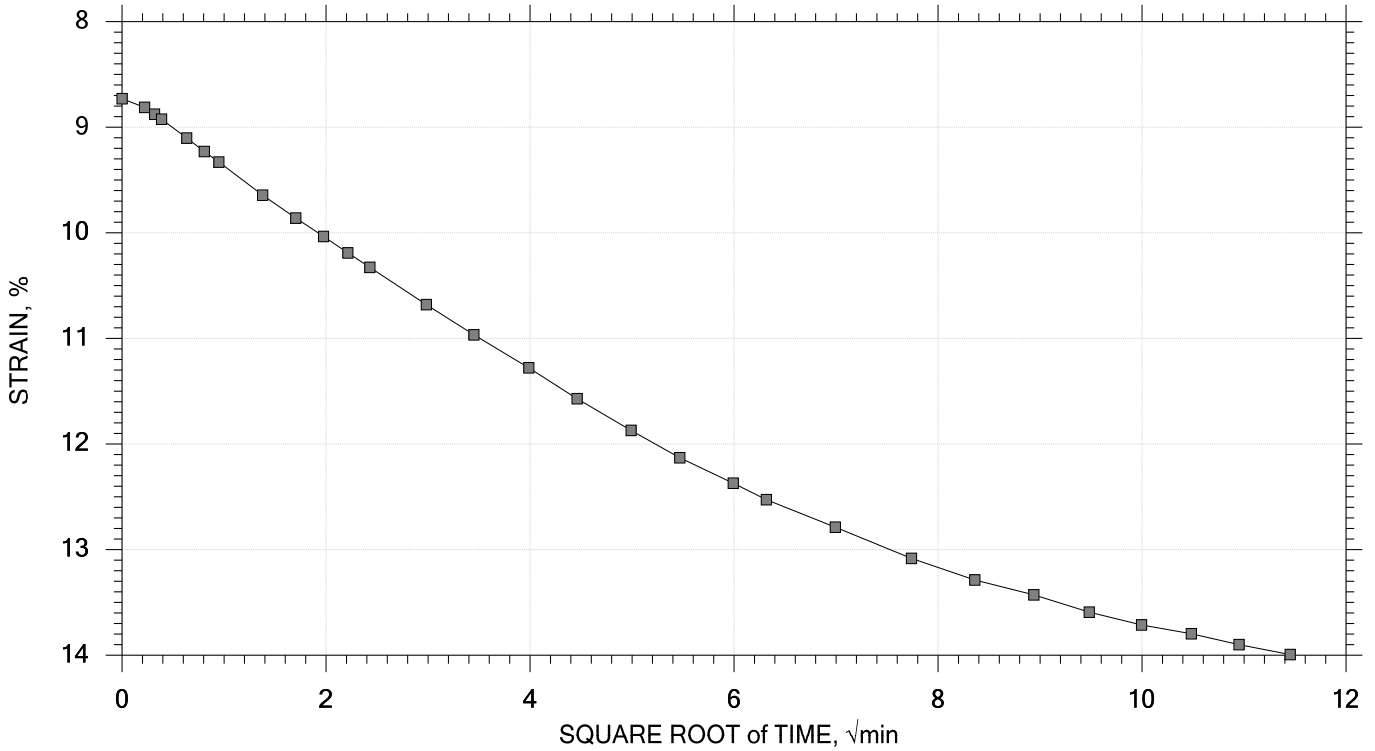
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 6 of 19

Stress: 2 tsf





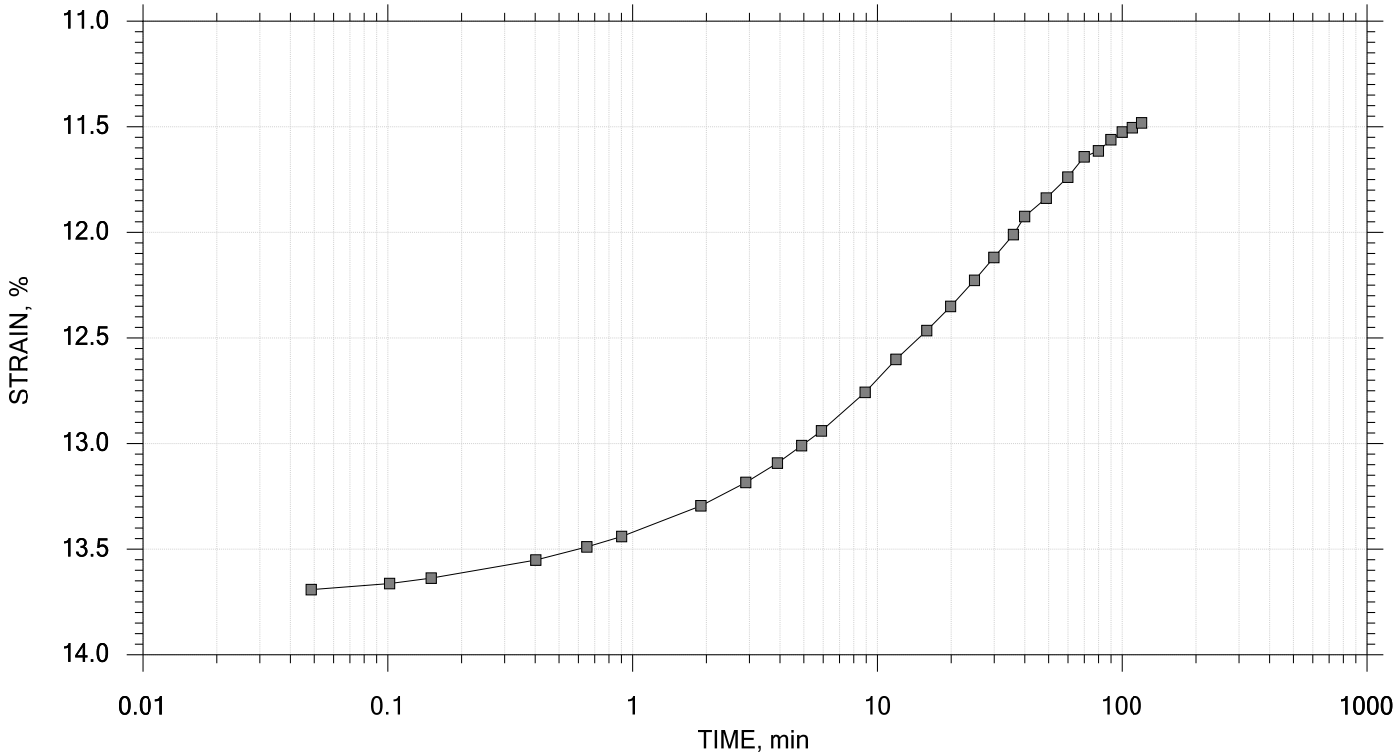
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

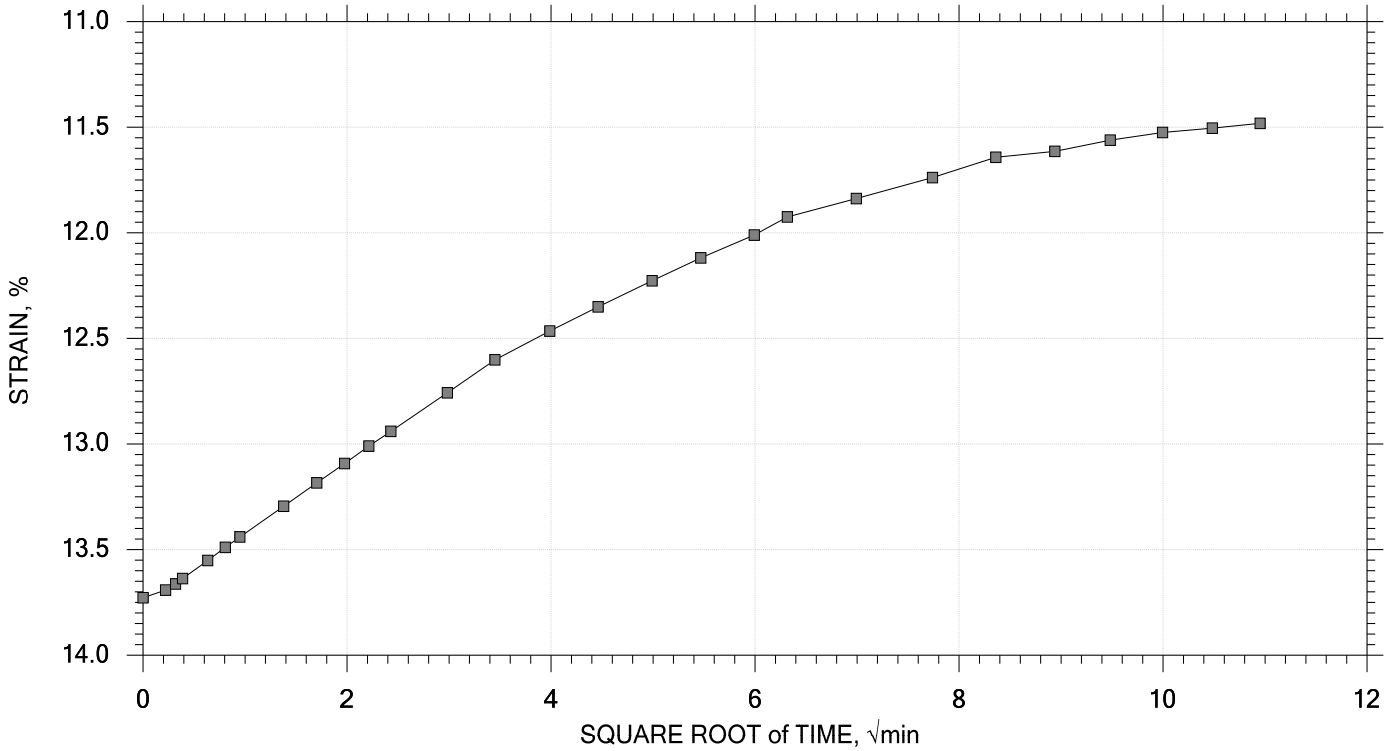
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 7 of 19

Stress: 0.5 tsf





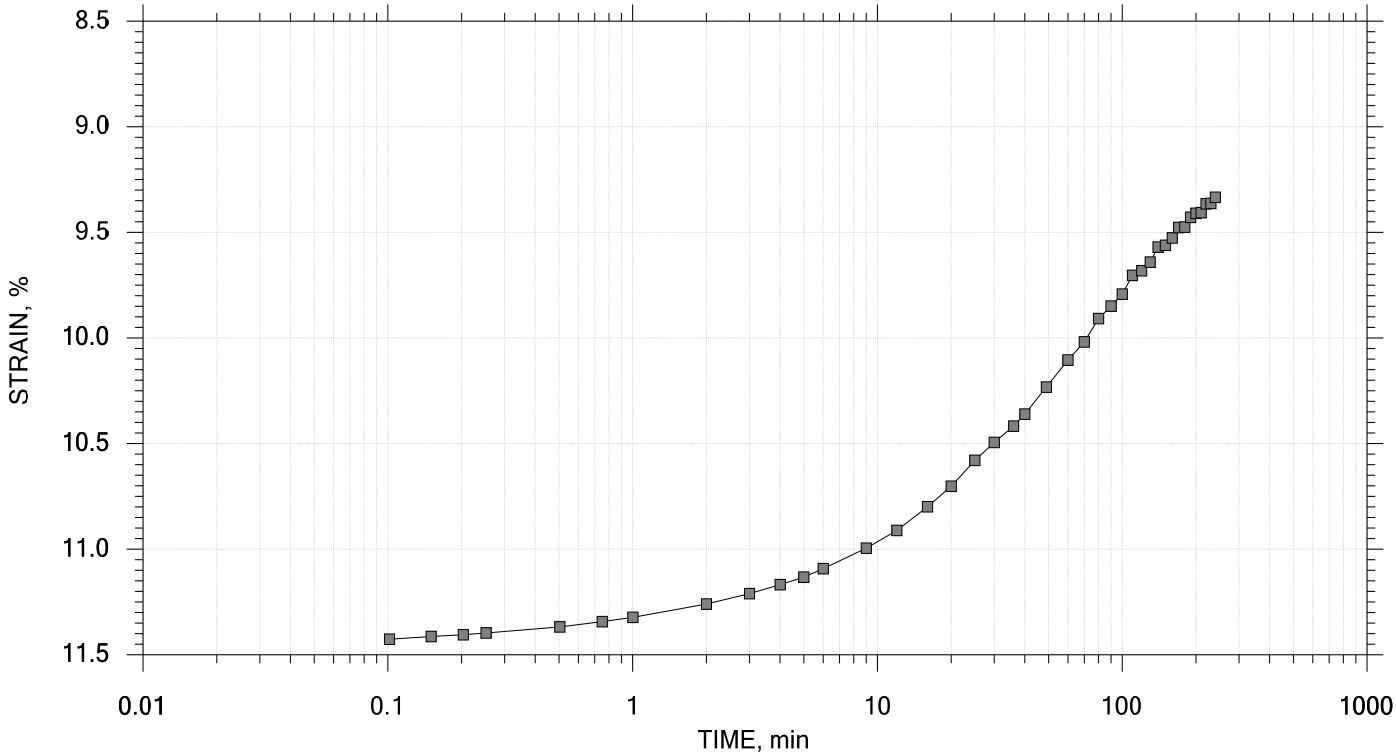
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

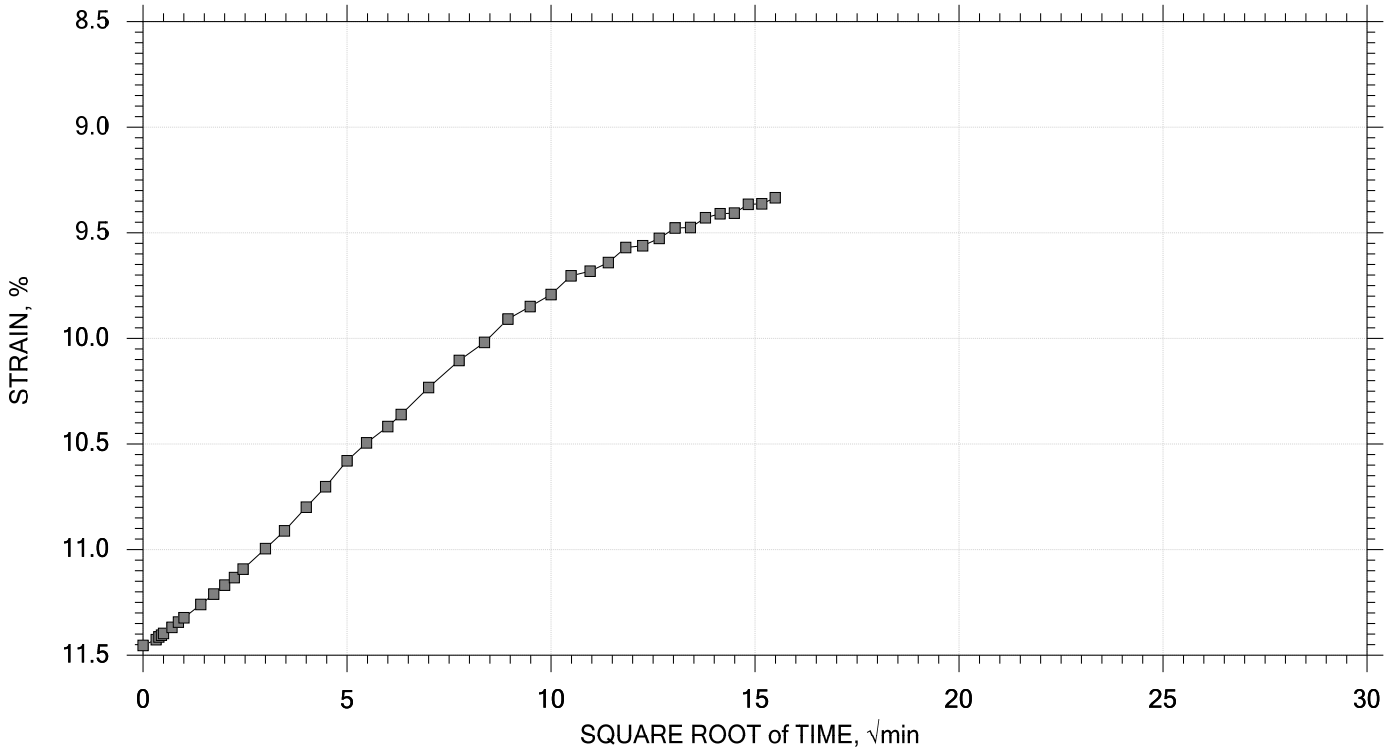
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 8 of 19

Stress: 0.25 tsf





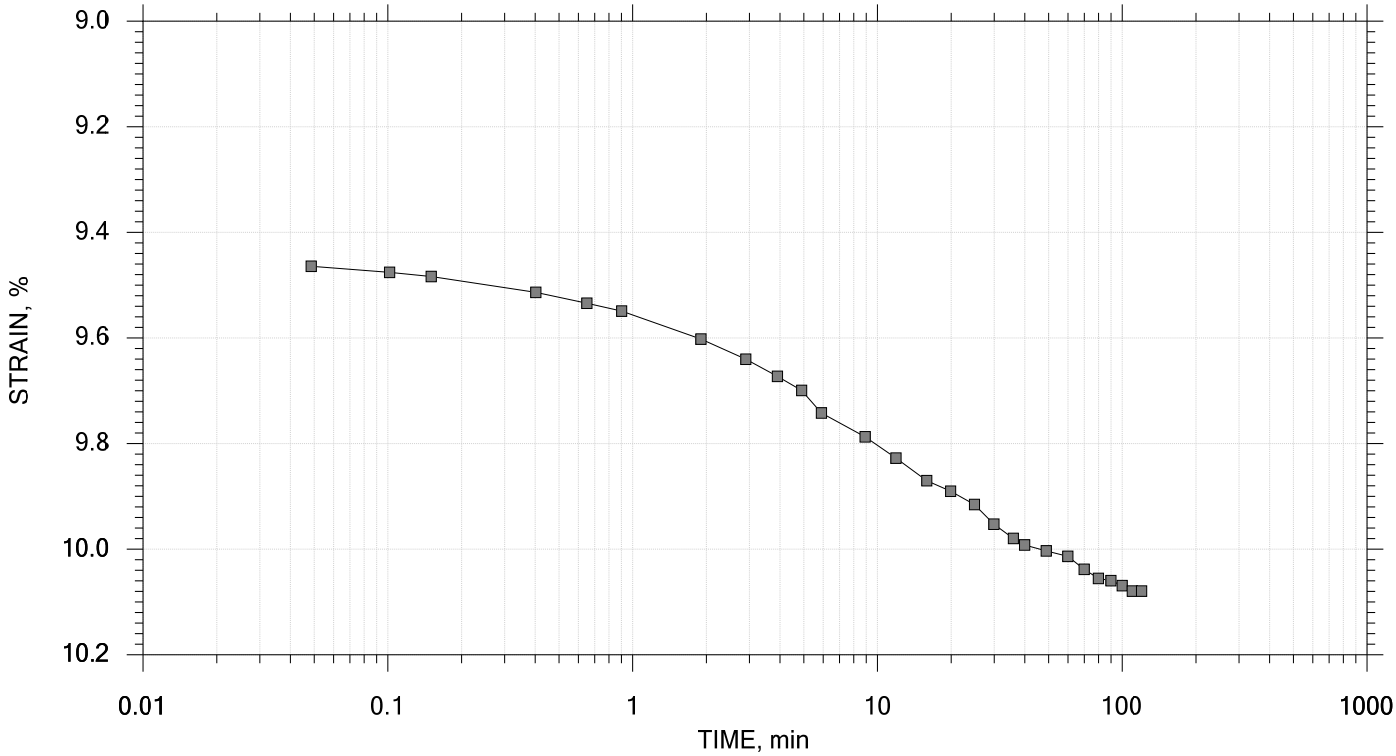
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

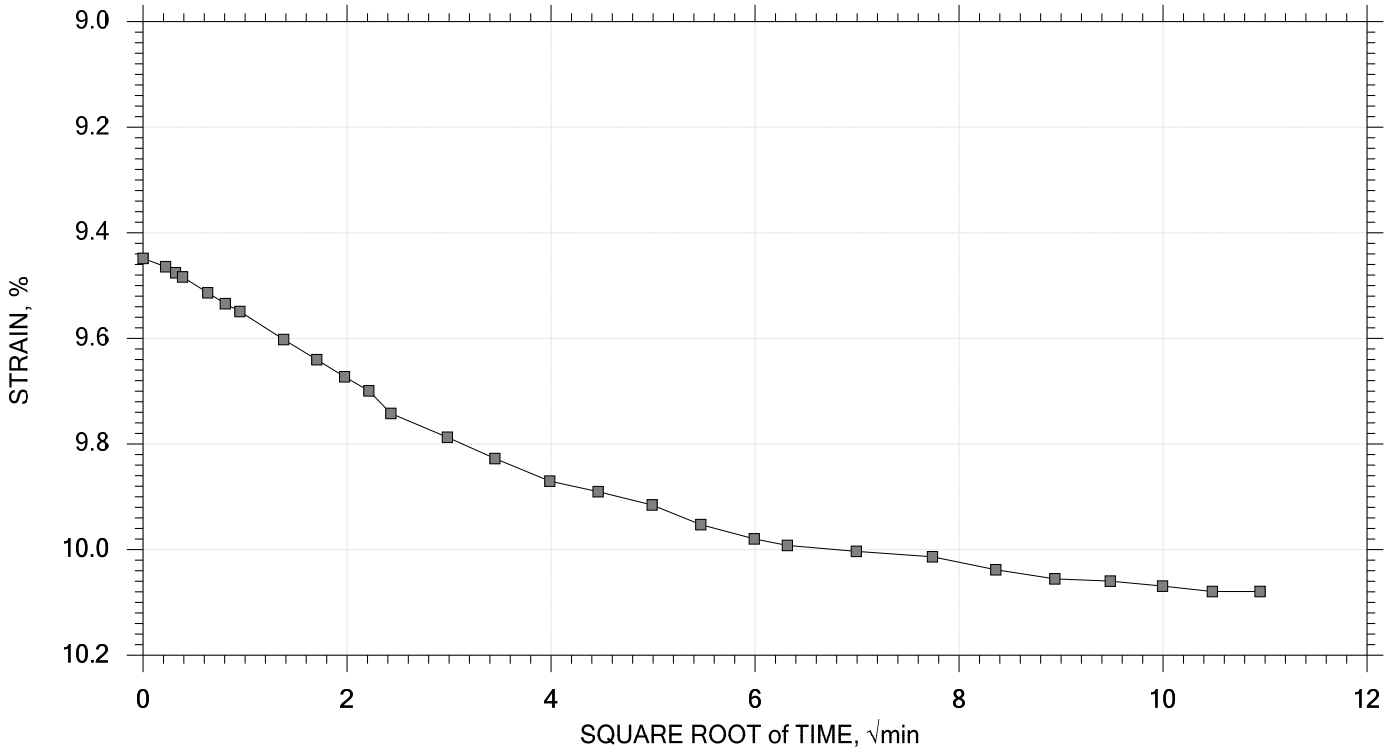
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 9 of 19

Stress: 0.5 tsf





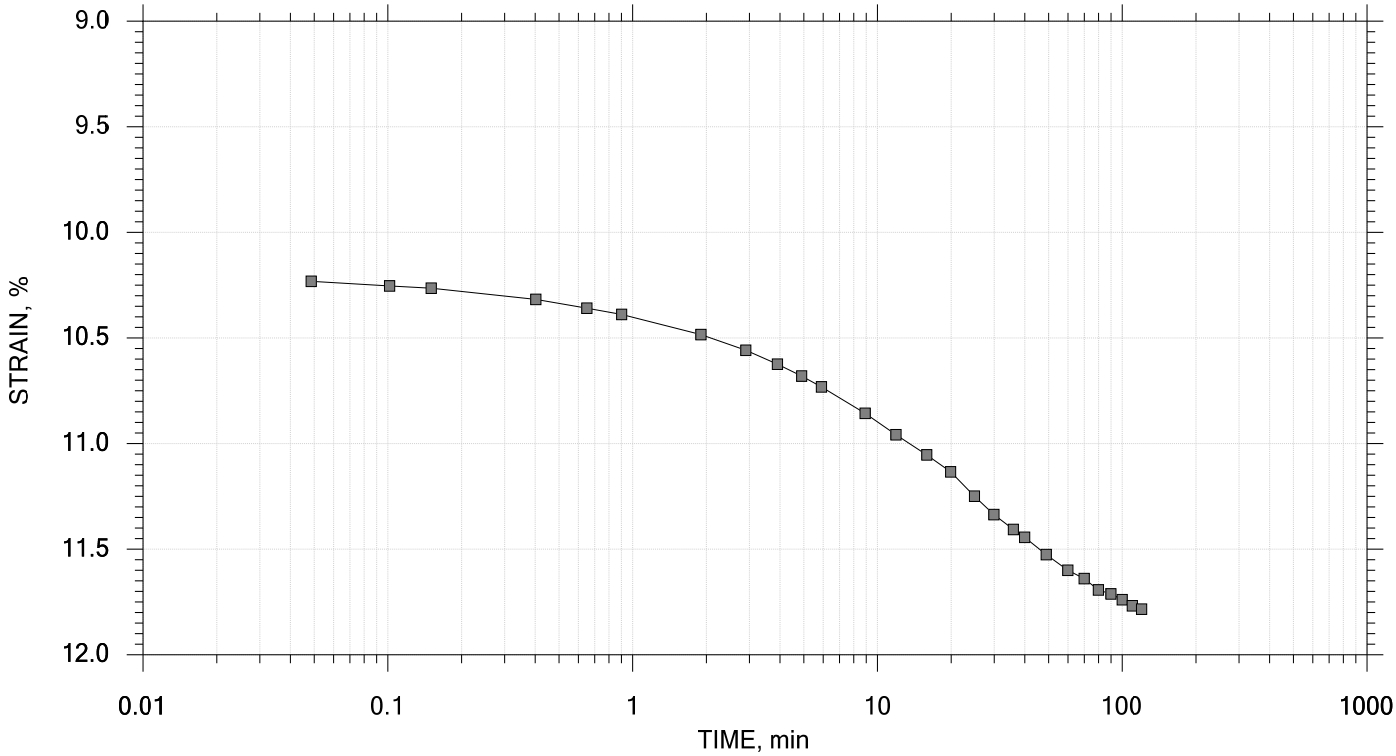
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

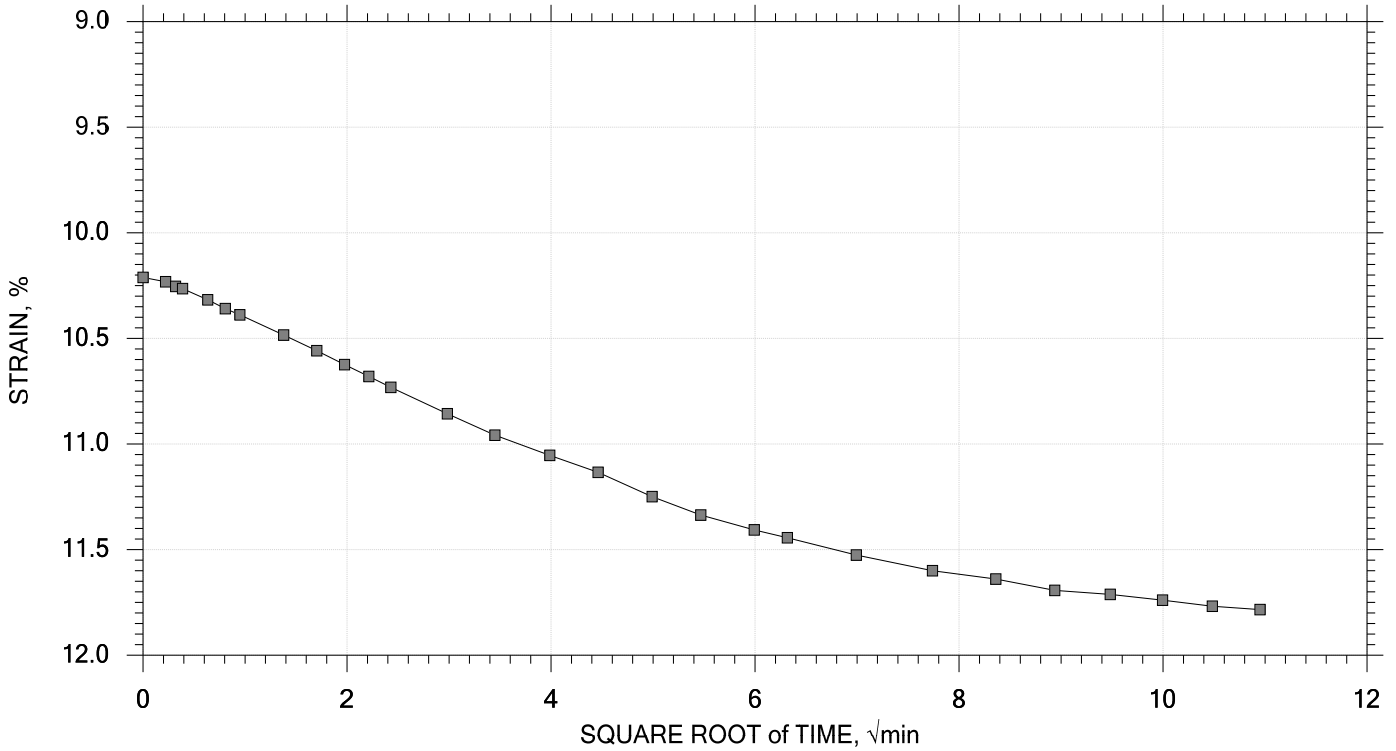
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 10 of 19

Stress: 1 tsf





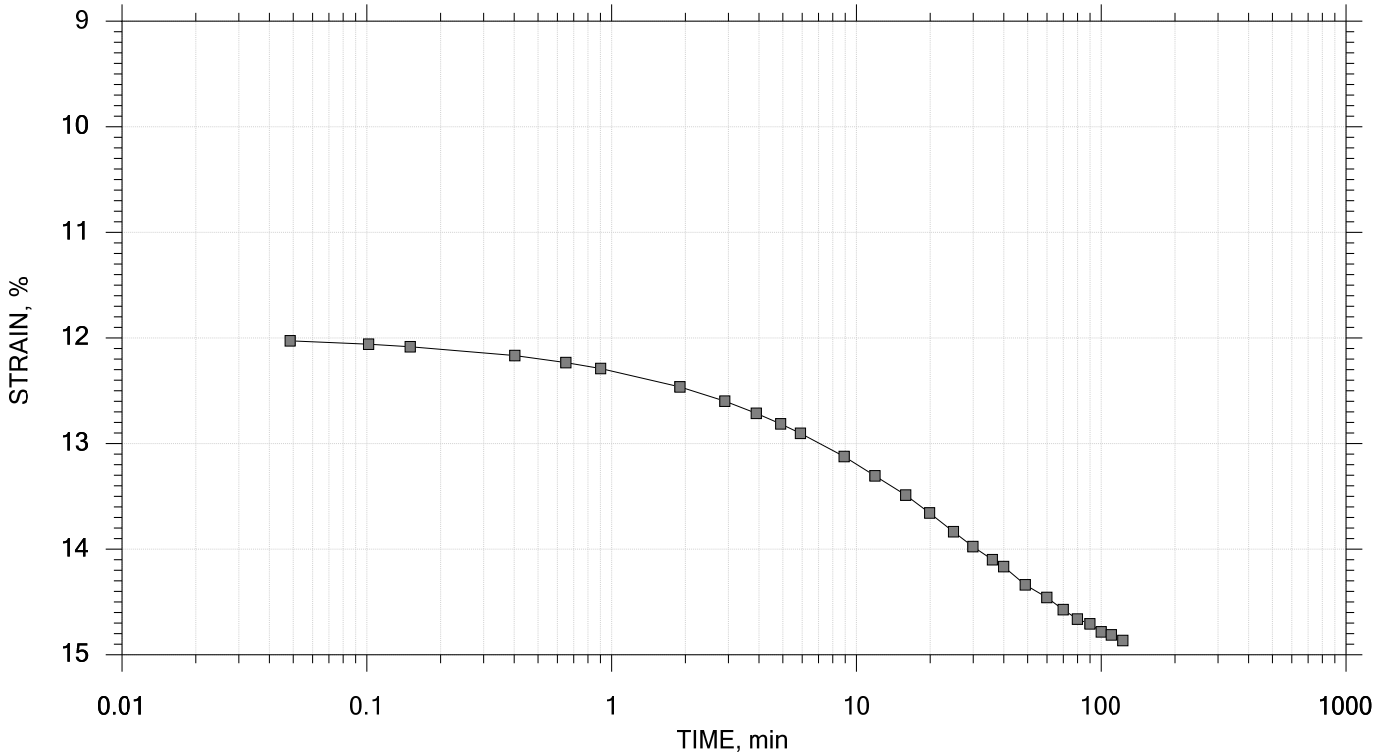
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

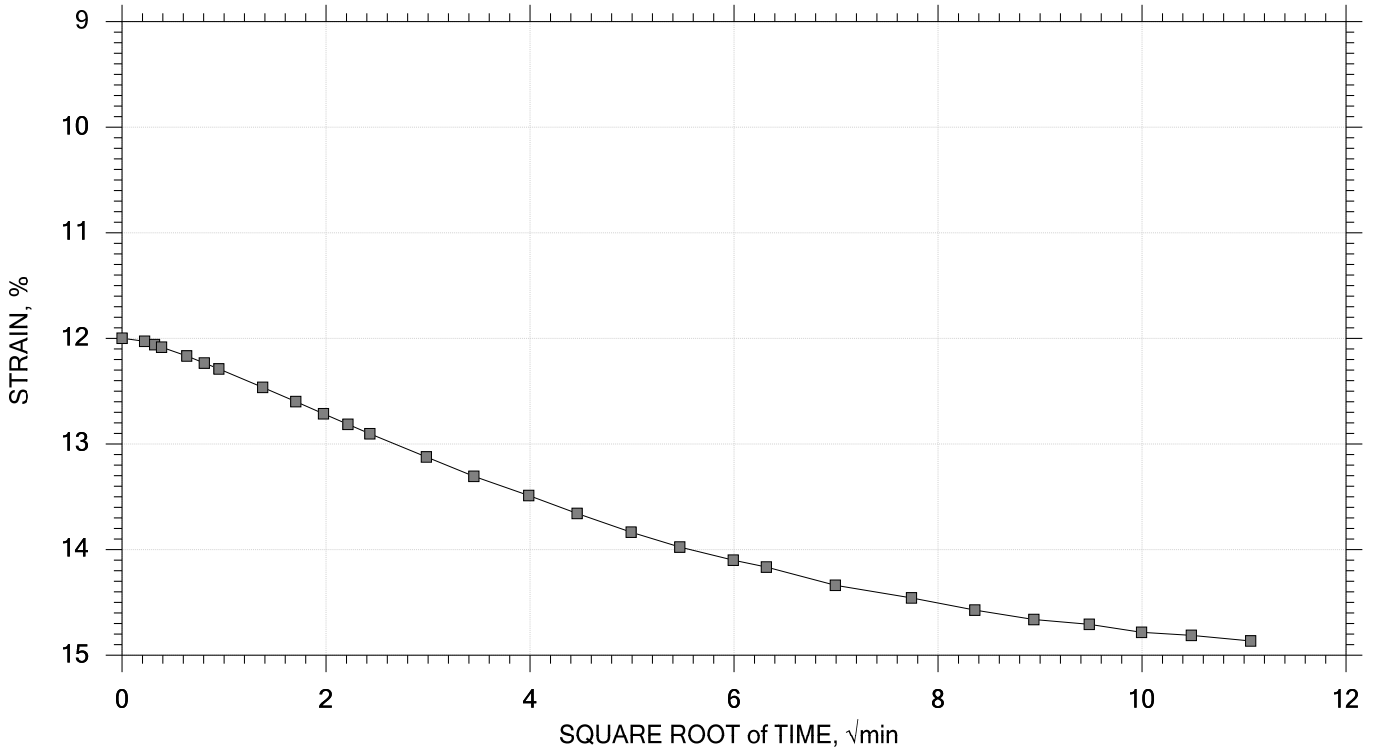
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 11 of 19

Stress: 2 tsf





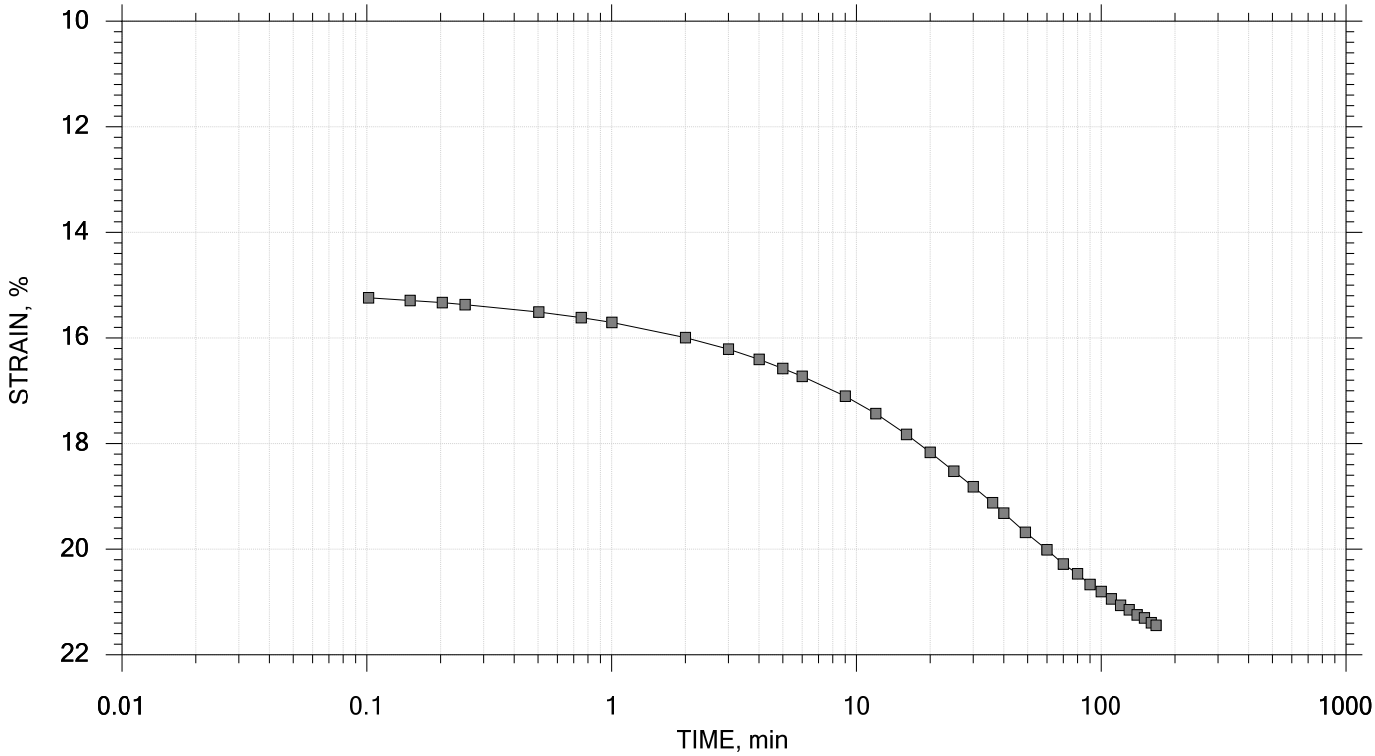
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

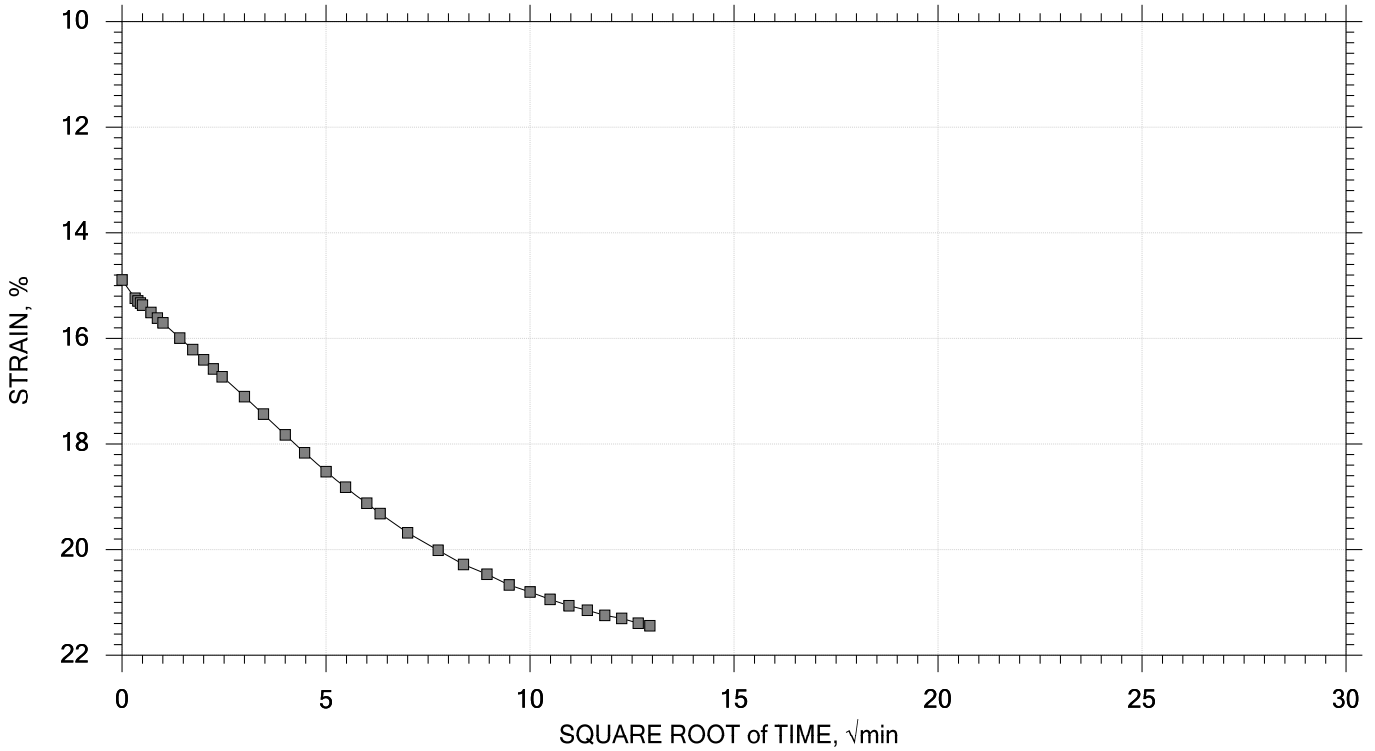
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 12 of 19

Stress: 4 tsf





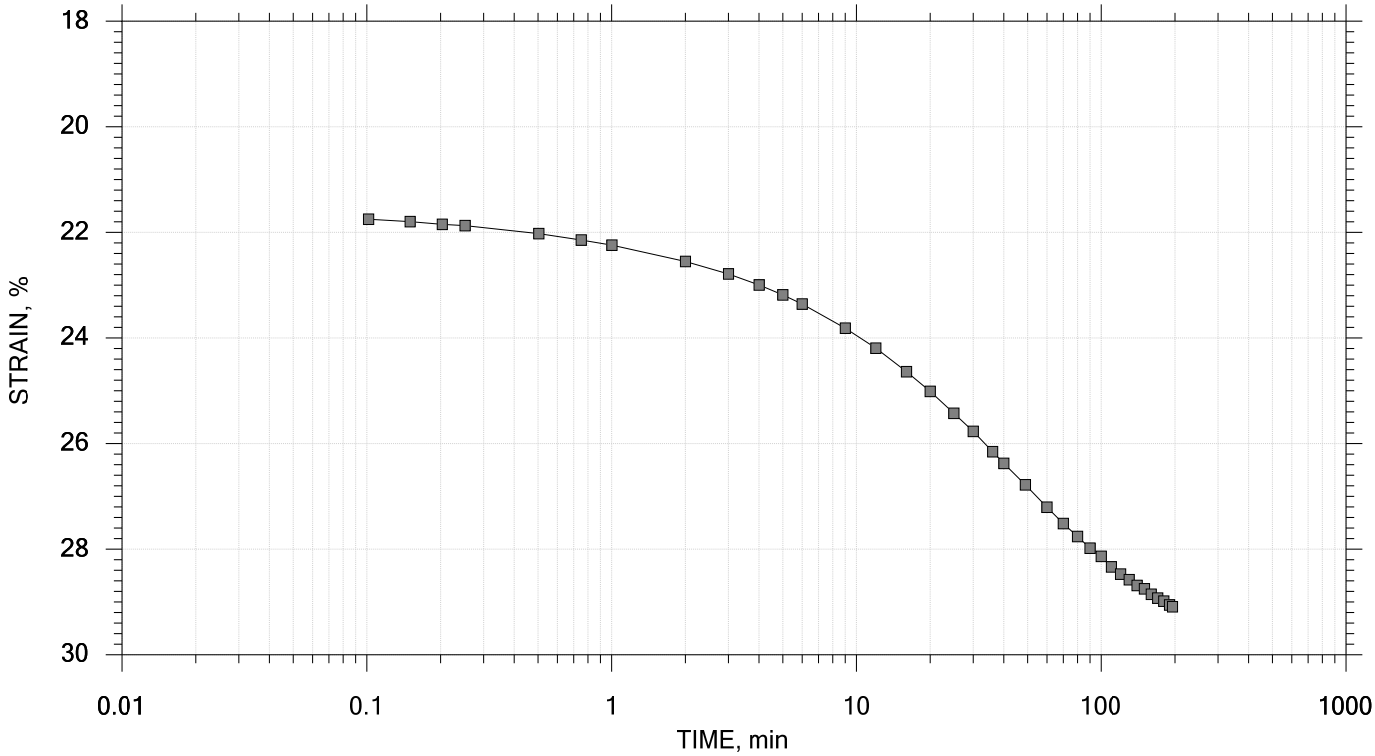
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

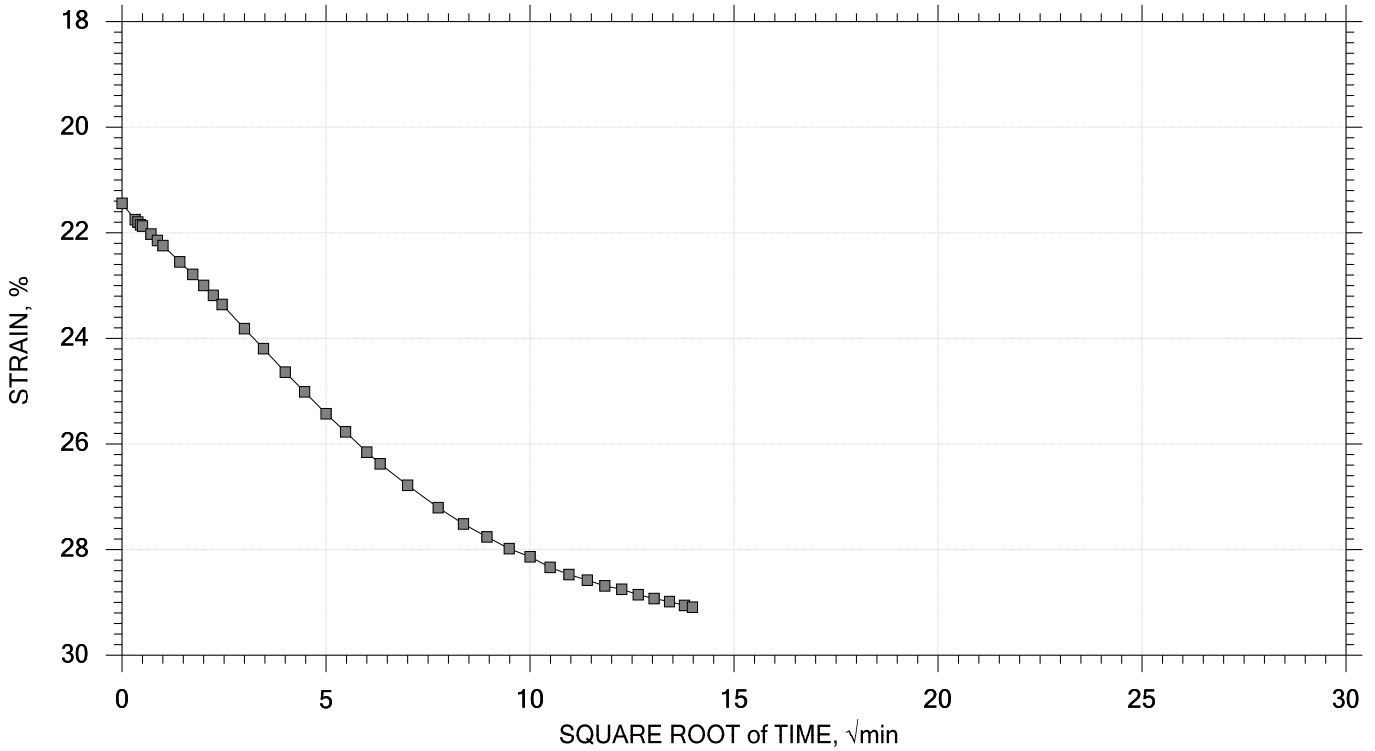
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 13 of 19

Stress: 8 tsf





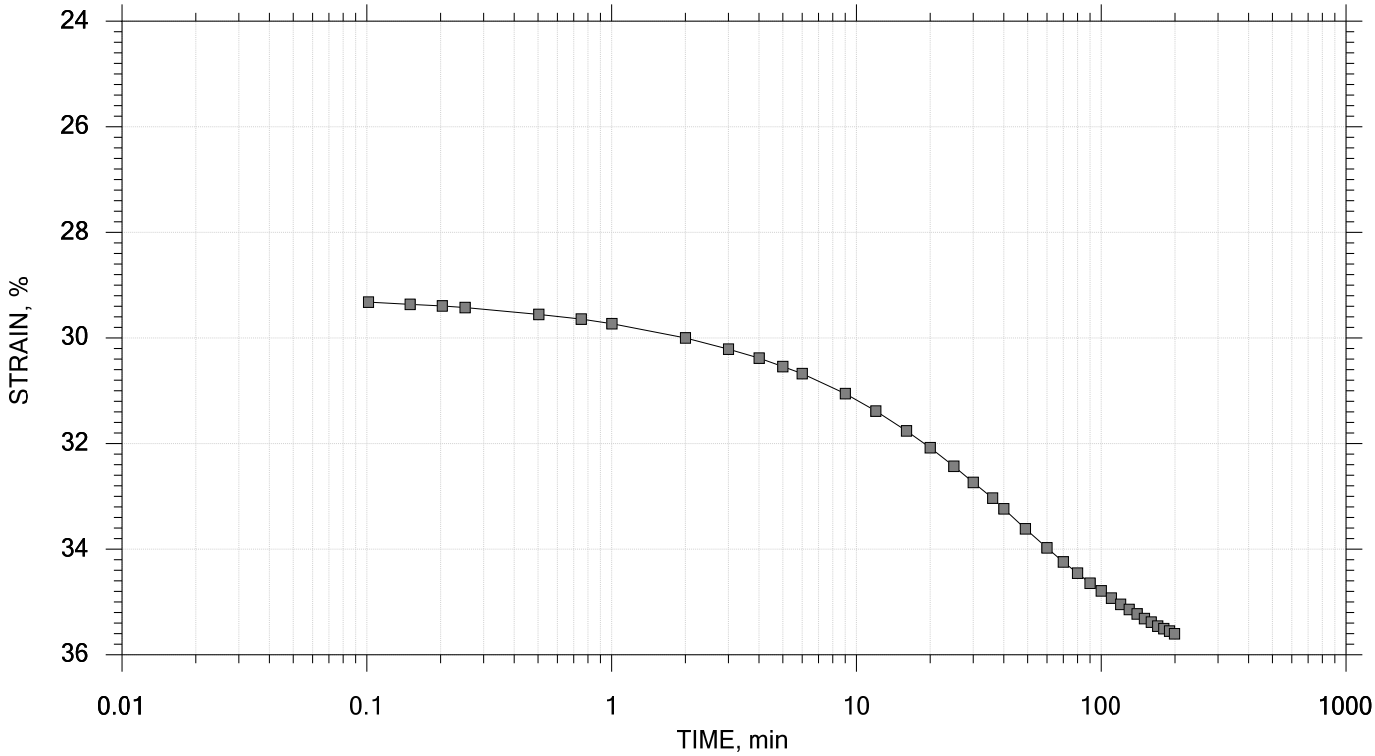
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

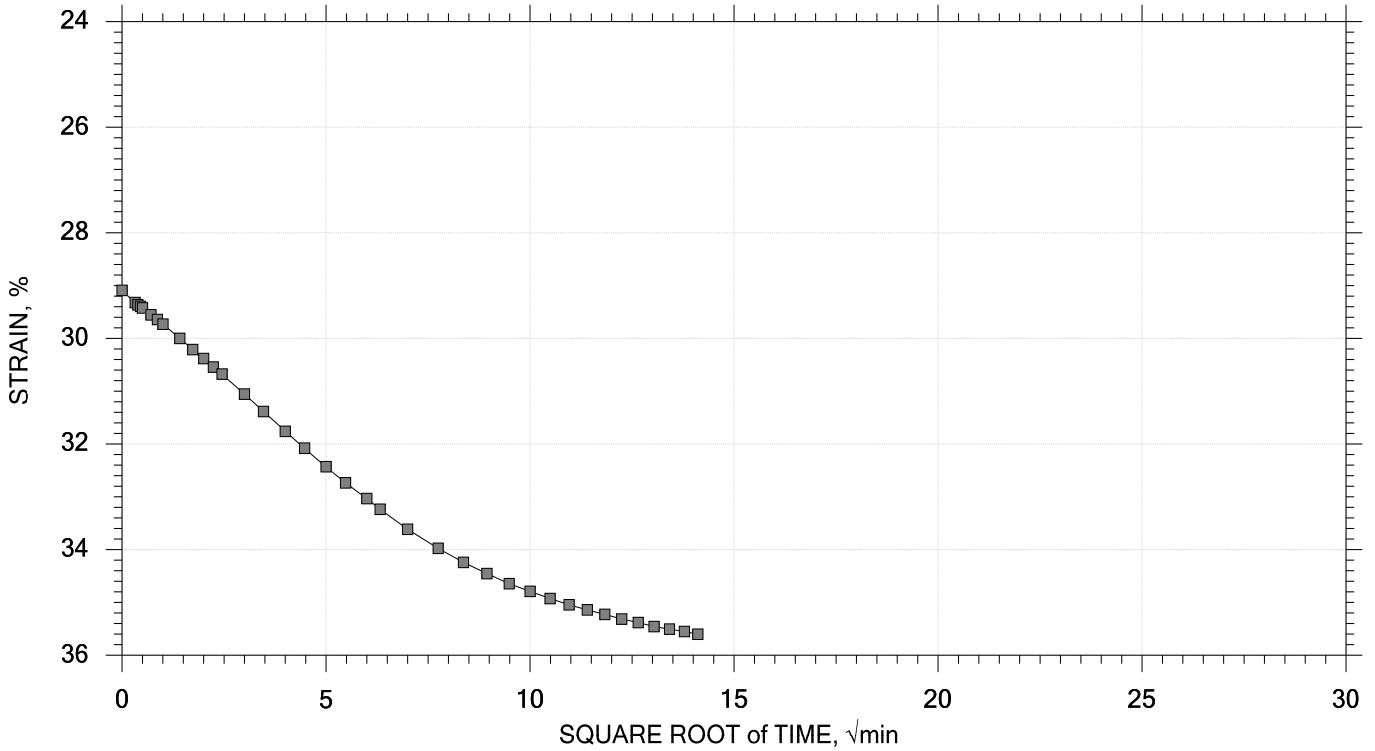
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 14 of 19

Stress: 16 tsf





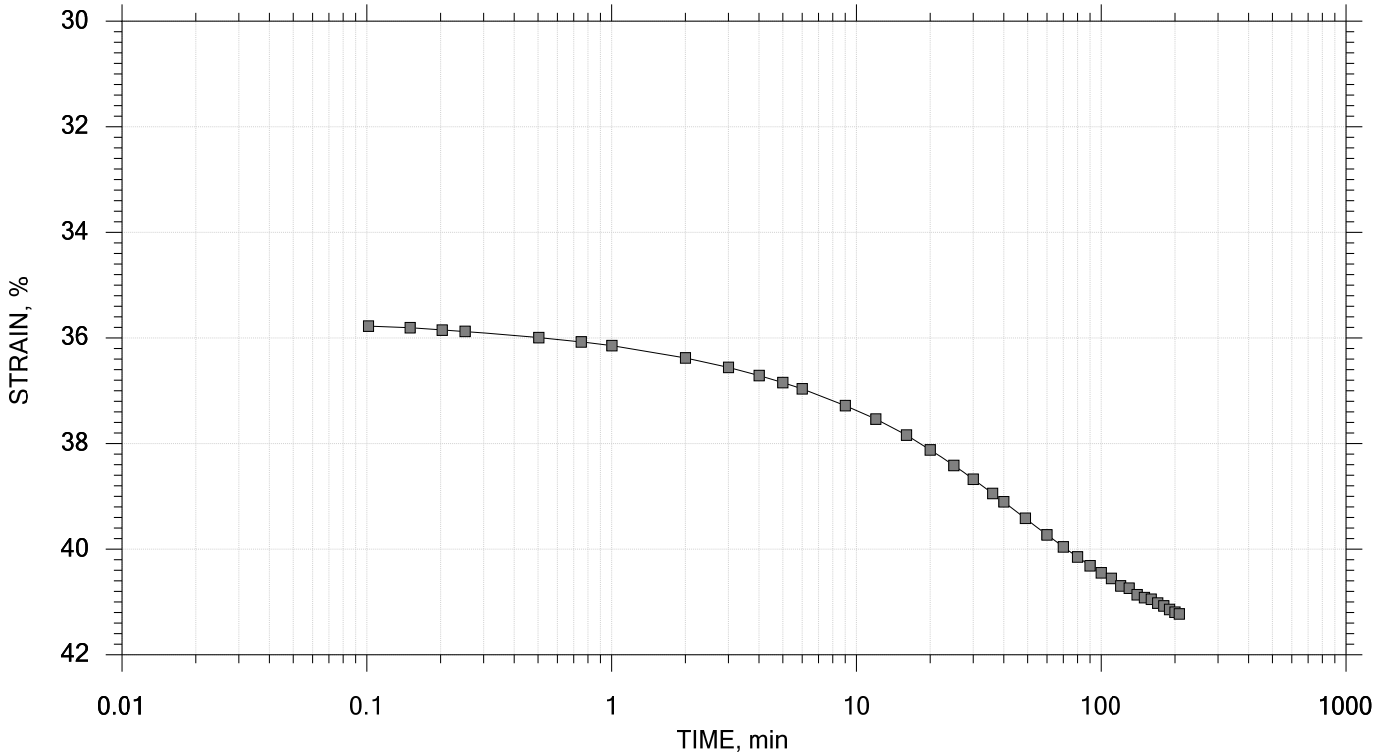
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

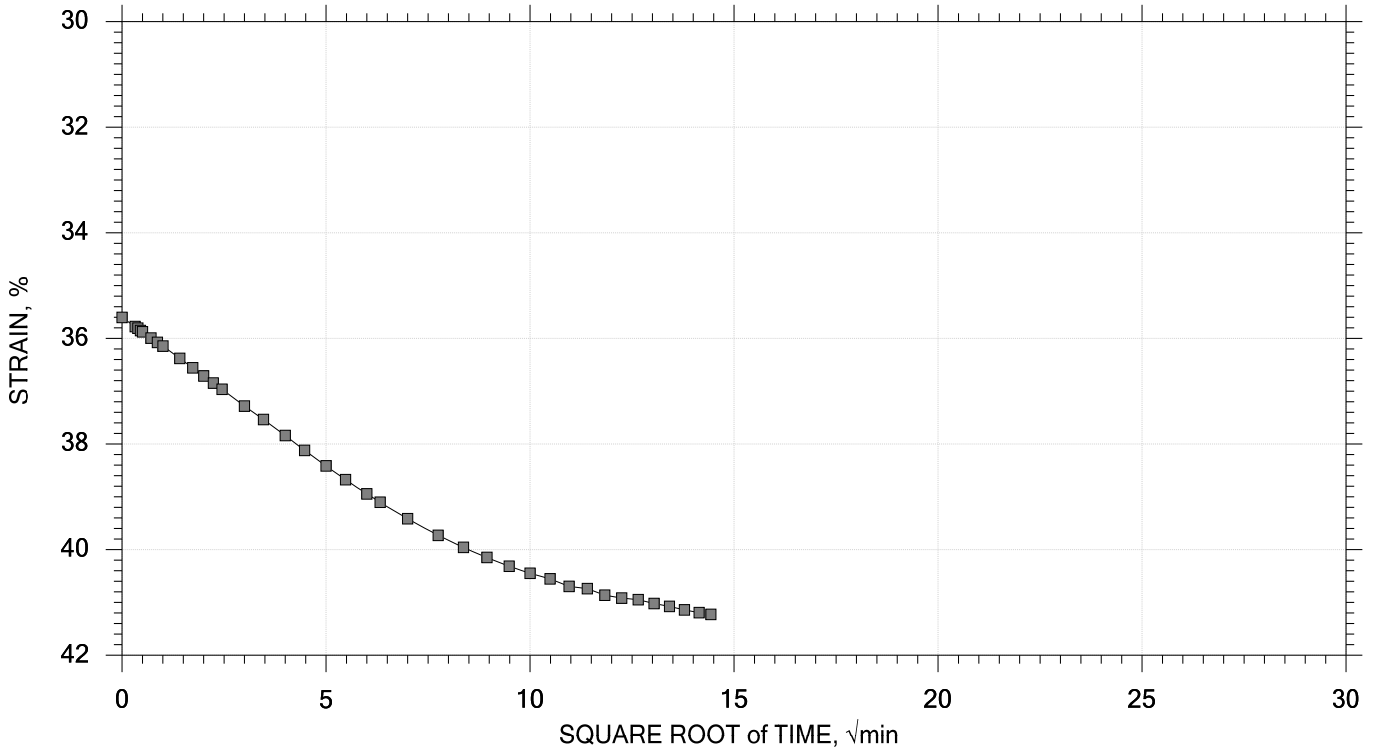
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 15 of 19

Stress: 32 tsf





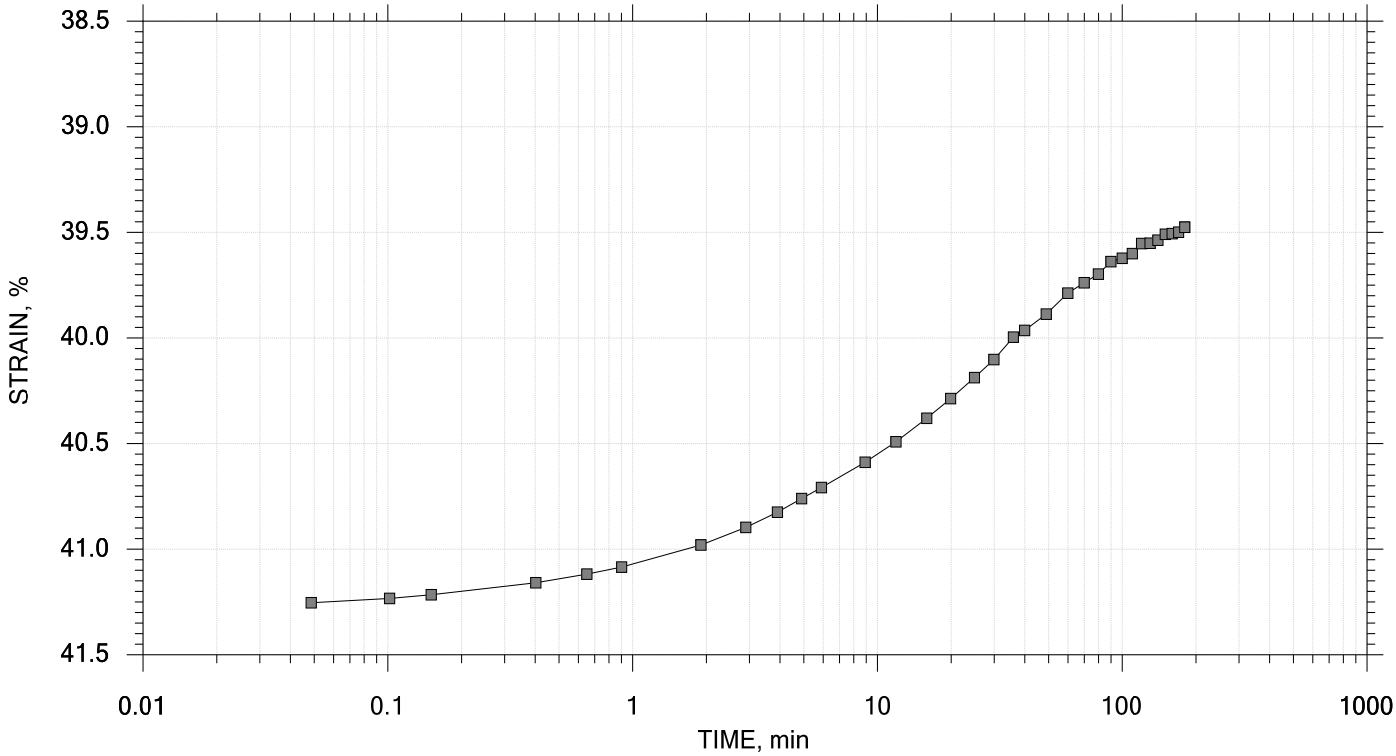
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

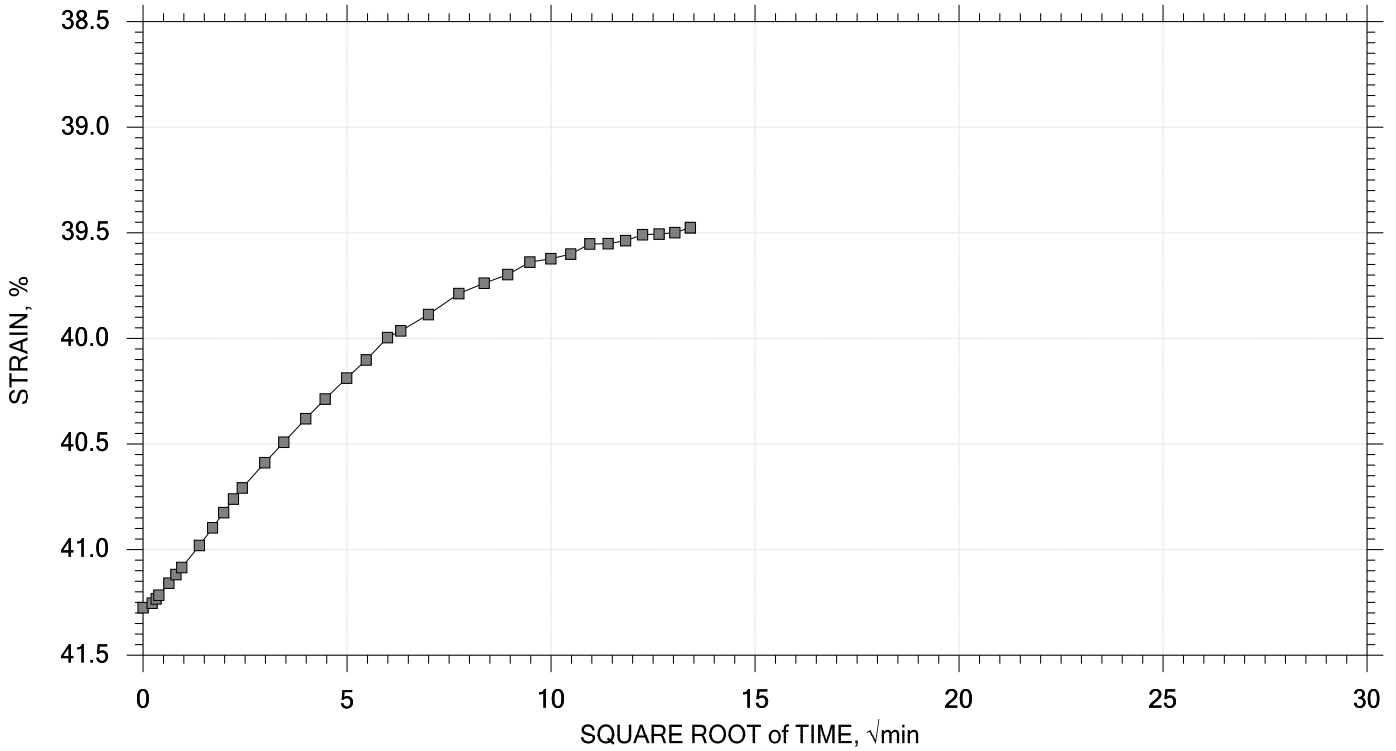
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 16 of 19

Stress: 8 tsf





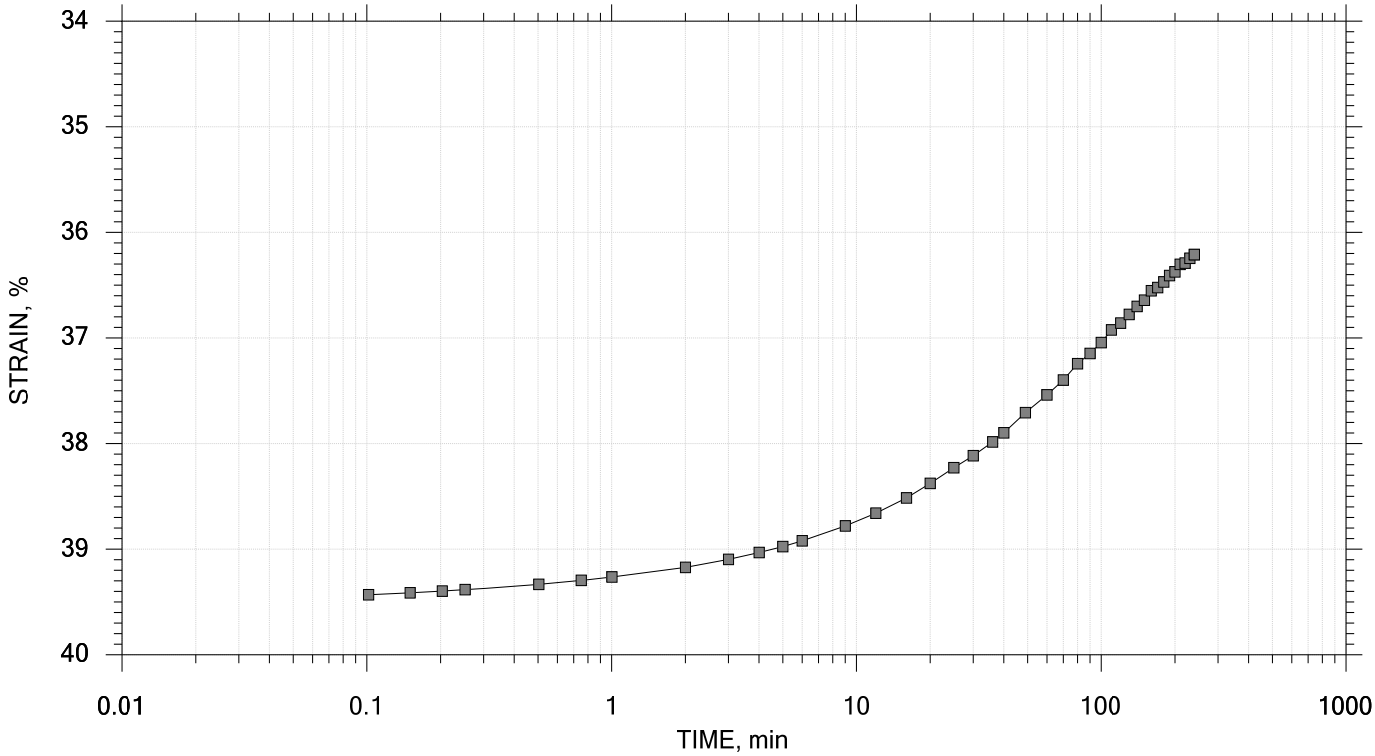
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

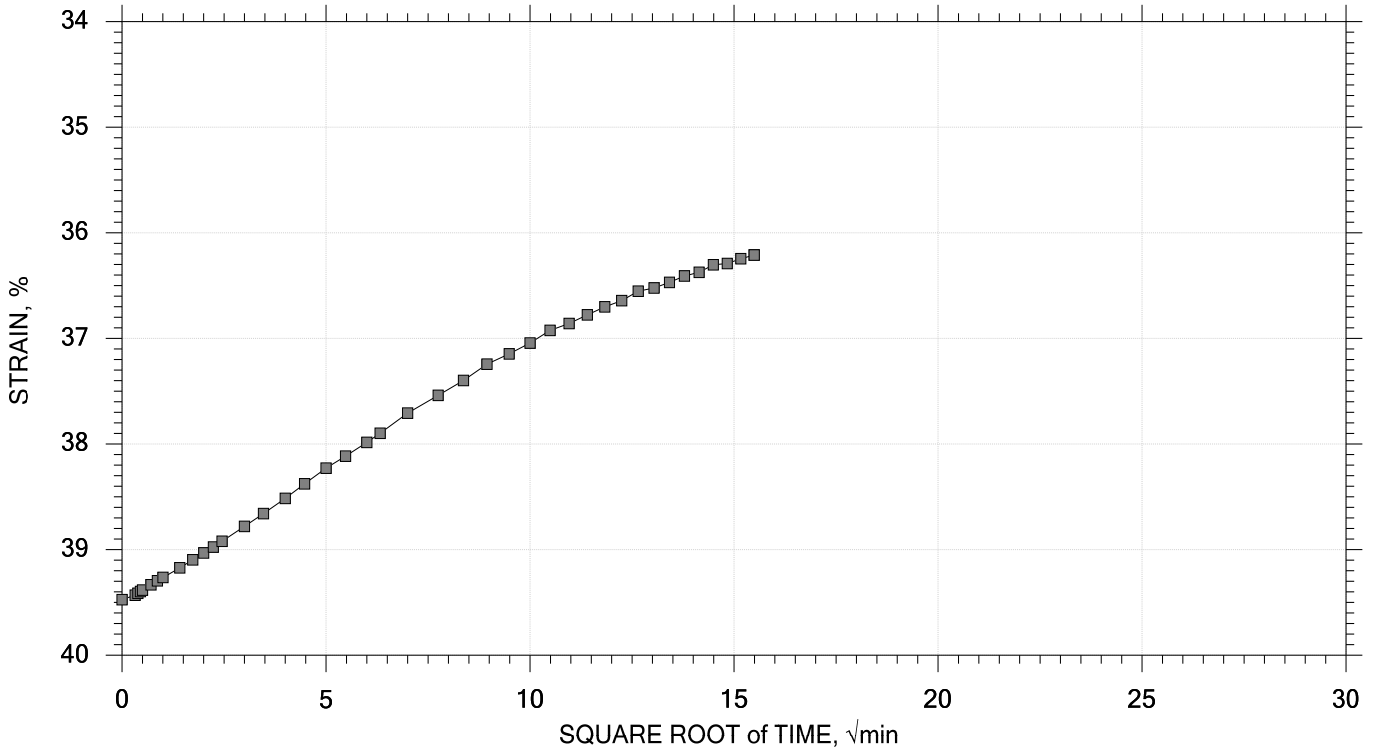
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 17 of 19

Stress: 2 tsf





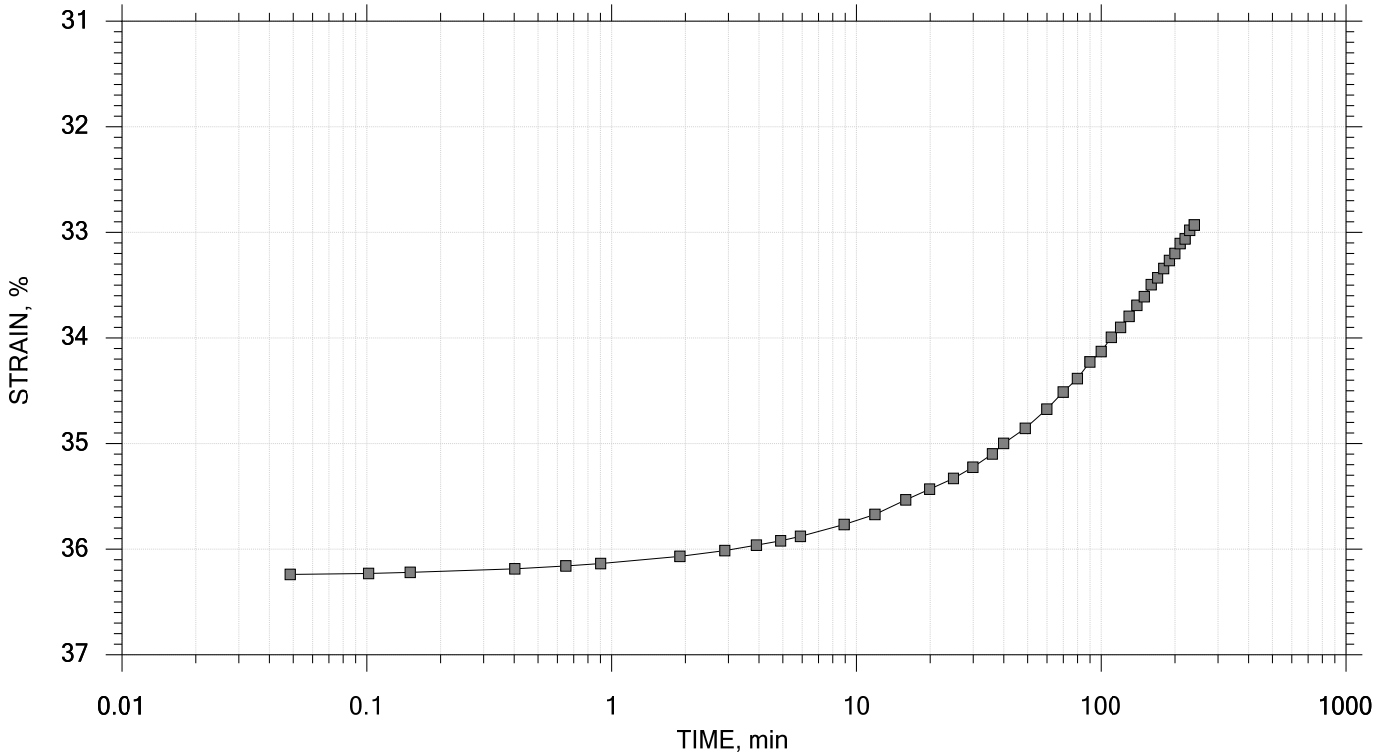
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

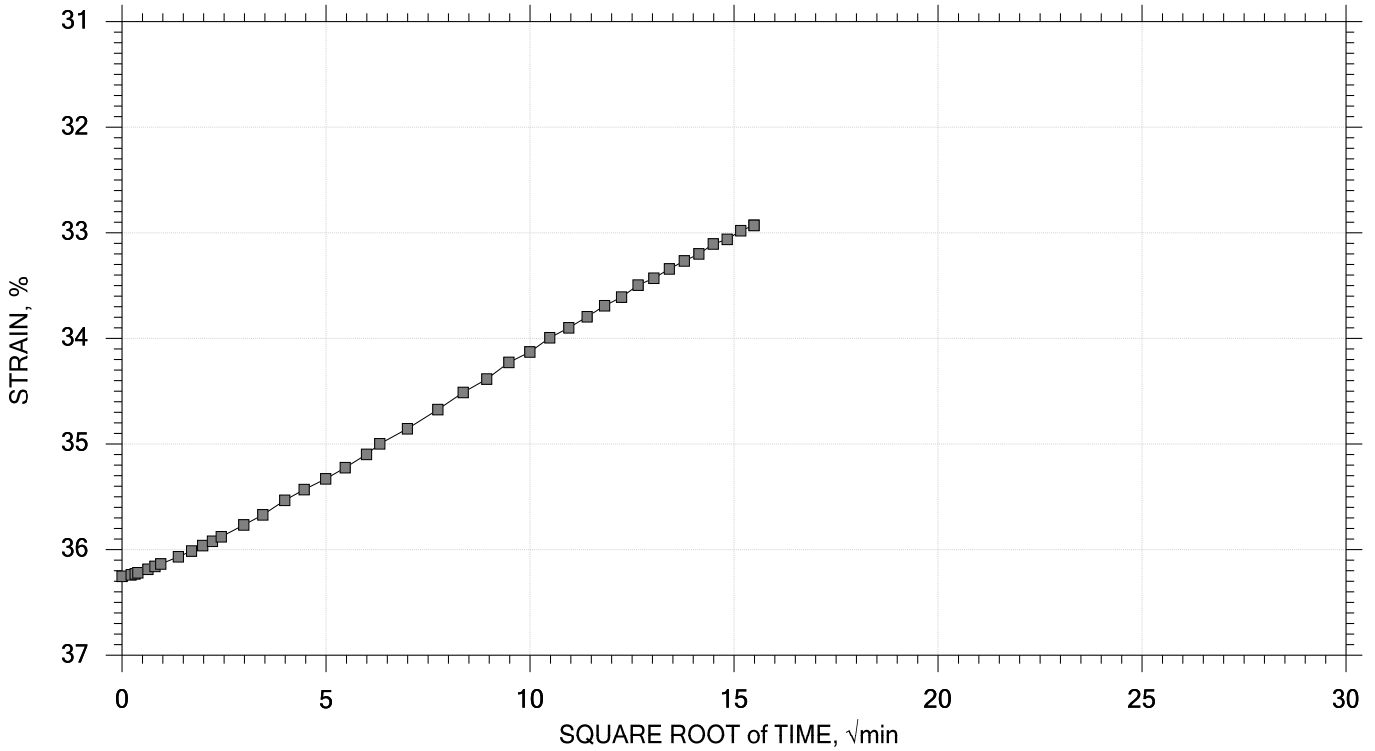
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 18 of 19

Stress: 0.5 tsf





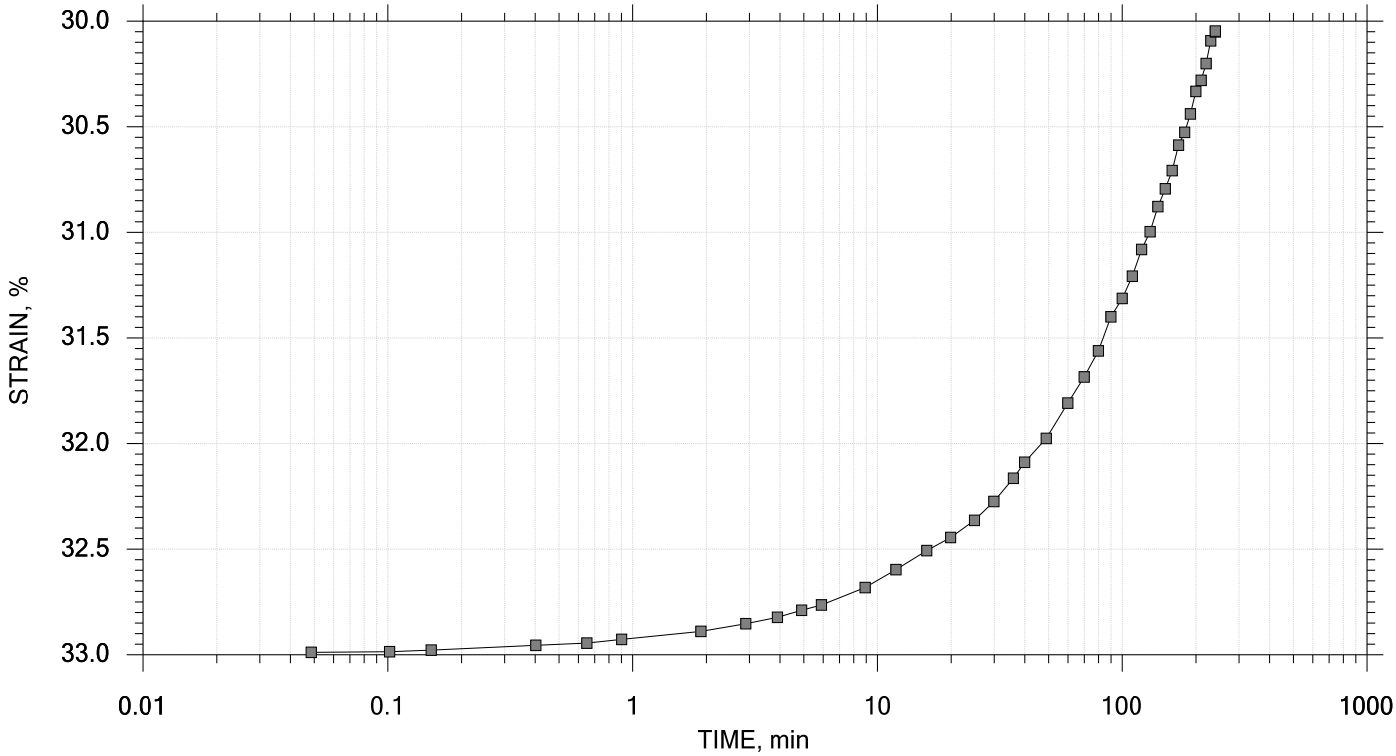
GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

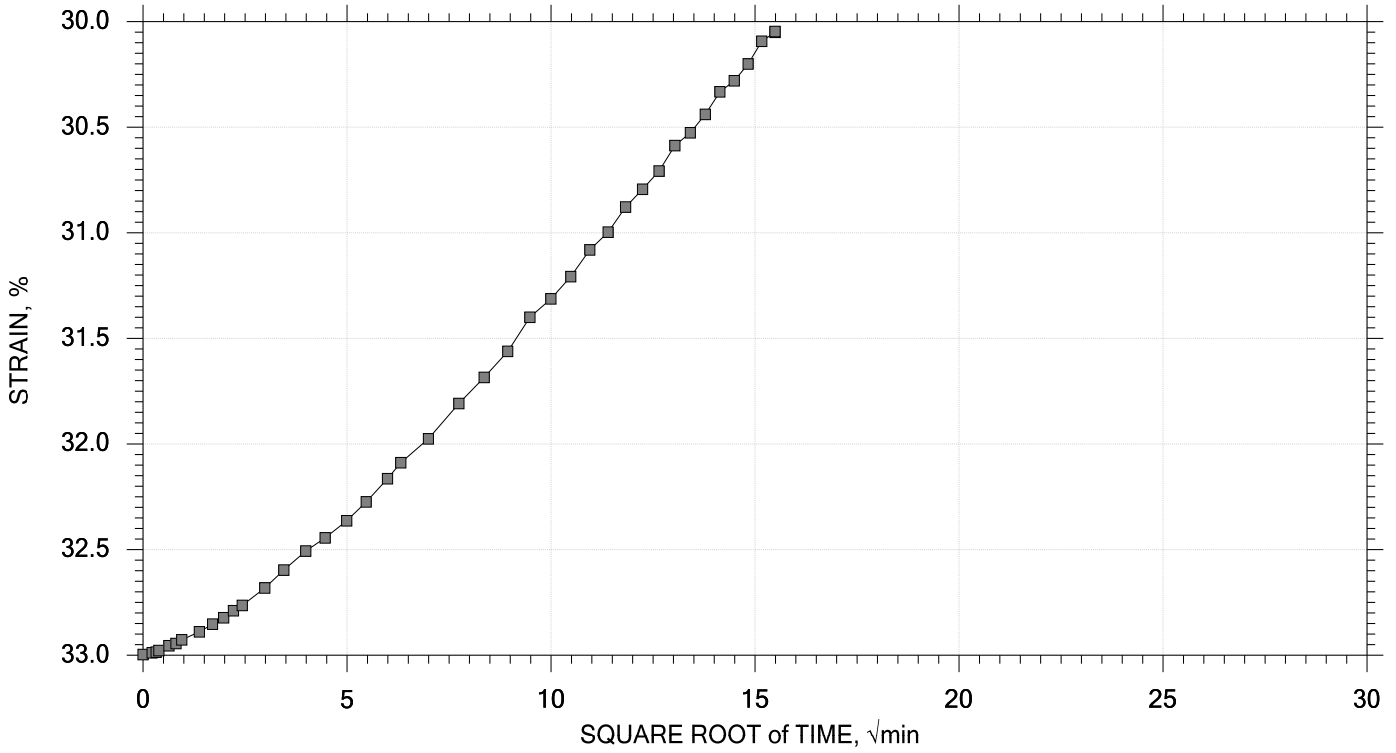
One-Dimensional Consolidation by ASTM D2435 - Method B

TIME CURVES

Constant Load Step 19 of 19

Stress: 0.125 tsf





GeoTesting EXPRESS	Project: Dynegy Hennepin West Ash Pond	Location: Hennepin, IL	Project No.: GTX-307445
	Boring No.: GS-B04	Tested By: jm	Checked By: mcm
	Sample No.: 9	Test Date: 12/18/17	Test No.: IP-3
	Depth: 33.5-35.5 f	Sample Type: intact	Elevation: ---
	Description: Moist, very dark gray clay		
	Remarks: System 5077, Swell Pressure = 0.0737 tsf		

Client:	Geosyntec Consultants		
Project Name:	Dynergy Hennepin West Ash Ponds		
Project Location:	Hennepin, IL		
GTX #:	GTX-307367		
Start Date:	12/15/2017	Tested By:	jm
End Date:	12/20/2017	Checked By:	mcm
Boring	GS-B01	Test #: K1	
Sample #:	3		
Depth:	5-7 ft		
Visual Description:	Moist, dark gray silty sand (ASH)		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084 Increasing Tailwater

Sample Type:	Intact	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	P2

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Moisture content determined at 60°C for ash.

Parameter	Initial	Final
Height, in	1.67	1.60
Diameter, in	2.81	2.79
Area, in^2	6.20	6.11
Volume, in^3	10.4	9.8
Mass, g	236	242
Bulk Density, pcf	87	94
Moisture Content, %	59.1	63.3
Dry Density, pcf	54.5	57.7
Degree of Saturation, %	---	96

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	84	Pressure Increment, psi:	3.8
Sample Pressure, psi:	80	B Coefficient:	0.95

FLOW DATA

Date	Trial #	Pressure, psi		Head readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	H_1	H_2	H_1-H_2						
12/19	1	84	80	42.0	40.5	1.5	15	10.3	2.0E-05	21	0.976	2.0E-05
12/19	2	84	80	40.5	39.0	1.5	15	10.0	2.1E-05	21	0.976	2.1E-05
12/19	3	84	80	39.0	37.5	1.5	15	9.6	2.2E-05	21	0.976	2.1E-05
12/19	4	84	80	37.5	36.0	1.5	15	9.2	2.3E-05	21	0.976	2.2E-05

PERMEABILITY AT 20° C: 2.1 x 10^{-5} cm/sec (@ 4 psi effective stress)

Client:	Geosyntec Consultants		
Project Name:	Dynergy Hennepin West Ash Ponds		
Project Location:	Hennepin, IL		
GTX #:	GTX-307367		
Start Date:	12/18/2017	Tested By:	jm
End Date:	12/21/2017	Checked By:	mcm
Boring	GS-B01	Test #:	K2
Sample #:	4		
Depth:	7.5-9.5 ft		
Visual Description:	Moist, dark gray silt (ASH)		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084 Increasing Tailwater

Sample Type:	Intact	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	P2

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Moisture content determined at 60°C for ash.

Parameter	Initial	Final
Height, in	2.23	2.07
Diameter, in	2.84	2.83
Area, in^2	6.33	6.29
Volume, in^3	14.1	13.0
Mass, g	359	351
Bulk Density, pcf	96	102
Moisture Content, %	49.9	46.6
Dry Density, pcf	64.3	69.8
Degree of Saturation, %	---	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	85	Pressure Increment, psi:	4.8
Sample Pressure, psi:	80	B Coefficient:	0.96

FLOW DATA

Date	Trial #	Pressure, psi		Head readings			Elapsed Time,	Gradient	Permeability K,	Temp,	R_t	Permeability K @ 20 °C,
		Cell	Sample	H_1	H_2	H_1-H_2	sec		cm/sec	°C		cm/sec
12/20	1	85	80	62.6	61.5	1.1	15	11.9	1.2E-05	21	0.976	1.2E-05
12/20	2	85	80	61.5	60.4	1.1	15	11.7	1.3E-05	21	0.976	1.2E-05
12/20	3	85	80	60.4	59.4	1.1	15	11.5	1.3E-05	21	0.976	1.2E-05
12/20	4	85	80	59.3	58.2	1.1	15	11.3	1.3E-05	21	0.976	1.3E-05

PERMEABILITY AT 20° C: 1.2 x 10^{-5} cm/sec (@ 5 psi effective stress)

Client:	Geosyntec Consultants		
Project Name:	Dynergy Hennepin West Ash Ponds		
Project Location:	Hennepin, IL		
GTX #:	GTX-307367		
Start Date:	12/15/2017	Tested By:	jm
End Date:	12/20/2017	Checked By:	mcm
Boring	GS-B02	Test #: K3	
Sample #:	1		
Depth:	5-7 ft		
Visual Description:	Moist, dark gray silty sand (ASH)		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084 Increasing Tailwater

Sample Type:	Intact	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	K5

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Moisture content determined at 60°C for ash.

Parameter	Initial	Final
Height, in	2.35	2.28
Diameter, in	2.81	2.78
Area, in^2	6.20	6.07
Volume, in^3	14.6	13.8
Mass, g	403	387
Bulk Density, pcf	105	106
Moisture Content, %	47.4	41.8
Dry Density, pcf	71.3	75.0
Degree of Saturation, %	---	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	84	Pressure Increment, psi:	3.8
Sample Pressure, psi:	80	B Coefficient:	0.95

FLOW DATA

Date	Trial #	Pressure, psi		Head readings			Elapsed Time,	Gradient	Permeability K,	Temp,	R_t	Permeability K @ 20 °C,
		Cell	Sample	H_1	H_2	H_1-H_2	sec		cm/sec	°C		cm/sec
12/19	2	84	80	42.3	41.6	0.7	30	7.3	6.7E-06	21	0.976	6.5E-06
12/19	3	84	80	41.6	40.9	0.7	30	7.2	6.8E-06	21	0.976	6.6E-06
12/19	4	84	80	40.9	40.2	0.7	30	7.1	6.9E-06	21	0.976	6.8E-06
12/19	5	84	80	40.2	39.5	0.7	30	6.9	7.0E-06	21	0.976	6.9E-06

PERMEABILITY AT 20° C: 6.7 x 10^{-6} cm/sec (@ 4 psi effective stress)

Client:	Geosyntec Consultants		
Project Name:	Dynergy Hennepin West Ash Ponds		
Project Location:	Hennepin, IL		
GTX #:	GTX-307367		
Start Date:	12/15/2017	Tested By:	jm
End Date:	12/21/2017	Checked By:	mcm
Boring	GS-B02	Test #:	K4
Sample #:	2		
Depth:	7-9 ft		
Visual Description:	Moist, dark gray silt (ASH)		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084 Increasing Tailwater

Sample Type:	Intact	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	K5

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Moisture content determined at 60°C for ash.

Parameter	Initial	Final
Height, in	2.24	2.15
Diameter, in	2.82	2.82
Area, in^2	6.25	6.25
Volume, in^3	14.0	13.4
Mass, g	367	360
Bulk Density, pcf	100	102
Moisture Content, %	53.9	51.0
Dry Density, pcf	64.9	67.6
Degree of Saturation, %	---	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	84	Pressure Increment, psi:	3.8
Sample Pressure, psi:	80	B Coefficient:	0.95

FLOW DATA

Date	Trial #	Pressure, psi		Head readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	H_1	H_2	H_1-H_2						
12/20	2	85	80	37.8	37.1	0.7	15	6.9	1.4E-05	21	0.976	1.3E-05
12/20	3	85	80	37.1	36.4	0.7	15	6.8	1.4E-05	21	0.976	1.4E-05
12/20	4	85	80	36.4	35.7	0.7	15	6.7	1.4E-05	21	0.976	1.4E-05
12/20	5	85	80	35.7	35.0	0.7	15	6.5	1.5E-05	21	0.976	1.4E-05

PERMEABILITY AT 20° C: 1.4 x 10^{-5} cm/sec (@ 5 psi effective stress)

Client:	Geosyntec Consultants		
Project Name:	Dynergy Hennepin West Ash Ponds		
Project Location:	Hennepin, IL		
GTX #:	GTX-307367		
Start Date:	12/15/2017	Tested By:	jm
End Date:	12/19/2017	Checked By:	mcm
Boring	GS-P07	Test #: K5	
Sample #:	10		
Depth:	18-20 ft		
Visual Description:	Moist, very dark gray sandy clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084 Increasing Tailwater

Sample Type:	Intact	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	P6

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content.

Parameter	Initial	Final
Height, in	1.98	1.90
Diameter, in	2.80	2.80
Area, in^2	6.16	6.16
Volume, in^3	12.2	11.7
Mass, g	388	375
Bulk Density, pcf	121	122
Moisture Content, %	33.5	28.7
Dry Density, pcf	90.8	94.6
Degree of Saturation, %	---	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	85	Pressure Increment, psi:	4.8
Sample Pressure, psi:	80	B Coefficient:	0.95

FLOW DATA

Date	Trial #	Pressure, psi		Head readings			Elapsed Time,	Gradient	Permeability K,	Temp,		Permeability K @ 20 °C,
		Cell	Sample	H_1	H_2	H_1-H_2	sec		cm/sec	°C	R_t	cm/sec
12/18	2	90.5	80	152.9	151.6	1.3	1920	31.7	4.4E-08	21	0.976	4.3E-08
12/18	3	90.5	80	151.6	150.0	1.6	2400	31.4	4.4E-08	21	0.976	4.3E-08
12/18	4	90.5	80	150.0	148.5	1.5	2040	31.1	4.9E-08	21	0.976	4.8E-08
12/18	5	90.5	80	148.5	147.2	1.3	1860	30.8	4.7E-08	21	0.976	4.6E-08

PERMEABILITY AT 20° C: 4.5 x 10^{-8} cm/sec (@ 10.5 psi effective stress)

Client:	Geosyntec Consultants		
Project Name:	Dynergy Hennepin West Ash Ponds		
Project Location:	Hennepin, IL		
GTX #:	GTX-307367		
Start Date:	12/15/2017	Tested By:	jm
End Date:	12/19/2017	Checked By:	mcm
Boring	GS-P08	Test #:	K6
Sample #:	9		
Depth:	15-18 ft		
Visual Description:	Moist, very dark gray clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084 Increasing Tailwater

Sample Type:	Intact	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	P6

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content.

Parameter	Initial	Final
Height, in	2.17	2.11
Diameter, in	2.82	2.82
Area, in^2	6.25	6.25
Volume, in^3	13.6	13.2
Mass, g	407	400
Bulk Density, pcf	114	116
Moisture Content, %	37.6	35.4
Dry Density, pcf	83.0	85.3
Degree of Saturation, %	---	98

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	85	Pressure Increment, psi:	4.8
Sample Pressure, psi:	80	B Coefficient:	0.95

FLOW DATA

Date	Trial #	Pressure, psi		Head readings			Elapsed Time,	Gradient	Permeability K,	Temp,	R_t	Permeability K @ 20 °C,
		Cell	Sample	H_1	H_2	H_1-H_2	sec		cm/sec	°C		cm/sec
12/18	3	89.5	80	155.2	154.8	0.4	360	29.0	7.8E-08	21	0.976	7.6E-08
12/18	4	89.5	80	154.8	154.4	0.4	360	28.9	7.8E-08	21	0.976	7.6E-08
12/18	5	89.5	80	154.4	153.9	0.5	480	28.8	7.3E-08	21	0.976	7.1E-08
12/18	6	89.5	80	153.9	152.9	1.0	900	28.7	7.8E-08	21	0.976	7.6E-08

PERMEABILITY AT 20° C: 7.5 x 10^{-8} cm/sec (@ 9.5 psi effective stress)

APPENDIX F

ISGS Water Well Log

ILLINOIS STATE GEOLOGICAL SURVEY

Irrigation Well	Top	Bottom
gravel	0	4
gravel & boulders	4	18
12-25 slot sand	18	26
gravel & boulders	26	33
1/8" - 1" gravel, no fines	33	80
20-60 slot sand	80	83
shale at	83	83
Total Depth		**83**

Casing: 12" STEEL from 0' to 62'
12" STAINLESS STL SCREEN from 62' to 82'

Screen: 20' of 12" diameter 80 slot

Grout: BENTONITE from 0 to 20.

Grout: #2 MUSCATINE from 20 to 82.

Water from sand at 33' to 82'.
Static level 13' below casing top which is 2' above GL
Pumping level 20' when pumping at 50 gpm for 1 hour

Permanent pump installed at 60'

Remarks: est yield 50 gpm w/air, PICS 15534260 #7

Owner Address: R.R. 1 Box 200A Hennepin, IL

Address of well: same as above

Location source: Location from permit

Permit Date: August 9, 2004 **Permit #:**

COMPANY Harold Dean Albrecht

FARM Dynegy Midwest-Hennepin Power

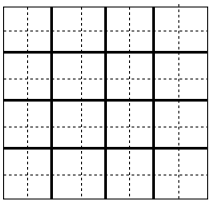
DATE DRILLED August 11, 2004 **NO.**

ELEVATION 0 **COUNTY NO.** 20702

LOCATION NE NW SW

LATITUDE 41.296294 **LONGITUDE** -89.335163

COUNTY Putnam **API 121552070200** **27 - 33N - 2W**



APPENDIX I
PUBLIC NOTIFICATION AND PUBLIC MEETING CERTIFICATION (845.220(a)(9))

Dynegy Midwest Generation, Inc.
1500 Eastport Plaza Drive
Collinsville, IL 62234

April 24, 2025

Illinois Environmental Protection Agency
DWPC – Permits MC # 15
ATTN: Part 845 Coal Combustion Residual Rule Submittal
2520 West Iles
Springfield, IL 62794-9276

Re: 35 IAC 845.220(a)(9) Certification Statement
Hennepin Power Plant; West Ash Pond (IEPA ID # W1550100002-01-03)

Dear Mr. Darin LeCrone:

For the above-refenced CCR surface impoundments and in accordance with 35 IAC 845.220(a)(9), Dynegy Midwest Generation, Inc. certifies that the public notification and public meetings required under 35 IAC 845.240 were completed. Please find enclosed both the public meeting summary and listserv.

Sincerely,
Dynegy Midwest Generation, Inc.

Dianna Tickner, PE, PMP
Senior Director, Demolition and Decommission

Hennepin Public Meeting Summary, April 8, 2025

On March 9, 2025, Dynegy Midwest Generation, LLC ("Dynegy") made available to the public its proposed plans to implement corrective action at the previously closed West Ash Pond System (WAPS) located at the Hennepin Power Plant. On Tuesday, April 8, 2025 Dynegy held in-person public meetings at 3:00 pm and 5:00 pm at the AmericInn Lodge & Suites in Princeton, IL to present its decision-making process. A discussion of the corrective measures assessment and corrective action alternatives analysis, including an objective comparison of pros and cons and projected groundwater impacts for each of the alternatives, was presented at these meetings. During the question-and-answer portion of the meetings, the public asked questions relating to the proposed remedial measures which the company addressed. As required by Section 845.240(g), this document provides a general summary of the issues or comments raised by the public relating to the closure, a summary of the company's responses to those issues or comments, and a summary of any revisions or changes made to the proposed corrective action as a result of issues and comments raised by the public. All questions asked during the meeting were addressed. This document also provides as required by 845.240(f)(3), written responses to subsequent questions posed following the meeting.

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
1.	Closure Method	The purpose of the current public meeting is to discuss the corrective action evaluation for groundwater remediation at the West Ash Pond System. The West Ash Pond System was previously closed and capped in 2020 with IEPA approval. The final closure system meets the cover design requirements of Part 845 and Federal Part 257. The approved closure method included protecting the ash pond from flood events, such as armoring the pond with rip rap for protective measures.	The final closure system includes riprap armoring on the exterior dikes adjacent to the Illinois River. The riprap armoring was designed based on calculated floodwater velocities. No adverse affects to the completed closure have been observed.
2.	Groundwater Impacts and Monitoring	A risk assessment confirmed that the ash pond is not adversely impacting human health and the environment; specifically the ash pond is not negatively impacting the river habitat and does not present a risk to river users. No potable water wells are impacted. The corrective action will reduce, to the maximum extent feasible, further releases and minimize further migration of CCR-derived constituents in groundwater until	

		the groundwater quality standards are achieved. Adaptive site management action will be taken if the remedy performance does not correspond with the expected performance. Groundwater is required to be monitored quarterly for a minimum of 30 years beginning after closure to ensure conditions are as anticipated. Groundwater monitoring will continue until groundwater quality standards are met.	
3.	Corrective Action Plan	Corrective action will consist of supplementing the completed source control (IEPA approved ash pond closure) through the installation of a vertically- and laterally-continuous, permanent, and low-permeability deep cutoff wall that will extend from the perimeter dikes of the West Ash Pond System into low-permeability bedrock beneath. This will result in the CCR within the West Ash Pond System being physically isolated from the environment on all sides by a permanent barrier, including the final cover system on the surface, the cutoff wall laterally, and competent shale bedrock below the ash pond. The proposed cutoff wall would prevent impacts from high river elevations. Cutoff walls are widely used and a common technology used for corrective action. Additional information and drawings are provided in the draft corrective action plan previously posted on Dynegy's publicly accessible website (noted below).	There is no evidence that bentonite clay cutoff walls degrade or "wear out" over time, due to the material being a blend of natural, inert, soil components. The chemicals of concern at West Ash Pond System are inorganic and do not affect soil properties or permeability of the bentonite mixture that will be utilized in the cutoff wall. Upgradient groundwater monitoring has not detected any chemicals of concerns that would impact the performance of the cutoff wall. The surrounding soils vary from clays to sands, and are compatible with the cutoff wall. The target hydraulic conductivity for the cutoff wall will be $1x10^{-7}$ cm/sec. This is approximately 120,000 times (5 orders of magnitude) lower than that of the surrounding aquifer materials (1.2×10^{-2} cm/sec for the gravel deposits). This will result in the wall having an appropriately lower hydraulic conductivity to function as a lateral barrier. During construction of the deep cutoff wall portion of the remedy, Dynegy will

			implement a construction quality control and quality assurance continual monitoring and testing of the actual slurry materials to verify that the as-installed deep cutoff wall will perform as in accordance with the proposed design. Additional information on this QA/QC program will be added to the Construction Permit Application for the WAPS.
4.	Working with IEPA	Dynegy has met all the required Part 845 deadlines for corrective action and public meeting notification. Prior closure of the West Ash Pond System was done with approval from IEPA. Dynegy has submitted an operating permit application under Part 845 in 2021. No permit has been issued yet.	
5.	More Information	Additional information about the items discussed in this Public Meeting can be found online. Data and documents for compliance with the Illinois CCR Rule: www.luminant.com/ccr/illinois-ccr/	

In accordance with 845.240(f)(4), a list of people who requested to be added to the IEPA Listserv from the Hennepin public meeting held on April 8, 2025, are as follows:

Name	**Email address**
Robert Hamann	roberthamann@sbcglobal.net
Robert Rowe	Rowe@bradley.edu
Dawn Neubaum	dawn.neubaum@yahoo.com
Donna Blomquest	herecrookshanks@hotmail.com
Brittany Blomquest	et.alibi@gmail.com
Mike Silver	michaelsilver@uccenvironmental.com
Kathie Brown	kbrown@greaterpeoriaedc.org
Joyce Blumenshine	joblumen@yahoo.com
Dana Collins	ndana@comcast.net
Uylaine Barringer	uylaine@frontier.com
Tracy Fox	tracy@tracyfox.com

APPENDIX J
CONTRACTOR TRAINING CERTIFICATION
(45 ILCS 5/22.59(b)(4))

Dianna Tickner
Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

May 6, 2025

Illinois Environmental Protection Agency
DWPC – Permits MC # 15
ATTN: Part 845 Coal Combustion Residual Rule Submittal
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Re: 415 ILCS 5/22.59(b)(4) Certification Statement
Hennepin Power Plant West Ash Pond (IEPA ID # W1550100002-01-03)

Dear Mr. Darin LeCrone:

For the above-refenced CCR surface impoundments and in accordance with 415 ILCS 5/22.59(b)(4), Dynegy Midwest Generation, LLC certify that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment will be participants in a training program that is approved by and registered with the US Department of Labor's Employment and Training Administration and that includes instruction in the following: erosion control, environmental remediation, operation of heavy equipment and excavation.

Sincerely,
Dynegy Midwest Generation, LLC

Dianna Tickner
Sr Director, Decommissioning &
Demolition